# PROJECT MANUAL

## Issued for Permit

**21 November 2025**

**Volume 2**

# Oakton College

## Adjacencies Renovations – Phase 2a

## Des Plaines, Illinois

**Perkins&Will Project Number: 021075.000**

Perkins&Will

410 N. Michigan Avenue, Suite 1600, Chicago, IL 60611 | 312.755.0770

**DOCUMENT 00 01 07**

**PROFESSIONAL SEALS PAGE**

The following Specification Sections have been prepared by or under the direct supervision of the Mechanical/Electrical/Plumbing Engineer:


**MECHANICAL/ELECTRICAL/PLUMBING ENGINEER**
Mechanical Services Assoc. Corp.
111 S. Virginia St.
Crystal Lake, IL
815.788.8901

**DIVISION 21 – FIRE PROTECTION**

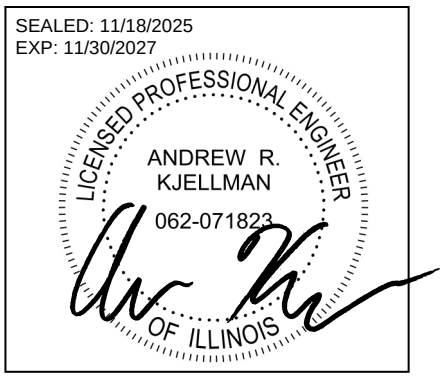
| | |
|---|---|
| 21 00 00 | General Requirements for Fire Suppression |
| 21 05 00 | Common Work Results for Fire Suppression |
| 21 05 29 | Hangers and Supports for Fire Suppression Piping and Equipment |
| 21 05 53 | Identification for Fire Suppression Piping and Equipment |
| 21 13 13 | Wet-Pipe Sprinkler Systems |

**DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)**

| | |
|---|---|
| 23 00 00 | General Requirements for Heating, Ventilating and Air Conditioning |
| 23 05 00 | Common Work Results for HVAC |
| 23 05 29 | Hangers and Supports for HVAC Piping and Equipment |
| 23 05 48 | Vibration Controls for HVAC Piping and Equipment |
| 23 05 53 | Identification for HVAC Piping and Equipment |
| 23 05 93 | Testing, Adjusting, and Balancing for HVAC |
| 23 07 13 | Duct Insulation |
| 23 09 00 | Instrumentation and Control for HVAC |
| 23 09 93 | Sequence of Operations for HVAC Controls |
| 23 31 13 | Metal Ducts |
| 23 33 00 | Air Duct Accessories |
| 23 36 00 | Air Terminal Units |
| 23 37 13 | Diffusers, Registers, and Grilles |

**DIVISION 26 – ELECTRICAL**

| | |
|---|---|
| 26 00 00 | Electrical, General |
| 26 05 00 | Common Work Results for Electrical |
| 26 05 19 | Low-Voltage Electrical Power Conductors and Cables |
| 26 05 23 | Control-Voltage Electrical Power Cables |
| 26 05 26 | Grounding and Bonding for Electrical Systems |
| 26 05 29 | Hangers and Supports for Electrical Systems |
| 26 05 33 | Raceway and Boxes for Electrical Systems |
| 26 05 53 | Identification for Electrical Systems |
| 26 09 23 | Lighting Control Devices |
| 26 22 00 | Low-Voltage Transformers |
| 26 24 16 | Panelboards |
| 26 27 26 | Wiring Devices |
| 26 28 16 | Enclosed Switches and Circuit Breakers |
| 26 29 13 | Enclosed Controllers |
| 26 43 13 | Surge Protective Devices |
| 26 51 00 | Interior Lighting |




**DIVISION 27 – COMMUNICATIONS**

| | |
|---|---|
| 27 05 00 | Common Work Results for Communications |
| 27 11 00 | Communications Equipment Room Fittings |
| 27 13 00 | Communications Backbone Cabling |
| 27 15 00 | Communications Horizontal Cabling |
| 27 51 16 | Public Address System |
| 27 51 19 | Local Audio and Video Systems |

**DIVISION 28 – ELECTRONIC SAFETY AND SECURITY**

| | |
|---|---|
| 28 05 00 | Common Work Results for Electronic Safety and Security |
| 28 05 13 | Conductors and Cables for Electronic Safety and Security |
| 28 31 11 | Fire-Alarm and Voice-Notification System |

**END OF DOCUMENT**

# SECTION 21 00 00

# GENERAL REQUIREMENTS FOR FIRE SUPPRESSION

## PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work includes the furnishing of all materials, supplies, labor, equipment, tools, transportation, facilities and services necessary for and required in connection with or properly incidental to all work, as shown on the drawings and specified herein or reasonably implied therefore. Contractor shall be responsible for his own required cutting and patching. Contact utility companies, municipal agencies and J.U.L.I.E. services.

B. Accomplish necessary demolition and removal work, including but not limited to piping.

C. Contractor shall provide all temporary services required to maintain normal building operation during construction. Temporary interruption of services shall occur during non-school hours. Contractor shall be solely responsible for determining construction sequencing and shall include all costs required for maintaining fire protection services to entire facility.

D. Include in the Bid all costs for system testing.

1.2 DRAWINGS

A. Drawings for this work consist of area zoning plans and detailed drawings and diagrams to which will be added, during the period of construction any other detail drawings as may be necessary in the opinion of the Owner's representative to show the proper installation of various appliances or equipment. These drawings and diagrams show arrangement and size of connection and shall be considered as part of, and complementing the specifications. They shall be followed as closely as actual building construction will permit. For all locations of fixtures, partitions and all other details of construction, this contractor shall consult the architectural drawings before submitting his bid to make sure all equipment will fit in the assigned space. Failure to do so does not relieve this contractor from installing the system complete in all details as described and shown.

B. The drawings for this work accompanying these specifications are to be considered as an integral part of same and anything omitted from one and embodied in the other is to be considered essential to the requirements of the contract and must be furnished and installed by this contractor.

C. Should the drawings and specifications contradict each other, the matter should be referred to the Owner's representative for his interpretation and correction before signing the contract. Otherwise, this contractor shall be held responsible for and he shall meet the requirements without extra cost to the Owner.

1.3 QUALITY ASSURANCE

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

B. Standard and regulations: The work under these sections shall comply with the latest editions of the following applicable standards, in addition to local (city) and state codes:
   1. ASME: American Society of Mechanical Engineers
   2. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
   3. ACRI: Air Conditioning and Refrigeration Institute
   4. ASTM: American Society of Testing Materials
   5. ANSI: American National Standards Institute
   6. NFPA: National Fire Protection Association
   7. UL: Underwriter's Laboratories
   8. NEMA: National Electrical Manufacturers' Association
   9. NEC: National Electrical Code
   10. AGA: American Gas Association
   11. ISC: Illinois School Code 175 (supersedes 156A)
   12. ADA: Americans with Disabilities Act
   13. BOCA: Building Officials and Code Administrators
   14. IMC: International Fire Code
   15. IBC: International Building Code

C. Include all items of labor and material required to comply with such codes in accordance with the contract documents. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of code requirements, the specifications and/or drawings shall govern regardless of code requirements.

1.4 SUBMITTALS

A. At the completion of the work covered by this contract, this contractor shall be responsible for furnishing a complete set of certified as-built drawings showing the heating, ventilating, air conditioning, plumbing and fire protection work as it was actually installed so as to make a permanent record. As-builts shall be furnished to Owner electronically in AutoCAD format. As-builts shall be uniformly drafted at 1/4” scale.

1.5 SHOP DRAWINGS

A. Submit to the Owner’s representative copies of a list of the materials which he proposes to use in the execution of his contract. If any items are omitted from the list, such undeclared items shall be furnished strictly as specified. Provide manufacturer’s certified drawings for all equipment as herein specified.

B. Manufacturer’s standard drawings will be accepted for manufacturer's standard production items if verified for installation at the location noted. Shop drawings shall be made for all items of equipment specially fabricated for this contract. Installation drawings shall show, in detail, the work to be installed by this contractor and the clearances, spaces, provisions or requirements for the work of the other contractors. When phrase "by others" appears on shop drawings, indicate who is to furnish material or operations so marked.

C. Quarter-inch (1/4”) scale piping shop drawings and hydraulic calculations shall be submitted for review. Shop drawings shall contain all required installation information including, but not limited to:
   1. Bottom of pipe height.
   2. Pipe size, lengths.
   3. All fittings.
   4. Hangers and supports.
   5. Indicate all coordination conflicts with other trades.

D. Note: All equipment and piping shall be weather protected at all times. Non-protected material and equipment will be rejected and removed from the project without exception.

1.6 RULES AND REGULATIONS

A. All workmanship and materials shall conform and comply with the requirements of the building ordinances and rules and regulations of all departments and bureaus of the County and State of Illinois having lawful jurisdiction irrespective of any statements herein to the contrary.

B. All changes in the work of this contract which may be required by the said departments or bureaus or by the law or ordinances, when approved and ordered by the Owner's representative, shall be made by this contractor without extra cost to the Owner.

C. One final inspection will be conducted for completion of work after written notification from the contractor. Additional inspections will be conducted at the expense of the contractor.

1.7 MATERIALS AND WORKMANSHIP

A. All materials used throughout this installation shall be the best of their respective kind, and same shall be installed in a neat, accurate and workmanlike manner. This workmanship and these materials must be executed and furnished in a manner entirely satisfactory to the Owner's representative.

B. Wherever in the specifications a particular article or material is definitely mentioned, it shall be provided and no substitutions will be allowed, especially insofar as the submittal of the base bid is concerned. Should the contractor desire to substitute other materials for those specified, he may submit these substitutions in the form of alternates to the base bid designating appropriate additions or deductions for each alternate.

C. Final approval of all equipment will be by the Owner’s representative.

D. All materials used shall be asbestos free.

1.8 SUBSTANTIAL AND FINAL COMPLETION

A. The contractor shall provide written notification to the engineer that the project is substantially complete. The engineer will accomplish a substantial completion inspection and provide the contractor with a list of work requiring corrective action. Upon completion of the corrective work, the contractor shall provide written notice that all corrective work has been completed. The engineer will conduct an inspection of the corrective work. The contractor shall bear costs of correcting such work, including additional testing and inspections, and compensation for the engineer's services and expenses made necessary thereby.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

3.1 COORDINATION

A. It is presumed that the contractor has carefully examined the drawings and specifications for the entire work and the job conditions which will ensure before submitting his bid and has reported to the Owner's representative in writing any interferences or conflicts with his work.

B. If the contractor has failed to call such interferences or conflicts relative to his work and the drawings, specifications, the work of other contractors in the event of separate contracts and job conditions to the Owner's representative's attention in writing prior to execution of the contract, it will be presumed that no conflicts exist.

C. When conflicts arise during the construction period, they shall be immediately reported to the Owner's representative in writing and they will be subject to the Owner's representative's decision. Contractor shall submit coordinated 1/4-inch scale shop drawings. Drawings shall indicate multiple conduit runs.

3.2 PROJECT CONDITIONS

A. Existing Building Systems: Contractor shall provide all temporary services required to maintain all building systems in working order during construction. Temporary interruption of building systems shall only occur during non-school hours. Contractor shall be solely responsible for determining construction sequencing and shall include all costs required for maintaining all systems throughout the entire facility.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect at least two weeks in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with utility interruptions without Architect’s written permission.

3.3 COOPERATION OF CONTRACTORS

A. Each contractor, in laying out his work, shall cooperate with the other contractors on the work so as to avoid any interferences with their work. If this is not done, Owner's representative reserves the right to make such changes in the work as are necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the contractor.

3.4 JURISDICTION OF WORK

A. Where it becomes necessary for contractor in order to fulfill his contract to furnish labor or materials other than that which is generally accepted by trade agreement or general practice to belong to his particular trade or branches of work, the contractor shall submit same to subcontractor engaged in the type of work involved to the end that there will be no stoppage of work due to violations of trade agreements as to jurisdiction.

B. All cutting, patching, and fire safeing related to this contractor's work shall be accomplished by this contractor. All fire safeing material will be as directed by the architectural specification.

3.5 DEFECTIVE WORK AND MATERIALS

A. All materials or work found to be defective, or not in strict conformity with the drawings, or different from the requirements of the drawings and specifications, or defaced or injured through negligence of this contractor or his employees, or through the action of fire, shall immediately be removed from the premises by this contractor and satisfactory material and work substituted therefore without delay.

B. Any defective work or imperfect work which may be discovered shall be corrected immediately upon notice from the Owner's representative.

3.6 BASIS OF DESIGN

A. Contract documents have been designed using scheduled/specified equipment manufacturers. Use of a specified acceptable manufacturer that requires changes in design shall be completed by the contractor at no additional cost to the Owner.

3.7 COORDINATION AND COOPERATION

A. Coordinate the work with the other contractors on this project and also coordinate the work in this contract with the Local Authorities Having Jurisdiction.

B. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of all piping systems and equipment and the equipment shall be installed in proper sequence with other trades without any unnecessary delay.

C. Should it be necessary, detailed drawings of a proposed departure due to actual field conditions or other causes shall be submitted to the Owner's representative for approval.

D. Cover with all other contractors engaged in the construction of the project whose work may in any way affect his installation, and whenever interferences might

occur and before installing any of the work in question, this contractor shall consult with them as to the exact location and level of his piping and/or other parts of his equipment. This contractor shall be solely responsible for the proper arrangement of his piping and equipment.

3.8 ACCESS PANELS

A. Arrange piping so that all concealed valves and/or concealed equipment can be operated and/or properly maintained through access panels. Contractor shall be responsible for coordinating locations with architect. Contractor shall furnish and install proper number and rated access panels required for his work. Access panels shall be 18-inch x 18-inch or larger as required.

3.9 FIRE-STOPS

A. Penetrations through fire rated walls and floors shall be sealed to the original hourly fire rating with a fire-stop system capable of preventing the passage of flames and hot gases when subject to the requirements of the test standards specific for Fire-Stops ASTM E119 and E814 (UL 1479).

3.10 INSTRUCTIONS AND TRAINING

A. Each contractor shall instruct Owner's personnel in the operation and maintenance of equipment installed. In addition, each contractor shall furnish to Owner three (3) sets of typewritten instructions on the operation and maintenance of each piece of equipment. Each contractor shall also furnish to Owner three (3) sets of equipment maintenance and operations manuals for each item of equipment.

B. In addition to written instructions and manufacturer’s training requirements, the contractors shall provide field training sessions as follows:

| Contractor | Minimum No. of Sessions | Minimum Hours of Instruction |
|---|---|---|
| Sprinkler | 1 | 4 |

C. Training session scheduling requests shall be presented to Owner’s representatives a minimum of seven days prior to date for scheduling of all Owner’s personnel.

D. For each session, the contractor shall submit a training session log prepared by the contractor and signed by the Owner and contractor, certifying that the above has been satisfactorily completed and that the Owner’s operations manuals and written instruction were on hand at the time of the session.

E. All training sessions shall be video taped by the contractor and two copies shall be given to the Owner.

F. The training sessions shall be coordinated by the contractor to avoid numerous trips by Owner’s personnel. Training should be combined when possible.

**END OF SECTION**

# SECTION 21 05 00

# COMMON WORK RESULTS FOR FIRE SUPPRESSION

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Sleeves.
   3. Escutcheons.
   4. Grout.
   5. Fire-suppression equipment and piping demolition.
   6. Painting and finishing.
   7. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in "Access Doors and Frames."

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

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

## 2.4 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.6 GROUT

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

## PART 3 - EXECUTION

### 3.1 FIRE-SUPPRESSION DEMOLITION

A. Refer to "Cutting and Patching" and "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean and store equipment. When appropriate, reinstall, reconnect and make equipment operational.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

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

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

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

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

F. Install piping to permit valve servicing.

G. Install piping at slopes required to drain system. Install drain valves with hose connections at all low points.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation, where heat tracing is installed.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
   h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
   i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
   j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
   k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
   l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
   g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
   h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
   i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
   j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
   k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

## 3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

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

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

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

## 3.4 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.5 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified.

## 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION**

# SECTION 21 05 29

# HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fastener systems.

B. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers.
   2. Metal framing systems.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2019 ASME Boiler and Pressure Vessel Code, Section IX.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

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

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

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

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper B-line; brand of Eaton, Electrical Sector.
   b. G-Strut.
   c. Unistrut; Atkore International.
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: No coating.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-line; brand of Eaton, Electrical Sector.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   2. Indoor Applications: Stainless steel.

2.6 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A240/A240M.

D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

3.1 APPLICATION

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

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

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.

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

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

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

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

## 3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

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

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

## 3.5 PAINTING

A. Touchup:
   1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

## 3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

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

H. Hanger-Rod Attachments: Comply with NFPA requirements.

I. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

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

L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

**END OF SECTION**

# SECTION 21 05 53

# IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUPIMENT

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Equipment signs.
   4. Access panel and door markers.
   5. Pipe markers.
   6. Valve tags.
   7. Valve schedules.
   8. Warning tags.
   9. Ceiling grid markers.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

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

## PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Data: Instructions for operation of equipment and for safety procedures.
   2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
   3. Thickness: 1/16 inch, unless otherwise indicated.
   4. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
   5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

## 2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch-thick brass.
2. Material: 0.0375-inch-thick stainless steel.
3. Material: 3/32-inch-thick laminated plastic with 2 black surfaces and white inner layer.
4. Valve-Tag Fasteners: Brass wire-link, beaded chain, or S-hook.

## 2.4 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
   4. Color: Yellow background with black lettering.

2.6 CEILING GRID MARKERS

A. Ceiling Grid Markers: Self-adhesive round, 1/2 inch diameter color coding removable labels.
   1. Similar to Avery® Model 5050, 5051, 5052, or 5053.

## PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Divisions 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Pumps and similar motor-driven units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Fire department hose valves and hose stations.
      b. Meters, gages, thermometers, and similar units.
      c. Pumps and similar motor-driven units.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:
   a. **Green**: For cooling equipment and components.
   b. **Yellow**: For heating equipment and components.
   c. **Orange**: For combination cooling and heating equipment and components.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:
   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   b. Pumps and similar motor-driven units.

D. Install access panel markers with screws on equipment access panels.

## 3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
   1. Valve-Tag Size and Shape:
      a. Fire Protection: 1-1/2 inches, round.
   2. Valve-Tag Color:
      a. Fire Protection: Natural.
   3. Letter Color:
      a. Fire Protection: Black.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

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

3.7 CEILING GRID MARKER INSTALLATION

A. Install ceiling grid markers on lay-in tile ceiling grid, ceiling access panels and wall access panels. Locate markers visible from occupied space to identify mechanical equipment, valves, dampers, etc., located above.

B. Ceiling Grid Markers Schedule:
   1. Equipment: Red, Avery® 5051
   2. Valves: Green, Avery® 5052
   3. Dampers: Blue, Avery® 5050
   4. Control Device: Orange, Avery® 5062

C. If schedule requires different color labels in one location, install all colors required for proper identification.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices.

**END OF SECTION**

# SECTION 21 13 13

# WET-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Manual control stations.
6. Control panels.
7. Pressure gages.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Contractor shall perform a fire pump test prior to design.
2. Contractor shall perform fire-hydrant flow test prior to design.

C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 (or as required by local authority) percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:
   a. Building Service Areas: Ordinary Hazard, Group 1.
   b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c. General Storage Areas: Ordinary Hazard, Group 1.
   d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   e. Classrooms, Office and Public Areas: Light Hazard.
3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
   a. Classroom, Office Spaces: 225 sq. ft.
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft.
   d. Electrical Equipment Rooms: 130 sq. ft.
   e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated.

1.6 SUBMITTALS

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

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Domestic water piping.
   2. HVAC hydronic piping.
   3. Items penetrating finished ceiling include the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Welding certificates.

H. Fire pump test report.

I. Fire-hydrant flow test report.

J. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

K. Field quality-control reports.

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

1.7 QUALITY ASSURANCE

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

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

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

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   1. Notify Construction Manager no fewer than five days in advance of proposed interruption of sprinkler service.
   2. Do not proceed with interruption of sprinkler service without Construction Manager's written permission.

1.9 COORDINATION

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

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench.

Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Schedule 40 Galvanized and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Thinwall Galvanized and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

C. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

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

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

G. Cast-Iron Flanges: ASME 16.1, Class 125.

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

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
   2. Pressure Rating: 175 psig minimum.
   3. Galvanized painted or uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

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

## 2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.
   2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Victaulic Company.
   2. Standard: UL 1091 except with ball instead of disc.
   3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Iron Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
   2. Standard: UL 1091.
   3. Pressure Rating: 175 psig.
   4. Body Material: Cast or ductile iron.
   5. Style: Lug or wafer.
   6. End Connections: Grooved.

D. Check Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
   2. Standard: UL 312.
   3. Pressure Rating: 250 psig.
   4. Type: Swing check.
   5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

E. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

F. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Stockham Division.
   b. Milwaukee Valve Company.
   c. Tyco Fire & Building Products LP.
2. Standard: UL 262.
3. Pressure Rating: 250 psig.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

G. NRS Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Stockham Division.
   b. Mueller Co.; Water Products Division.
   c. NIBCO INC.
   d. Tyco Fire & Building Products LP.
2. Standard: UL 262.
3. Pressure Rating: 250 psig.
4. Body Material: Cast iron with indicator post flange.
5. Stem: Nonrising.
6. End Connections: Flanged or grooved.

H. Indicator Posts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Stockham Division.
   b. Mueller Co.; Water Products Division.
   c. NIBCO INC.
   d. Tyco Fire & Building Products LP.
2. Standard: UL 789.
3. Type: Horizontal for wall mounting.
4. Body Material: Cast iron with extension rod and locking device.
5. Operation: Wrench.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

C. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. Fire Protection Products, Inc.
c. Milwaukee Valve Company.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.

2.6 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Globe Fire Sprinkler Corporation.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

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

a. Anvil International, Inc.
b. National Fittings, Inc.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Elkhart Brass Mfg. Company, Inc.
b. Fire-End & Croker Corporation.
c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing Inc.
b. Triple R Specialty.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.
e. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing; a division of Anvil International, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

## 2.8 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Victaulic Company.
5. Viking Corporation.

B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:
1. Chrome plated.
2. Bronze.
3. Painted.

E. Special Coatings:
1. Wax.
2. Lead.
3. Polyester.
4. Corrosion-resistant paint.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Plastic, white finish, one piece, flat.
   2. Sidewall Mounting: Plastic, white finish, one piece, flat.

G. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.9 ALARM DEVICES

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

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

C. Valve Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Fire-Lite Alarms, Inc.; a Honeywell company.
      b. Kennedy Valve; a division of McWane, Inc.
      c. Potter Electric Signal Company.
      d. System Sensor; a Honeywell company.
   2. Standard: UL 346.
   3. Type: Electrically supervised.
   4. Components: Single-pole, double-throw switch with normally closed contacts.
   5. Design: Signals that controlled valve is in other than fully open position.

D. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Potter Electric Signal Company.
   b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK; U.S. Gauge Division.
   2. Ashcroft, Inc.
   3. Brecco Corporation.
   4. WIKA Instrument Corporation.

B. Standard: UL 393.

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

D. Pressure Gage Range: 0 to 250 psig.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

## PART 3 - EXECUTION

3.1 PREPARATION

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

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install alarm devices in piping systems.

I. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

J. Install pressure gages on riser or feed main, at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

K. Fill sprinkler system piping with water.

L. Install sleeves for piping penetrations of walls, ceilings, and floors.

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

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

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

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

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

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and

bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

## 3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

## 3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

## 3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   4. Energize circuits to electrical equipment and devices.
   5. Coordinate with fire-alarm tests. Operate as required.
   6. Coordinate with fire-pump tests. Operate as required.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.9 PIPING SCHEDULE

A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:
   1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 5, shall be one of the following:
   1. Standard-weight, Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Thinwall, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 6 and larger, shall be one of the following:
   1. Thinwall, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Piping Fittings and Couplings located in pool areas and/or corrosive environments to be Hot-Dipped Galvanized.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Concealed sprinklers.
   3. Wall Mounting: Sidewall sprinklers.
   4. Spaces Subject to Freezing: Upright sprinklers, Pendent Dry Sprinklers, Sidewall Dry Sprinklers.
   5. Special Applications: Extended-coverage, sprinklers where indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   2. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated or polyester where exposed to acids, chemicals, or other corrosive fumes and pool areas.

**END OF SECTION**

# SECTION 23 00 00

# GENERAL REQUIREMENTS FOR HEATING, VENTILATING AND AIR CONDITIONING

## PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work includes the furnishing of all materials, supplies, labor, equipment, tools, transportation, facilities and services necessary for and required in connection with or properly incidental to all work, as shown on the drawings and specified herein or reasonably implied therefore. Contractor shall be responsible for his own required cutting and patching. Contact utility companies, municipal agencies and J.U.L.I.E. services.

B. Use of the new equipment for temporary heating or cooling will not be approved.

C. Accomplish necessary demolition and removal work, including but not limited to VAV and fan powered boxes, temperature control system, piping, exhaust fans, ductwork, grilles, etc.

D. Contractor shall provide all temporary services required to maintain normal building operation during construction. Temporary interruption of services shall occur during non-school hours. Contractor shall be solely responsible for determining construction sequencing and shall include all costs required for maintaining all mechanical, plumbing, and electrical services to entire facility during school year.

E. Furnish two spare sets of air filters and fan belts for each piece of equipment requiring filters and fan belts.

F. Include in your bid all costs for equipment start-up services from manufacturer’s technicians. Start-up services shall be provided for boilers, pumps, rooftop units, air handlers, and as specified herein.

G. Training of Owner’s personnel.

1.2 DRAWINGS

A. Drawings for this work consist of mechanical plans and detailed drawings and diagrams to which will be added, during the period of construction any other detail drawings as may be necessary in the opinion of the Owner's representative to show the proper installation of various appliances or equipment. These drawings and diagrams show arrangement and size of connection and shall be considered as part of, and complementing the specifications. They shall be followed as closely as actual building construction will permit. For all locations of fixtures, partitions and all other details of construction, this contractor shall consult the architectural drawings before submitting his bid to make sure all equipment will fit in the assigned space. Failure to do so does not relieve this contractor from installing the system complete in all details as described and shown.

B. The drawings for this work accompanying these specifications are to be considered as an integral part of same and anything omitted from one and embodied in the other is to be considered essential to the requirements of the contract and must be furnished and installed by this contractor.

C. Should the drawings and specifications contradict each other, the matter should be referred to the Owner's representative for his interpretation and correction before signing the contract. Otherwise, this contractor shall be held responsible for and he shall meet the requirements without extra cost to the Owner.

1.3 QUALITY ASSURANCE

A. Standard and regulations: The work under the mechanical sections shall comply with the latest editions of the following applicable standards, in addition to local (city) and state codes:
1. ASME: American Society of Mechanical Engineers
2. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
3. ACRI: Air Conditioning and Refrigeration Institute
4. ASTM: American Society of Testing Materials
5. ANSI: American National Standards Institute
6. NFPA: National Fire Protection Association
7. UL: Underwriter's Laboratories
8. NEMA: National Electrical Manufacturers' Association
9. NEC: National Electrical Code
10. AGA: American Gas Association
11. ISC: Illinois School Code 175 (supersedes 156A)
12. ADA: Americans with Disabilities Act
13. BOCA: Building Officials and Code Administrators
14. IMC: International Mechanical Code
15. IBC: International Building Code

B. Include all items of labor and material required to comply with such codes in accordance with the contract documents. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of code requirements, the specifications and/or drawings shall govern regardless of code requirements.

1.4 SUBMITTALS

A. At the completion of the work covered by this contract, this contractor shall be responsible for furnishing a complete set of certified as-built drawings showing the heating, ventilating, air conditioning, plumbing and fire protection work as it was actually installed so as to make a permanent record. As-builts shall be furnished to Owner on reproducible sepia mylars and electronically in AutoCAD format. As-builts shall be uniformly drafted at 1/4” scale.

1.5 SHOP DRAWINGS

A. Submit to the Owner’s representative copies of a list of the materials which he proposes to use in the execution of his contract. If any items are omitted from the

list, such undeclared items shall be furnished strictly as specified. Provide manufacturer's certified drawings for all equipment as herein specified.

B. Manufacturer's standard drawings will be accepted for manufacturer's standard production items if verified for installation at the location noted. Shop drawings shall be made for all items of equipment specially fabricated for this contract. Installation drawings shall show, in detail, the work to be installed by this contractor and the clearances, spaces, provisions or requirements for the work of the other contractors. When phrase "by others" appears on shop drawings, indicate who is to furnish material or operations so marked.

C. Quarter-inch (1/4") scale piping and ductwork shop drawings shall be submitted for review. Shop drawings shall contain all required installation information including, but not limited to:
1. Bottom of duct/pipe height.
2. Duct/pipe size.
3. All fittings.
4. Hangers and supports.
5. Insulation/lining size and location.
6. Indicate all coordination conflicts with other trades.

D. Note: All equipment and ductwork shall be weather protected at all times. Non-protected material and equipment will be rejected and removed from the project without exception.

1.6 RULES AND REGULATIONS

A. All workmanship and materials shall conform and comply with the requirements of the building ordinances and rules and regulations of all departments and bureaus of the County and State of Illinois having lawful jurisdiction irrespective of any statements herein to the contrary.

B. All changes in the work of this contract which may be required by the said departments or bureaus or by the law or ordinances, when approved and ordered by the Owner's representative, shall be made by this contractor without extra cost to the Owner.

C. One final inspection will be conducted for completion of work after written notification from the contractor. Additional inspections will be conducted at the expense of the contractor.

1.7 MATERIALS AND WORKMANSHIP

A. All materials used throughout this installation shall be the best of their respective kind, and same shall be installed in a neat, accurate and workmanlike manner. This workmanship and these materials must be executed and furnished in a manner entirely satisfactory to the Owner's representative.

B. Wherever in the specifications a particular article or material is definitely mentioned, it shall be provided and no substitutions will be allowed, especially insofar as the submittal of the base bid is concerned. Should the contractor desire to substitute other materials for those specified, he may submit these substitutions in the form of alternates to the base bid designating appropriate additions or deductions for each alternate.

C. Final approval of all equipment will be by the Owner's representative.

D. All materials used shall be asbestos free.

1.8 SUBSTANTIAL AND FINAL COMPLETION

A. The contractor shall provide written notification to the engineer that the project is substantially complete. The engineer will accomplish a substantial completion inspection and provide the contractor with a list of work requiring corrective action. Upon completion of the corrective work, the contractor shall provide written notice that all corrective work has been completed. The engineer will conduct an inspection of the corrective work. The contractor shall bear costs of correcting such work, including additional testing and inspections, and compensation for the engineer's services and expenses made necessary thereby.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

3.1 COORDINATION

A. It is presumed that the contractor has carefully examined the drawings and specifications for the entire work and the job conditions which will ensure before submitting his bid and has reported to the Owner's representative in writing any interferences or conflicts with his work.

B. If the contractor has failed to call such interferences or conflicts relative to his work and the drawings, specifications, the work of other contractors in the event of separate contracts and job conditions to the Owner's representative's attention in writing prior to execution of the contract, it will be presumed that no conflicts exist.

C. When conflicts arise during the construction period, they shall be immediately reported to the Owner's representative in writing and they will be subject to the Owner's representative's decision. Contractor shall submit coordinated 1/4-inch scale shop drawings. Drawings shall indicate multiple conduit runs.

3.2 PROJECT CONDITIONS

A. Existing Building Systems: Contractor shall provide all temporary services required to maintain all building systems in working order during construction. Temporary interruption of building systems shall only occur during non-school hours. Contractor shall be solely responsible for determining construction sequencing and shall include all costs required for maintaining all mechanical, plumbing, and electrical systems throughout the entire facility during the school year.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect at least two weeks in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
   2. Indicate method of providing temporary utilities.

3. Do not proceed with utility interruptions without Architect's written permission.

3.3 COOPERATION OF CONTRACTORS

A. Each contractor, in laying out his work, shall cooperate with the other contractors on the work so as to avoid any interferences with their work. If this is not done, Owner's representative reserves the right to make such changes in the work as are necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the contractor.

3.4 JURISDICTION OF WORK

A. Where it becomes necessary for contractor in order to fulfill his contract to furnish labor or materials other than that which is generally accepted by trade agreement or general practice to belong to his particular trade or branches of work, the contractor shall submit same to subcontractor engaged in the type of work involved to the end that there will be no stoppage of work due to violations of trade agreements as to jurisdiction.

B. All cutting, patching, and fire safeing related to this contractor's work shall be accomplished by this contractor. All fire safeing material will be as directed by the architectural specification.

3.5 DEFECTIVE WORK AND MATERIALS

A. All materials or work found to be defective, or not in strict conformity with the drawings, or different from the requirements of the drawings and specifications, or defaced or injured through negligence of this contractor or his employees, or through the action of fire, shall immediately be removed from the premises by this contractor and satisfactory material and work substituted therefore without delay.

B. Any defected work or imperfect work which may be discovered shall be corrected immediately upon notice from the Owner's representative.

3.6 BASIS OF DESIGN

A. Contract documents have been designed using scheduled/specified equipment manufacturers. Use of a specified acceptable manufacturer that requires changes in design shall be completed by the contractor at no additional cost to the Owner.

3.7 COORDINATION AND COOPERATION

A. Coordinate the mechanical work with the other contractors on this project. Coordinate the mechanical work in this contract with the local gas company where appropriate.

B. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of all piping and sheet metal duct systems and mechanical equipment and the equipment shall be installed in proper sequence with other trades without any unnecessary delay.

C. Should it be necessary, detailed drawings of a proposed departure due to actual field conditions or other causes shall be submitted to the Owner's representative for approval.

D. Cover with all other contractors engaged in the construction of the project whose work may in any way affect his installation, and whenever interferences might occur and before installing any of the work in question, this contractor shall consult with them as to the exact location and level of his piping and ductwork and/or other parts of his equipment. This contractor shall be solely responsible for the proper arrangement of his piping and equipment.

3.8 ACCESS PANELS

A. Arrange piping so that all concealed valves and/or concealed equipment can be operated and/or properly maintained through access panels. Contractor shall be responsible for coordinating locations with architect. Contractor shall furnish and install proper number and rated access panels required for his work. Access panels shall be 18-inch x 18-inch or larger as required.

3.9 FIRE-STOPS

A. Penetrations through fire rated walls and floors shall be sealed to the original hourly fire rating with a fire-stop system capable of preventing the passage of flames and hot gases when subject to the requirements of the test standards specific for Fire-Stops ASTM E119 and E814 (UL 1479).

3.10 INSTRUCTIONS AND TRAINING

A. Each contractor shall instruct Owner's personnel in the operation and maintenance of equipment installed. In addition, each contractor shall furnish to Owner three (3) sets of typewritten instructions on the operation and maintenance of each piece of equipment. Each contractor shall also furnish to Owner three (3) sets of equipment maintenance and operations manuals for each item of equipment.

B. In addition to written instructions and manufacturer's training requirements, the contractors shall provide field training sessions as follows:

| Contractor | Minimum No. Of Sessions | Minimum Hours Of Instruction |
|---|---|---|
| HVAC | 1 | 4 |

C. Training session scheduling requests shall be presented to Owner's representatives a minimum of seven days prior to date for scheduling of all Owner's personnel.

D. For each session, the contractor shall submit a training session log prepared by the contractor and signed by the Owner and contractor, certifying that the above has been satisfactorily completed and that the Owner's operations manuals and written instruction were on hand at the time of the session.

E. All training sessions shall be video taped by the contractor and two copies shall be given to the Owner.

F. The training sessions shall be coordinated by the contractor to avoid numerous trips by Owner's personnel. Training should be combined when possible.

3.11 BUILDING COMMISSIONING

A. The mechanical contractor shall be responsible for the commission of the HVAC system as described below:
   1. All air filters shall be changed before the test and balance is performed.
   2. All equipment shall be checked for proper operation.
   3. The building systems shall be tested as follows:
      a. The air conditioning system(s) shall be started and placed in full operation for a period of one week before the building is occupied.

3.12 CONTROLS COMMISSIONING

A. All devices and points in the control system shall be thoroughly and systematically verified for proper installation, wiring, calibration, addressing, operations, etc.

B. Provide five (5) copies of a commissioning report, which documents, in detail, the commissioning of each and every point and field device in the system. The commissioning report shall contain, as a minimum, the following data for each point and device:
   1. Point name.
   2. Device tag as shown on as-built drawings.
   3. Point type (analog input, analog output, binary input, binary output).
   4. Point address.
   5. Description of field device.
   6. Manufacturer of field device.
   7. Part number of field device.
   8. The computer state or value of the point as displayed on the CPU (temperature/pressure/humidity reading, on/off, % open/closed, etc.).
   9. The actual, measured value or state of the point. This data must be measured on a separate device such as a thermometer, pressure gauge, meter, etc.
   10. The signature of the temperature control contractor's employee who commissioned the point.
   11. The date that the point was commissioned.

C. Provide a technician to demonstrate to the engineers/architects the operation of all control sequences, alarm activation, etc. Include eight (8) hours for this demonstration.

D. The temperature control contractor shall be responsible for providing one hour of technical check-out time per each piece of equipment to assist the balancing contractor at start-up. This time is separate from the temperature control start-up and commissioning described above.

E. An additional 10% over the normal contract amount to be held back from the temperature controls contractor until training and commissioning are completed and Owner has accepted.

3.13 CONTROLS TRAINING – TRAINING OF OWNER’S PERSONNEL

A. Provide three (3) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. Instruct the Owner's designated representatives in these procedures during the startup and test period. The duration of the instruction period shall be no less than (1 eight-hour

sessions) 8 hours. These instructions are to be conducted during normal working hours. The instruction shall consist of both hands-on and classroom training at job site. Substantial completion will not be initiated until this phase of training is completed. All training sessions shall be requested in writing to the Owners representative a minimum of 7 days prior.

B. A second training session of eight hour sessions shall be provided when requested by the Owner.

C. If the contractor does not attend a scheduled training session, he will be back-charged for the Owner's time and expenses.

3.14 CONTROL GUARANTEE

A. The control system shall be free from defects in workmanship and material under normal use and service for two years from the date of substantial completion of the entire project. After completion of the installation, the control manufacturer/contractor shall regulate and adjust all thermostats, control valves, operators and other equipment provided under this contract during this period.

B. This warranty shall extend to material that is supplied and installed by the control manufacturer/contractor. Material supplied but not installed by the control manufacturer/contractor shall be covered per the above to the extent of the product only. Installation labor for valves and dampers shall be the responsibility of the company performing and installation covered during this period.

C. This warranty shall not start until training is completed and the control systems have been commissioned and accepted by the Owner.

**END OF SECTION**

# SECTION 23 05 00

# COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in "Access Doors and Frames."

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Available Manufacturers:
      a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Available Manufacturers:
      a. Thompson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, [CPVC] [PVC] [CPVC and PVC] four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Available Manufacturers:
      a. NIBCO INC.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

## 2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

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

## PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to "Cutting and Patching" and "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   3. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   4. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   5. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

6. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Contractor is responsible for all isolation, draining, storage and refilling of system water/chemicals within piping being removed or connected into. Contractor to field verify all required isolation or lack there of and include all related costs in bid.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:
a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to "Sheet Metal Flashing and Trim" for flashing.
   1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

## 3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

## 3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

## 3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified.

## 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION**

# SECTION 23 05 29

# HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.

B. Refer to architectural sheets for corrosive area designation.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections include the following:
   1. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
   2. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

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

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

3. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Manufacturers hot dipped galvanized coating and duplex coating procedures and certifications.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.

14. Tolco Inc.

C. Galvanized Metallic Coating: Hot Dipped Galvanized coating after fabrication, minimum 3 Mil thickness.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.3 TRAPEZE PIPE HANGERS

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

B. Hot Dipped Galvanized Coating: After fabrication, minimum 3 mil thickness; ASTM A123.

C. Duplex Coating: After fabrication, consists of a minimum 3 mil thickness, hot dipped galvanized coating; ASTM A123, followed by a painted finish (ASTM D 6386).

## 2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type hot dipped zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

## 2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   1. Available Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
   1. Available Manufacturers:
      a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   1. Available Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.
   2. Base: Plastic or stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   1. Available Manufacturers:
      a. Portable Pipe Hangers.
   2. Bases: One or more plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

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

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

## PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

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

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish or are located in corrosive locations including all pool areas.

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

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
   10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
   11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
   16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
   17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
   18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

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

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

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

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

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

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to "Roof Accessories" for curbs.

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

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install

concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.3 EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches or as required.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

**END OF SECTION**

# SECTION 23 05 48

# VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.
   3. Housed spring mounts.
   4. Elastomeric hangers.
   5. Spring hangers.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, and wind forces required to select vibration isolators, and wind restraints, and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Welding certificates.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

## PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

E. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to "Demonstration and Training."

**END OF SECTION**

# SECTION 23 05 53

# IDENTIFICATION FOR HVAC PIPING AND EQUPIMENT

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Access panel and door markers.
   3. Duct markers.
   4. Warning tags.
   5. Ceiling grid markers.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

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

## PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Access Panel and Door Markers: 1/16-inch-thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
   1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.3 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
   4. Color: Yellow background with black lettering.

2.4 CEILING GRID MARKERS

A. Ceiling Grid Markers: Self-adhesive round, 1/2 inch diameter color coding removable labels.
   1. Similar to Avery® Model 5050, 5051, 5052, or 5053.

## PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Divisions 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

## 3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   2. Pumps, chillers, and similar motor-driven units.
   3. Cooling towers, heat recovery units, and similar equipment.
   4. Fans, blowers, primary balancing dampers, and mixing boxes.
   5. Packaged HVAC central-station and zone-type units.

B. Install access panel markers with screws on equipment access panels.

## 3.3 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:
   1. **Green**: For cold-air supply ducts.
   2. **Yellow**: For hot-air supply ducts.
   3. **Blue**: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
   4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
   5. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

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

## 3.4 WARNING-TAG INSTALLATION

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

## 3.5 CEILING GRID MARKER INSTALLATION

A. Install ceiling grid markers on lay-in tile ceiling grid, ceiling access panels and wall access panels. Locate markers visible from occupied space to identify mechanical equipment, valves, dampers, etc., located above.

B. Ceiling Grid Markers Schedule:
   1. Equipment: Red, Avery® 5051
   2. Valves: Green, Avery® 5052
   3. Dampers: Blue, Avery® 5050
   4. Control Device: Orange, Avery® 5062

C. If schedule requires different color labels in one location, install all colors required for proper identification.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices.

**END OF SECTION**

# SECTION 23 05 93

# TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

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

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

1.4 SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Architect, Owner, Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

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

D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager.

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

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

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

## PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

E. Examine ceiling plenums return or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

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

## 3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1-2021, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "Duct Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

## 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Report the cleanliness status of filters and the time static pressures are measured.
   4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
   5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   6. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in

Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

## 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
   2. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

3. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
4. Record final fan-performance data.

## 3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

## 3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

## 3.9 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

## 3.10 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

## 3.11 REPORTING

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

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 3.12 FINAL REPORT

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

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Pipe and valve sizes and locations.
4. Terminal units.

5. Balancing stations.
6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   3. Test Data (Indicated and Actual Values):
      a. Total air flow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan rpm.
      d. Discharge static pressure in inches wg.
      e. Filter static-pressure differential in inches wg.
      f. Preheat-coil static-pressure differential in inches wg.
      g. Cooling-coil static-pressure differential in inches wg.
      h. Heating-coil static-pressure differential in inches wg.
      i. Outdoor airflow in cfm.
      j. Return airflow in cfm.
      k. Outdoor-air damper position.
      l. Return-air damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft.
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
    a. Air flow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.
    i. Water pressure differential in feet of head or psig.
    j. Entering-water temperature in deg F.
    k. Leaving-water temperature in deg F.
    l. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft.
    g. Indicated air flow rate in cfm.
    h. Indicated velocity in fpm.

i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm.
b. Coil kw.
c. Coil stages, kw per stage.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.

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

## 3.13 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:
   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

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

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION**

# SECTION 23 07 13

# DUCT INSULATION

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:
   1. Section 23 31 13 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   2. Detail application of field-applied jackets.
   3. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

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

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

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

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

F. Glass-Fiber Blanket Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite XG.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Owens Corning; SOFTR All-Service Duct Wrap.

G. Glass-Fiber Board Insulation: Glass or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Johns Manville; 800 Series Spin-Glas.
      c. Knauf Insulation; Insulation Board.
      d. Owens Corning; Fiberglas 700 Series.

## 2.2 ADHESIVES

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

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
      b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

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

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
   b. Eagle Bridges - Marathon Industries; 501.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
   d. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
   b. Eagle Bridges - Marathon Industries; 570.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

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

## 2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
      b. Vimasco Corporation; 713 and 714.
   3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
   4. Service Temperature Range: 0 to plus 180 deg F.
   5. Color: White.

## 2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
      b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      c. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 FACTORY-APPLIED JACKETS

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

## 2.7 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White unless noted color as selected by Architect.

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

c. Moisture Barrier for Indoor Applications 3-mil-thick polysurlyn.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick polysurlyn.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Sheet and roll stock ready for shop or field sizing.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil-thick polysurlyn.
   d. Moisture Barrier for Outdoor Applications: 3-mil-thick polysurlyn.

## 2.8 TAPES

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

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.
   2. Width: 2 inches.

3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

## 2.9 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1) AGM Industries, Inc.; CHP-1.
   2) GEMCO; Cupped Head Weld Pin.
   3) Midwest Fasteners, Inc.; Cupped Head.
   4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 316.

## PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Insulation securement material shall match ductwork material.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

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

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

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

## 3.4 PENETRATIONS

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

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

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

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in "Penetration Firestopping" and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in "Penetration Firestopping."

## 3.5 INSTALLATION OF GLASS-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one

end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

## 3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

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

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

## 3.7 FINISHES

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

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

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

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. Ft nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. Ft nominal density.

C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
1. Round/flat-oval duct not permitted in this application.

D. Concealed, round and flat-oval, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
1. Round/flat-oval duct not permitted in this application.

E. Concealed, rectangular, supply-air duct insulation shall be the following:
1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation in non-return plenum location shall be the following:
   1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
   2. Return-air duct concealed and located within return-air plenum is not required to be insulated.

G. Concealed, rectangular, outdoor-air duct insulation shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

I. Concealed, supply-air plenum insulation shall be the following:
   1. Glass-Fiber Board: 1 inch 3-lb/cu. ft. nominal density.

J. Concealed, return-air plenum insulation shall be the following:
   1. Glass-Fiber Board: 1 inch thick and ft. 3-lb/cu. ft. nominal density.

K. Concealed, outdoor-air plenum insulation shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

L. Concealed, exhaust-air plenum insulation between isolation damper and penetration of building exterior shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

M. Concealed, exhaust-air plenum insulation at penetration of building exterior shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

N. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
   1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

O. Exposed, round and flat-oval, return-air duct insulation in non-conditioned space shall be the following:
   1. Glass-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
   2. Return-air duct exposed in conditioned space not required to be insulated.

P. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
   1. Glass-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.

Q. Exposed, round and flat-oval, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
   1. Glass-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.

R. Exposed, rectangular, supply-air duct within non-conditioned space, insulation shall be the following:
   1. Glass-Fiber Board: 2 inch thick and 3-lb/cu. ft. nominal density.

S. Exposed, rectangular, supply-air duct within conditioned space, insulation shall be the following:
   1. Glass-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density

T. Exposed, rectangular, return-air duct within conditioned space, insulation shall be the following:
   1. Insulation not required.

U. Exposed, rectangular, return-air duct within non-conditioned space, insulation shall be the following:
   1. Glass-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density

V. Exposed, rectangular, outdoor-air duct insulation shall be the following:
   1. 3 inches thick and 3-lb/cu. ft. nominal density.

W. Exposed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
   1. 3 inches thick and 3-lb/cu. ft. nominal density.

X. Exposed, supply-air plenum insulation shall be the following:
   1. Glass-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

Y. Exposed, return-air plenum in non-conditioned space, insulation shall be the following:
   1. Glass-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

Z. Exposed, outdoor-air plenum insulation shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

AA. Exposed, exhaust-air plenum insulation between isolation damper and penetration of building exterior shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

BB. Concealed, exhaust-air plenum insulation at penetration of building exterior shall be the following:
   1. Glass-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density

## 3.11 OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation material and thickness are identified below. If more than one material is listed for a duct system, selection from the material listed is contractors option.

B. Round and flat oval, supply air duct insulation shall be the following:
   1. Glass fiber board: 3 inches thick and 3 lb/cu-ft nominal density.

C. Round and flat oval, return air duct insulation shall be the following:
   1. Glass fiber board: 2 inches thick and 3 lb/cu-ft nominal density.

D. Rectangular supply air duct insulation shall be the following:
   1. Glass fiber board: 2 inches thick and 3 lb/cu-ft nominal density.

E. Rectangular return air duct insulation shall be the following:
   1. Glass fiber board: 2 inches thick and 3 lb/cu-ft nominal density.

F. Supply air plenum insulation shall be the following:
   1. Glass fiber board: 3 inches thick and 3 lb/cu-ft nominal density.

G. Return air plenum insulation shall be the following:
   1. Glass fiber board: 2 inches thick and 3 lb/cu-ft nominal density.

## 3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. None.

D. Insulated Ducts and Plenums, Exposed:
   1. None

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor’s option.

C. Ducts and Plenums:
   1. Aluminum, Stucco Embossed: 0.032 inch thick.

**END OF SECTION**

# SECTION 23 09 00

# INSTRUMENTATION AND CONTROL FOR HVAC

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:
   1. Section 23 09 93 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.3 WARRANTY

A. Twenty-four (24) months parts and labor.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

## 1.5 SEQUENCE OF OPERATION

A. See individual equipment sections.

B. See Section 23 09 93.

## 1.6 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

D. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

## 1.7 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.

C. Qualification Data: For Installer.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

E. Field quality-control test reports.

## 1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in "Operation and Maintenance Data," include the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.11 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Sections to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Section 28 31 11 "Fire-Alarm and Voice-Notification System" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate equipment with Division 26 Sections to achieve compatibility of communication interfaces.

F. Coordinate equipment with Division 26 Sections to achieve compatibility with motor starters and annunciation devices.

G. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements as specified.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:
   1. Carrier Global Corporation: Automated Logic
      a. Contact Erie Dones: 630-470-3705, Erie.Dones@carrier.com

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

A. Application Software:
   1. I/O capability from operator station.
   2. System security for each operator via software password and access levels.
   3. Automatic system diagnostics; monitor system and report failures.
   4. Database creation and support.
   5. Automatic and manual database save and restore.
   6. Dynamic color graphic displays with up to 10 screen displays at once.
   7. Custom graphics generation and graphics library of HVAC equipment and symbols.
   8. Alarm processing, messages, and reactions.
   9. Trend logs retrievable in spreadsheets and database programs.
   10. Alarm and event processing.
   11. Object and property status and control.
   12. Automatic restart of field equipment on restoration of power.
   13. Data collection, reports, and logs. Include standard reports for the following:
      a. Current values of all objects.

b. Current alarm summary.
c. Disabled objects.
d. Alarm lockout objects.
e. Logs.

14. Custom report development.
15. Utility and weather reports.
16. Workstation application editors for controllers and schedules.
17. Maintenance management.

B. Custom Application Software:
1. English language oriented.
2. Full-screen character editor/programming environment.
3. Allow development of independently executing program modules with debugging/simulation capability.
4. Support conditional statements.
5. Support floating-point arithmetic with mathematic functions.
6. Contains predefined time variables.

C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
3. Standard Application Programs:
a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

## 2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

## 2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
1. Manufacturers:
   a. BEC Controls Corporation.
   b. Ebtron, Inc.
   c. Heat-Timer Corporation.
   d. I.T.M. Instruments Inc.
   e. MAMAC Systems, Inc.
   f. RDF Corporation.
2. Accuracy: Plus or minus 0.5 deg F at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:
1. Manufacturers:
   a. BEC Controls Corporation.
   b. MAMAC Systems, Inc.
   c. RDF Corporation.
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
9. Humidity Sensors: Bulk polymer sensor element.
    a. Accuracy: 2 percent full range with linear output.
    b. Room Sensor Range: 20 to 80 percent relative humidity.
    c. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
    d. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
    e. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

D. Pressure Transmitters/Transducers:
1. Manufacturers:
    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Inc.
    d. ROTRONIC Instrument Corp.
    e. TCS/Basys Controls.
    f. Vaisala.
2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

## 2.6 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.7 THERMOSTATS

A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

D. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

E. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

F. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

G. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft of coil surface.

## 2.8 HUMIDISTATS

A. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

## 2.9 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
   2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
   5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Inc.
   2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   3. Dampers: Size for running torque calculated as follows:
      a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
      b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
      c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ftof damper.
      d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
      e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
      f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
   4. Coupling: V-bolt and V-shaped, toothed cradle.
   5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   7. Power Requirements (Two-Position Spring Return): 24-V ac.
   8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   10. Temperature Rating: Minus 22 to plus 122 deg F.
   11. Run Time: 12 seconds open, 5 seconds closed.

2.10 DAMPERS

A. Manufacturers:
1. Air Balance Inc.
2. Don Park Inc.; Autodamp Div.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, parallel or opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above the floor.
1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install automatic dampers according to Section 23 33 00 "Air Duct Accessories."

E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

F. Install labels and nameplates to identify control components according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Sections.

H. Install duct volume-control dampers according to Section 23 31 13 "Metal Ducts."

## 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

D. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control set points are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
   7. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check installation of air supply for each instrument.
   6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

## 3.5 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to "Demonstration and Training."

**END OF SECTION**

# SECTION 23 09 93

# SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:
1. Section 23 09 00 "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

C. Confirm all terminal unit sequence of operations with existing building controls. Modify as appropriate for integration into existing building control schemes.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.4 VAV – VARIABLE AIR VOLUME TERMINAL AIR UNITS WITH ELECTRIC COILS

A. Space temperature sensor reports temperature to system, which then modulates VAV damper and electric heating coil, in sequence, to maintain setpoint. All space temperature sensors shall have occupancy override button. Override button shall enable occupied mode for system serving space for period of 2 hours. VAV damper shall be at heating position (1/2 design CFM) when in heating mode. Room temperature sensor modulates control valve once VAV damper is at heating position (1/2 maximum flow).

B. With AHU fan operating in occupied mode, sequence the controls as follows:
1. Modulate volume damper to maintain room temperature.
2. On reduced-cooling demand, adjust volume damper closed to minimum position (1/3 of design CFM).
3. As cooling demand increases, open volume damper.
4. If no cooling or heating demand, control enters field-adjustable, no-load band.
5. On heating demand, adjust volume damper to heating position (1/2 of design CFM), and modulate electric heating coil to maintain room temperature.
6. Interlock with any other space heating equipment where applicable (perimeter fin tube, etc.).

C. With AHU fan operating in unoccupied mode (continued airflow with setback temperatures), sequence the controls as follows:
   1. Maintain field-adjustable setback temperature.
   2. Sequence VAV terminal similar to occupied sequence.

D. With AHU in morning warm-up mode enable electric heating coil. When space reaches occupied setpoint command space to occupied mode.

E. With AHU in morning cool-down mode adjust damper to full open position. When space reaches occupied setpoint command space to occupied mode.

F. Minimum control points:
   1. (AI) Space Temperature.
   2. (AI) Local Temperature Adjustment.
   3. (DO) Fan Control (enable/disable).
   4. (DI) Fan Status (current sensor).
   5. (AI) Terminal Unit Airflow.
   6. (AO) Terminal Unit Damper Modulation.
   7. (AO) Minimum CFM Setpoint.
   8. (AO) Maximum CFM Setpoint
   9. (AO) Electric Heating Coil Modulation.
   10. (DI) Occupancy Override.

G. Signal alarm for the following conditions:
   1. Space temperature is 3 degrees above or below room setpoint for more than 5 minutes.

H. Operator Workstation: Display the following data in addition to all points listed above:
   1. Room/area served.
   2. Room occupied/unoccupied.
   3. Room temperature.
   4. Local temperature adjustment.
   5. Room temperature set point, occupied.
   6. Room temperature set point, unoccupied.
   7. Fan status.
   8. Air-damper position as percent open.
   9. Electric Heating Coil Modulation.
   10. Alarms.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION (Not Applicable)

## END OF SECTION

# SECTION 23 31 13

# METAL DUCTS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:
1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Sections for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts and thermoplastic ducts.
3. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravityloads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Diffusers, grilles, registers, louvers, etc. locations including sizes, air quantity and system.
5. Reflected ceiling plan including all devices, equipment, etc. installed in ceiling by other trades.
6. Elevation of top of ducts.
7. Dimensions of main duct runs from building grid lines.
8. Fittings.
9. Reinforcement and spacing.
10. Seam and joint construction.
11. Penetrations through fire-rated and other partitions.
12. Equipment installation based on equipment being used on Project.
13. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
14. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.
g. Other devices installed in ceiling.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Lindab Inc.

b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless Steel Sheet: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No.2B, No. 2D, No. 3 or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
      b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
      a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless Steel Ducts: Stainless Steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor Exhaust Ducts: Seal Class C.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
4. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
5. Unconditioned Space, Exhaust Ducts: Seal Class C.
6. Unconditioned Space, Return-Air Ducts: Seal Class B.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
8. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
9. Conditioned Space, Exhaust Ducts: Seal Class B.
10. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in "Exterior Painting" and "Interior Painting."

B. Paint exterior of metal ducts as indicated on plans. Color to be as selected by the Architect. Paint materials and application requirements as specified.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

3.9 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:
a. Pressure Class: Positive 2-inch wg.
2. Ducts Connected to Constant-Volume Air-Handling Units:
a. Pressure Class: Positive 3-inch wg.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
a. Pressure Class: Positive 4-inch wg.
4. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive 3-inch wg.

C. Return Ducts:
1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:
a. Pressure Class: Positive or negative 1-inch wg.
2. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 3-inch wg.
3. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive or negative 2-inch wg.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
a. Pressure Class: Negative 2-inch wg.
2. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 2-inch wg
3. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive or negative 2-inch wg.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:
a. Pressure Class: Positive or negative 1-inch wg.
2. Ducts Connected to Air-Handling Units:
a. Pressure Class: Positive or negative 2-inch wg.
3. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive or negative 2-inch wg.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless Steel Ducts
a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum.

G. Liner:
1. Low Pressure Supply Air Ducts: Fibrous glass, Type I, 1-1/2 inch thick. (Low pressure ducts and ductwork downstream of terminal units.)
2. Return Air Ducts: Fibrous glass, Type I, 1-1/2 inch thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick. (Liner to not be installed in areas of high humidity exhaust.)
4. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

H. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   c. Velocity 1500 fpm or Higher:
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION**

# SECTION 23 33 00

# AIR DUCT ACCESSORIES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backdraft dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Flange connectors.
5. Turning vanes.
6. Remote damper operators.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control damper installation.
d. Fire-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

## PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90
   2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

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

B. Description: Gravity balanced.

C. Maximum Air Velocity: 3000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.063-inch-thick extruded aluminum, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
   1. Material: Aluminum.
   2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Screen Mounting: Front mounted in sleeve.
      a. Sleeve Thickness: 20-gageminimum.
      b. Sleeve Length: 6 inches minimum.
   6. Screen Mounting: Rear mounted.
   7. Screen Material: Aluminum.
   8. Screen Type: Bird.
   9. 90-degree stops.

## 2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance Inc.; a division of Mestek, Inc.
      b. American Warming and Ventilating; a division of Mestek, Inc.
      c. Flexmaster U.S.A., Inc.
      d. McGill AirFlow LLC.
      e. Nailor Industries Inc.
      f. Ruskin Company.
      g. Vent Products Company, Inc.
   2. Standard leakage rating.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   6. Blade Axles: Galvanized steel.
   7. Tie Bars and Brackets: Galvanized steel.

## 2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Nailor Industries Inc.
   3. Ruskin Company.
   4. Vent Products Company, Inc.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
   1. Use Static Fire Dampers for transfer ducts.
   2. Use Dynamic Fire Dampers for supply, return and exhaust ducts.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 Hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

## 2.6 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Nexus PDQ; Division of Shilco Holdings Inc.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

## 2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Elgen Manufacturing.
   4. METALAIRE, Inc.
   5. SEMCO Incorporated.
   6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.8 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 2 inches deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

## 2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Flexmaster U.S.A., Inc.
   3. McGill AirFlow LLC.
   4. Nailor Industries Inc.
   5. Pottorff.
   6. Ventfabrics, Inc.
   7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.

d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous hinge and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

## 2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel, 0.0428-inch stainless steel.

D. Fasteners: Carbon or Stainless steel, to match duct material. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.

4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Thermaflex.

B. Noninsulated, Flexible Duct: UL 181, Class 1 Similar to Thermaflex S-TL.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 6000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Fabric: Coated fiberglass woven fabric.
5. Steel Wire: Coated spring steel wire helix.
6. Flame Spread: Not to exceed 25.
7. Smoke Developed: Not to exceed 50.

C. Insulated, Flexible Duct: UL 181, Class 1, similar to Thermaflex M-KC.
1. Pressure Rating: 10-inch wg positive and 2.0-inch wg negative.
2. Maximum Air Velocity: 6000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Fabric: Coated fiberglass woven fabric.
5. Steel Wire: Coated spring steel wire helix.
6. Flame Spread: Not to exceed 25.
7. Smoke Developed: Not to exceed 50.
8. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at exhaust ducts as close as possible to exhaust louver unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Install silencer according to manufacturer’s written installation instructions.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. Downstream from manual volume dampers.
   2. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   4. At each change in direction and at maximum 50-foot spacing.
   5. Upstream from turning vanes.
   6. Control devices requiring inspection.
   7. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. Head and Hand Access: 18 by 10 inches.
2. Head and Shoulders Access: 21 by 14 inches.

L. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with draw bands.

Q. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

**END OF SECTION**

# SECTION 23 36 00

# AIR TERMINAL UNITS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Variable air volume terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed.

1.7 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

## PART 2 - PRODUCTS

2.1 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

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

   1. Carnes Company.
   2. Carrier Global Corporation.
   3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
   4. Price Industries Limited.
   5. Titus; brand of Johnson Controls International plc, Global Products.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22-gauge- thick galvanized steel.
   1. Casing Liner: Sustainable product comprised of recycled denim, containing no harmful irritants or chemicals. Must be EPA registered anti-microbial (biocide) mold and fungal inhibitor ensuring the product is safe for you and the environment. R value must meet latest International Energy Conservation Code requirement.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: AHRI 880 rated, 1 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity inlet sensors.

F. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. Location: Plenum air inlet.
2. Stage(s): SCR Controller.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
9. Mercury contactors.
10. Pneumatic-electric switches and relays.
11. Magnetic contactor for each step of control (for three-phase coils).

G. Direct Digital Controls:
1. Terminal Unit Controller, Section 23 09 23: Controller is to be field mounted and wired; unit controllers, integrated actuators, and room sensors to be furnished under Section 23 09 23 "Direct Digital Controls (DDC) for HVAC."

H. Control Sequence: See Section 23 09 93.11 "Sequence of Operation for HVAC" for control sequences.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

B. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION**

# SECTION 23 37 13

# DIFFUSERS, REGISTERS, AND GRILLES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Ceiling diffusers.
   2. Registers and grilles.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

## PART 2 - PRODUCTS

### 2.1 DIFFUSERS, REGISTERS, AND GRILLES

A. Rectangular and Square Ceiling Diffuser: Similar to TMSA-AA
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hart & Cooley, LLC.
      b. METALAIRE, Inc.
      c. Price Industries Limited.
      d. Titus; brand of Johnson Controls International plc, Global Products.
   2. Devices shall be specifically designed for variable-air-volume flows.
   3. Material: Aluminum.
   4. Finish: Baked enamel, color selected by Architect.
   5. Face Size: 24 by 24 inches
   6. Face Style: Three cone.
   7. Mounting: Refer to drawings.
   8. Pattern: Adjustable.

9. Dampers: Radial opposed blade.
10. Accessories:
    a. Equalizing grid.

B. Fixed Face Grille: Similar to Titus 350FL/S
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hart & Cooley, LLC.
    b. METALAIRE, Inc.
    c. Price Industries Limited.
    d. Titus; brand of Johnson Controls International plc, Global Products.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Horizontal; spaced 3/4 inch apart.
5. Face Arrangement: 35 degrees.
6. Frame: 1-1/4 inches wide.
7. Mounting: See drawings.

C. Slot Diffuser: Similar to Titus TBDI-80
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hart & Cooley, LLC.
    b. METALAIRE, Inc.
    c. Price Industries Limited.
    d. Titus; brand of Johnson Controls International plc, Global Products.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Aluminum.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: As selected by architect.
6. Finish - Pattern Controller: Black.
7. Finish - Tees: As selected by architect.
8. Slot Width: 1.0 inches.
9. Number of Slots: Refer to Drawings.
10. Length: 2 foot.
11. Accessories: Coordinate mounting with ceiling.
12. Plenum: 2-foot lined insulation.

D. Slot Return: Similar to Titus TBR-80
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hart & Cooley, LLC.
    b. METALAIRE, Inc.
    c. Price Industries Limited.
    d. Titus; brand of Johnson Controls International plc, Global Products.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Aluminum.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: As selected by architect.
6. Finish - Pattern Controller: Black.
7. Finish - Tees: As selected by architect.
8. Slot Width: 1.0 inches.
9. Number of Slots: Refer to Drawings.

10. Length: 2 foot.
11. Accessories: Coordinate mounting with ceiling.
12. Plenum: 2-foot lined insulation.

E. Double Deflection Supply: Similar to Titus 300FL
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hart & Cooley, LLC.
b. METALAIRE, Inc.
c. Price Industries Limited.
d. Titus; brand of Johnson Controls International plc, Global Products.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Style: Adjustable double deflection.
5. Mounting: Refer to drawings.
6. Dampers: Opposed blade damper.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION**

# SECTION 26 00 00

# ELECTRICAL, GENERAL

## PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. General provisions of contract include the following: Bidding requirements, contract forms, provisions of contract, and Division 1. These provisions contain requirements which affect electrical work under Divisions 26, 27 and 28 and which must be complied with as a part of the work.

B. Divisions 26, 27 and 28 are subdivided into various sections for general convenience.

C. Provide items, articles, materials, operations and methods required by drawings and specifications including labor, equipment, supplies and incidentals necessary for completion of work in Divisions 26, 27 and 28.

D. It is the intention of Divisions 26, 27 and 28 specifications and drawings to call for finished work, tested and ready for operation.

E. Apparatus, appliance, material or work not shown on the contract drawings, but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and ready for operation, even though not specified or shown on the contract drawings, shall be furnished and installed without additional expense to Owner.

F. Should there be any discrepancies or a question of intent, refer the matter to the architect for a decision before ordering any equipment or materials or before starting any related work.

1.2 WORK INCLUDED

A. Electrical work is indicated on drawings and includes but is not limited to the following:
   1. Demolition and remodeling.
   2. Feeder and branch circuit wire and conduit.
   3. Lighting fixtures and lamps.
   4. Wiring devices such as boxes, switches, receptacles, etc.
   5. Conduit fittings, supports, etc., though not shown.
   6. Panel boards and other service equipment or materials.
   7. Circuit breakers, safety switches, and other over current protection and safety devices.
   8. Fire alarm system.
   9. Inspection of Existing Systems

B. Contractor shall provide all temporary services required to maintain normal building operation during construction. Temporary interruption of services shall occur during non-school hours. Contractor shall be solely responsible for determining

construction sequencing and shall include all costs required for maintaining all mechanical, plumbing, and electrical services to entire facility during school year.

C. Mechanical, plumbing, and electrical equipment/systems shall not be taken out of service or demolished until end of the school year. Contractor shall include all costs associated for maintaining systems fully operational until end of school year.

1.3 WORK NOT INCLUDED

A. Unless otherwise stated, power wiring for all mechanical equipment is the responsibility of the electrical contractor with control wiring the responsibility of the mechanical contractor. This statement is not meant to preclude a different distribution of responsibility by the general contractor, who is responsible for a complete installation through interaction of subcontractors. Wiring (120 volt) between exhaust fan and powered damper and/or line voltage thermostats is by electrical contractor.

1.4 QUALITY ASSURANCE

A. Each major component of equipment shall have the manufacturer's name, address, model number and ratings on a plate securely affixed in a conspicuous place.

B. Code ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment, shall be in label of Underwriter's Laboratories, Inc. (UL). Approval must be obtained for materials furnished as equals. All proposals shall be prepared on the basis of using exactly the materials and items specified. If the contractor wishes to have other items considered, he must submit these items with his proposal and state the amount to be added or deducted.

1.5 ABBREVIATION

A. Reference to a technical society, institution, association, or governmental authority is made in these specifications in accordance with the following abbreviations. All groups listed below do not necessarily apply to this project and are listed for informational purposes only:
1. ASE: Association of Safety Engineers
2. ASME: American Society of Mechanical Engineers
3. EPA: Environmental Protection Agency
4. IEEE: Institute of Electrical and Electronics Engineers
5. MCAA: Mechanical Contractor's Association of America
6. NEMA: National Electrical Manufacturers Association
7. NEC: National Electrical Code
8. NFPA: National Fire Protection Agency
9. ADA: Americans with Disabilities Act
10. IBC: International Building Code
11. IFC: International Fire Code
12. IECC: International Energy Conservation Code
13. IAC: Illinois Accessibility Code
14. City of DesPlaines Code and Local Amendments.

1.6 SUBMITTALS

A. As-built drawings: The contractor shall keep continuous, up-to-date records of all deviations and changes between the work as shown on the drawings and as actually installed. Upon completion of the work and as a condition prior to final acceptance and payment, he shall furnish directly to the Owner the project record data. The accuracy of this data shall be the responsibility of the contractor, who shall bear all expenses for any required corrections. As-builts shall be furnished on reproducible heavy bond paper and electronically in PDF and Revit format (version selected by Architect). Obtain signed certification from an authorized Owner's representative. All devices turned over without a signature and later lost, will be replaced at the contractors expense. Provide three (3) sets of as-built information including electronic version on flash drive.

1.7 INSPECTION OF EXISTING SYSTEMS

A. The contractor will be responsible for inspecting all existing systems that will be worked on (during the course of the construction project) before touching them. This shall cover, but not limited to the following systems: electrical service, fire alarm system, intrusion/access control/security camera systems, local area network system, phone system, intercom/clock, etc.). This inspection will need to document any issues with the existing systems that are affecting their proper operation. If this report is not provided, the contractor is attesting that all systems were functional and properly operating before the start of the construction and will be responsible for all repairs. The onus is on the contractor to identify problems with any of the systems to the Owner prior to construction.

1.8 JOB REQUIREMENTS

A. The contractor shall keep himself informed as to the progress of the work and shall keep a sufficient force of workmen on the job so as not to delay the progress of the work.

B. The contractor shall be responsible for the exact location of all devices, and shall be responsible for all cutting and patching. No cutting shall be done without approval.

C. The Owner reserves the right to change the position of devices before the work is installed without extra charge. The contractor shall be responsible for determining exact locations in the field. In this sense the drawings are diagrammatic.

D. The contractor shall obtain all the necessary measurements in order that his work may fit all parts of the work. He shall further verify all the necessary measurements at the building in order that his work may fit that already in place.

1.9 CODE REQUIREMENTS AND INSPECTION AUTHORITIES

A. All work shall be installed according to the rules and regulations of the National Electrical Code, IBC, the Occupational Safety and Health Act, IAC and ADA regulations, and the local inspection authorities. This shall include all written provisions and amendments to the electrical code and all interpretive provisions and directives of the chief electrical inspector, which may be in effect or enacted and in force until the final acceptance of the work.

B. The quality and type of work referred to above shall be regarded as the minimum requirements, and shall be exceeded where required by this specification.

C. The contractor shall study the drawings and specifications prior to submitting his proposal and, if inspection authorities or labor conditions require work in addition to that specified or shown, the contractor shall state in his proposal the items involved and the additional amounts required for such items. After entering into a contract, the contractor agrees that all such items are included in his proposal and will not be cause for additional charges to the Owner.

1.10 DRAWINGS

A. The small scale of the drawings does not permit duplication of all panels, feeders, junction boxes and other equipment on all sheets. Drawings are, in essence, diagrammatic and it is the contractor's responsibility to install a complete working system. Special care shall be exercised in the installation of the work to include all material and fittings necessary for a complete installation. Exact dimensions and locations of all outlets shall be verified on-the-job. Before preparing his proposal the contractor shall examine all architectural drawings and engineering drawings. If any discrepancies or details of the construction interfere with the work, he shall report the same and obtain written instructions as to the changes necessary. Should he neglect to do so, he shall make the necessary changes at his own expense. Modifications of drawings are permissible as long as coordinated with Engineer/Architect and allowed by Owner.

B. The drawings show only the general routing of the conduit. The scale of the drawing does not permit the indication of all junction boxes, pull boxes, and fittings that may be required. The cost of such work shall be considered as part of the contract and extra payment will not be made for such work.

C. Contractor shall refer to plans for the location of light fixtures, fire alarm devices, wiring connections to kitchen equipment, etc.

1.11 COOPERATION AND COORDINATION

A. The contractor shall confer with other trades at the site, before installing his work, to avoid interferences so that maximum headroom and clearances may be maintained. In the event that interferences develop between work of various trades, the architect's decision will be final and additional compensation will not be allowed for moving of misplaced work.

B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
   1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

D. Coordinate any electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of any exterior underground utilities and services, including provision for electricity-metering components.

E. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

F. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

G. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

H. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

I. Particular attention shall be paid to situations where recessed equipment, pipes and lights occur, or where work of several trades occurs together above suspended ceilings, in pipe shafts or in areas where space is limited.

J. All fixtures, equipment, devices, switches and outlets shall be positioned to avoid all interferences with and to assure proper coordination with work of all other trades, cases, partitions, wall, floor and ceiling patterns, architectural features, etc. All recessed devices, fixtures, etc. shall be coordinated to work out conflicts and adjustments where such adjustments are warranted.

K. Contractor shall furnish and install all VFC’s motor starters and disconnect switches for mechanical equipment installed under Division 23 unless specifically called out for in mechanical contractor’s scope of work. Coordinate VFC’s starter and disconnect sizes with Division 23 contractor(s) before ordering and installing. Refer to mechanical and plumbing drawings. All 3-phase starters shall be furnished with phase loss/under-voltage protection.

L. The contractor shall provide and install junction box and conduit stubbed up above ceiling for mechanical contractor's thermostat and all other associated sleeves to accommodate thermostat cabling. Mount at 48" to top. Refer to mechanical drawings and coordinate with temperature control contractor for all thermostat locations.

1.12 TEST REQUIRED

A. Any wiring devices, lighting fixtures or electrical apparatus in the contract, if grounded or shorted, shall be corrected or replaced at the contractor’s expense.

1.13 DEFECTIVE WORK AND MATERIAL

A. All material or work found to be defective or not in strict conformity with drawings or different from requirements of drawings and specifications or defaced or injured through negligence of the contractor or his employees, through damage in shipments, or through action of fire or weather will be rejected and shall be immediately removed from premises by the contractor and satisfactory material and work substituted without delay.

B. Any defective work or imperfect work shall be corrected immediately on notice from the architect. No previous inspection or certificate on account shall be held to

relieve the contractor from his obligation to furnish sound material and to perform good and satisfactory work.

1.14 CUTTING, DRILLING, PATCHING AND PAINTING

A. All cutting, drilling, patching and painting of wood construction, masonry, steel or iron work belonging to the building shall be done by the contractor in order that his work may be properly installed, and all disturbed construction or finish must be made good, but under no conditions must structural work be cut except upon approval by the architect.

B. Cutting, patching and painting for electrical work shall be performed by this contractor unless noted otherwise. This contractor shall coordinate his work with the other trades for completing the work satisfactorily. Contractor is responsible for refinishing areas cut or patched by the execution of this work so as to match existing surrounding area. Trimmed cuts will be acceptable when approved by the architect.

C. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

D. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

1.15 DEMOLITION AND REMODELING

A. Work included:
   1. The work involved includes modifications, additions, and deletions to an existing electrical system. Contractor shall furnish all labor, equipment, supplies and incidentals necessary to alter the existing system to produce the desired result shown on the drawing and specified in the project manual.
   2. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

B. Existing conditions:
   1. Building plans shown are compiled from sources believed to be accurate. However, the information shown on these plans is conceptual and the contractor shall be responsible for field verification of all dimensions, sizes, system voltages, quantities and extent of work. The contractor shall carefully examine the premises in order familiarize himself with existing conditions and fully understand the nature and scope of work.
   2. Drawings are strictly schematic and a complete coordinated, functional and code approved system is intended.

C. Electrical demolition work shall include removal of all equipment, fixtures, piping, wire, receptacles and other electrical equipment and materials as shown on the drawings or necessary for the modification shown. Disconnect and remove all power wiring to mechanical equipment being removed.

1. Contractor shall bear all expenses for legally disposing of all light fixtures and their related ballasts, lamps and battery packs. Follow all EPA (Environmental Protection agency) guidelines and submit proper paperwork with certification of above.

D. Materials:
   1. Requirements for equipment, supplies, and accessories that are to be added to the electrical system are specified in other sections.
   2. Materials shall be new unless otherwise indicated. When so indicated existing equipment, supplies and accessories may be reused (sometimes relocated). Contractor must verify that existing materials are sound and fully functional for the design intended. Maintaining the condition of relocated materials is the responsibility of the contractor.

E. Conduit and wire:
   1. At contractor's option, existing raceway may be reused if not removed and meets new application. Existing power wiring for receptacle and lighting circuits may be reused if not removed and meets new application, unless otherwise indicated elsewhere. Wire and cable that has been removed shall not be reinstalled. Raceway that is in like-new condition may be reused if not removed. Raceway and power wiring that is being reused shall be tested for continuity of conduction and ground for insulation resistance of conductor and splices. Contractor shall remove and replace all wiring which is defective at contractor's expense.

F. Existing service:
   1. Existing building services shall be maintained and temporary services shall be provided when required at the contractor's expense. In the event that a shutdown cannot be avoided, the service interruption shall be with the minimum inconvenience to the occupants and with the approval of and under the supervision of the architect. In no case will the contractor interrupt service without the permission of the Owner or architect.
   2. Existing Building Systems: Contractor shall provide all temporary services required to maintain all building systems in working order during construction. Temporary interruption of building systems shall only occur during non-school hours. Contractor shall be solely responsible for determining construction sequencing and shall include all costs required for maintaining all mechanical, plumbing, and electrical systems throughout the entire facility during operational hours.

G. Revisions to the building:
   1. Refer to the architectural drawings and details for exact locations of existing partitions to be remodeled, existing partitions to remain and new partitions. This contractor shall repair all damages to existing construction due to his demolition operation or installation of new work.

H. Abandoned equipment and materials:
   1. Switches and outlets: When noted on drawings, the contractor shall abandon switches and outlets by removing them and providing solid cover plates. Electrical service to these devices shall be disconnected and/or spliced for resumption of service to devices not removed. Paint cover plate to match surrounding area. If box is prefinished material, install stainless steel cover plate.

2. Raceways and wire: Cut and removed buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

I. Installation:
1. Remove electrical equipment and installations, indicated to be demolished.
2. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.
3. All materials, such as light fixtures, that are to be removed, are the property of the Owner. Contractor shall store material as directed by the Owner, or at Owner's direction, the contractor shall assume responsibility for legal disposal per EPA requirements.
4. When removal of existing materials causes voids in existing cover plates or uncovered junction boxes, etc., provide solid finished covers that protect the void or opening and match surrounding area as closely as possible.
5. Remove demolished material from project site. Coordinate with drawing for disposal of removed materials.
6. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
7. All raceways and conduit shall be run concealed. Fish through existing walls and ceilings as required. For new devices placed on existing drywalls, contractor shall cut and install raceway and box flush behind the wall. Patch the existing drywall and paint to match surrounding areas. In the event concealed conduit is impossible, surface mounted metallic raceways shall be use. Surface mounted conduit shall also be used when specifically designated on the drawings in locations where exposed conduit is the predominant wiring method currently in use. Contractor may modify or add to that system with exposed conduit necessary to achieve design results. Exposed conduit in finished areas shall not be installed unless approved by the architect. Conduit installation shall be accomplished in a neat workmanlike manner. Run tight to walls at ceiling edge. Coordinate final routings in the field with the architect prior to installation. All exposed conduits shall be painted to match surrounding area.
8. Existing lay in ceiling tiles shall be removed and reinstalled as required for the installation of new electrical work. Tiles damaged by this work shall be replaced with identical materials at the contractor's expense.
9. Where the work of one trade will interfere with the work of other trades, all trades shall assist in working out space conditions, make satisfactory adjustments and shall be prepared to submit and revise coordinated shop drawings.
10. With the approval of the architect/engineer and without additional cost to the Owner, make minor modifications in the work, including rerouting as required by interferences with structural general and work of other trades or for the proper execution of the work.
11. Work installed before coordinating with other trades so as to cause interference with their work shall be reworked, without additional cost to the Owner, as directed by the architect. The contractors shall make all necessary provisions to pursue their work in a manner which will assure that the operation of the building is minimally impaired. This shall include, but not be

limited to, delivery of supplies, temporary utility connections, etc. Storage of materials must be at locations approved by the Owner.

12. Circuits shown to the panels for load and wiring are diagrammatic. The contractor shall have the option on conduit fill and runs in accordance with local municipal code for rewiring on the revision portion and standard conduit fill for new work. Final decisions for revision and connection to the new and existing system will have to be made in the field. Circuits shall be picked up overhead or through the floor to existing and new panels. Verify in the field.

1.16 CHASES AND OPENINGS

A. Provide to masonry or concrete trades, templates or details for chases and openings to be left in floors, walls and partitions to accommodate work for each trade.

1.17 CLEANING UP

A. After the completion of the electrical installation, the entire system shall be thoroughly cleaned. Clean all foreign matter from all fixtures, equipment, and exterior of conduits. Remove all rubbish, debris, etc. accumulated from this operation during the course of the work and at the completion of the project. Legally dispose of same off-the-site.

1.18 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements as specified.
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

1.19 FIRE-STOPS

A. Penetrations through fire rated walls and floors shall be sealed to the original hourly fire rating with a fire-stop system capable of preventing the passage of flames and hot gases when subject to the requirements of the test standards specific for Fire-Stops ASTM E119 and E814 (UL 1479). Utilize 3M, General Electric, Metalines Inc., Nelson Electric or Hilti products. The fire stop system installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

1.20 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified.

B. Concrete: 3000-psi, 28-day compressive strength as specified.

C. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

1.21 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

1.22 SUBSTANTIAL AND FINAL COMPLETION

A. The contractor shall provide written notification to the engineer that the project is substantially complete. The engineer will accomplish a substantial completion inspection and provide the contractor with a list of work requiring corrective action. Upon completion of the corrective work, the contractor shall provide written notice that all corrective work has been completed. The engineer will conduct an inspection of the corrective work. The contractor shall bear costs of correcting such work, including additional testing and inspections, and compensation for the engineer's services and expenses made necessary thereby.

B. One final inspection will be conducted for completion of work after written notification from the contractor. Additional inspections will be conducted at the expense of the contractor.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. See subsequent sections of the electrical division of these specifications for information.

2.2 GUARANTEE

A. Electrical work shall be guaranteed for both materials and labor for a period of (1) one year in accordance with the general conditions and Division 1.

B. Manufacturer's equipment guarantees or warranties for periods of more than one year shall be included in the maintenance manuals.

## PART 3 - EXECUTION

3.1 PREPARATION/INSTALLATION/APPLICATION

A. Adapt the work to the job conditions and make such changes as required and authorized by the architect, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, raising or lowering conduits, outlets

and fixtures to permit the proper installation of other mechanical or electrical equipment.

B. All work shall be performed by trained mechanics of the particular trade involved in a neat and workmanlike manner as approved by the architect.

3.2 PROTECTION

A. Protect the materials and work of other trades from damage during installation of the work provided under Divisions 26, 27 and 28.

B. Pay particular attention to the limited space available in certain locations of the project so that equipment may be installed without any interference.

C. In all rooms with exposed or concealed ductwork or piping, the exact locations of lighting fixtures shall be coordinated so as to clear all ducts and piping and obtain uniform light distribution.

**END OF SECTION**

# SECTION 26 05 00

# COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate sleeve selection and application with selection and application of firestopping specified.

## PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for all penetrations. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls. If above accessible ceiling, sleeves can extend 1 inch out of wall.

F. Extend sleeves installed in floors 2 inches above finished floor level or to above ceiling when concealing low voltage cabling of any type.

G. Size pipe sleeves to provide 1/4-inchannular clear space between sleeve and raceway. All other sleeves for cabling shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

N. Furnish and install sleeves for all low voltage cabling, including Data, Voice, Video, Intercom/Paging, Clock, Thermostat, Fire Alarm, Security, etc. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 3/4 inch conduit unless noted elsewhere. Use minimum of 1-1/4 inch conduit for data/voice cabling.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements as specified.

**END OF SECTION**

# SECTION 26 05 19

# LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V.
   2. Connectors, splices, and terminations rated 600 V.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
   1. Division 26 Section "Identification for Electrical Systems."

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. All devices and wiring shall be U.L. listed.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

1.7 WARRANTY

A. Provide a one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire Corp.
2. American Insulated Wire Corp.; a Leviton Company.
3. Belden.
4. Carol Cable Co.
5. Essex.
6. General Cable Corporation.
7. Senator Wire & Cable Company.
8. Southwire Company.
9. U.S. Wire & Cable.

B. Copper Conductors: Comply with NEMA WC 70, 98 percent conductivity.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN/THWN-2, 75 deg C wet/90 deg C dry, XHHW-2, 90 deg C wet/dry and SO, minimum 600 V.

2.2 CONNECTORS AND SPLICES AND TERMINAL BLOCKS

A. Manufacturers (for Connectors): Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Buchanan/Tyco.
4. FCI-Burndy.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.
7. O-Z/Gedney; EGS Electrical Group LLC.
8. 3M; Electrical Products Division.
9. Thomas & Beits Corp.
10. Tyco Electronics Corp.

B. Manufacturers (for Terminal Blocks): Subject to compliance with requirements, provide products by one of the following:
1. Burndy Products/FCI.
2. General Electric Co.
3. Ilsco.
4. Pass & Seymour.
5. Polaris.

6. Square D Co.
7. 3M Company.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
1. Bolted or screwed mechanical pressure/connector block type (insulated).
2. Compression/crimped pressure type.
3. Twist-on pressure type plastic or nylon insulator cap with internal threaded core and spring insert.

D. Terminal blocks: NEMA ICS4; modular, channel (rail) mounted with end-stops; solderless, box/clamp type terminals; 300 volt rated for control conductors, 600 volt rated for power conductors; wire size (cross-section) rated for applicable conductors; suitable for connection of copper conductors; with marking strips.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified.

C. Coordinate with Section 26 05 00 "Common Work Results for Electrical" for additional requirements.

2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## PART 3 - EXECUTION

3.1 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed below Slabs-on-Grade, and in Crawlspaces: Type THWN-2, single conductors in raceway.

D. Exposed Branch Circuits, including in Crawlspaces: Type THWN-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed below Slabs-on-Grade: Type THWN-2, single conductors in raceway.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

H. Fire Alarm Circuits: Refer to drawings for requirements.

I. Remote Control and Signal Cable:
   1. Control cable for Class I remote control and Signal circuits: Copper conductor, 600 volt THHN/THWN-2 insulation, rated 60 deg C, installed in raceway.
   2. Control cable for Class 2 or Class 3 remote control and Signal circuits: Copper conductor, 300 volt insulation, rated 60 deg C, individual conductors twisted together, shielded and covered with a PVC bracket; UL listed. Use plenum rated cable in plenum environments.
   3. Plenum cable for Class 2 or Class 3 remote control and Signal circuits: Copper conductor, 300 volt insulation, rated 60 deg C, individual conductors twisted together, shielded and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts and plenums.
   4. Coordinate open cabling requirements with local jurisdiction prior to bidding.

J. Connections to removal light fixtures in grid ceilings: FMC with THHN/THWN-2, maximum length 6’-0” whips, with ground wire. Provide plenum rated raceways when required by local codes.

K. Utilize type THWN-2 for underground feeders or branch circuits subject to becoming wet.

## 3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Install copper conductors:
   1. Install minimum #12 AWG conductors, except install minimum #14 AWG conductors for control circuits.
   2. Install stranded conductors for #10 AWG and larger, and solid or stranded conductors for #12 AWG. Use solid conductors for #14 AWG and smaller.
   3. Use #10 AWG conductor for 20 ampere, 120 Volt branch circuit home runs longer than 75 feet and 277volt circuits longer than 200 feet.

B. Install a separate dedicated neutral conductor for each phase of both lighting and power multi-wire branch circuits. If a multi-wire branch circuit contains three phase wires, the circuit will require three dedicated neutrals. The use of multi-pole branch breakers to eliminate neutral conductors is not allowed.

C. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

D. Completely and thoroughly swab raceway system before installing conductors.

E. Provide protection for exposed cables where subject to damage.

F. Install all power conductors in raceways. Install low voltage wiring in conduit unless otherwise indicated on drawings.

G. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

H. Use U.L. listed pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

I. Pull conductors together where more than one is being installed in conduit. Place an equal number of conductors for each phase of a circuit in same raceway or cable. Make conductor lengths equal for all parallel circuits. Size conductors and raceways per NEC. Derate conductor ampacities per NEC.

J. Install control conductors in conduit runs separate from power conductors.

K. Install cables in conduits parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

L. Support according to Division 26 Section “Hangers and Supports for Electrical Systems,” and as noted on drawings, above accessible ceiling; do not rest on ceiling tiles.

M. Seal wall/floor penetrations accordingly.

N. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

## 3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Thoroughly clean wires before installing lugs and connectors.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Tape uninsulated connectors with electrical tape to 150 percent of the insulating rating of conductor.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Splice conductors only in accessible pull and junction boxes or outlet boxes. Neatly train and lace wiring inside boxes, equipment, and panelboards.

E. Install block connectors with insulating covers for copper conductor splices or taps, #8 AWG and larger.

F. Install compression/crimped connectors for copper conductor control circuits terminal.

G. Install twist-on connectors for copper conductor splices, #10 AWG and smaller, except install terminal blocks for connectors in pull and junction boxes containing 20 or more splices.

H. Terminate spare conductors with electrical tape.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified.

B. Coordinate with Section 26 05 00 "Common Work Results for Electrical" for additional requirements.

C. Concrete Slabs and Walls: Install sleeves for all penetrations. Install sleeves during erection of slabs and walls.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces. If above accessible ceiling, sleeves can extend 1 inch out of wall.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed. All other sleeves for cabling shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required.

H. Seal space outside of sleeves (both sides of wall) with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials.

K. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

N. Furnish and install sleeves for all low voltage cabling, including Data, Voice, Video, Intercom, Clock, Thermostat, Fire Alarm, Security, etc. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for

future cables. Utilize multiple sleeves as required. Minimum sleeve size is 3/4 inch conduit unless noted elsewhere. Use 1-1/4 inch conduit for data/voice cabling.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

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

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual (for physical damage and proper connection) and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Torque test conductor connections and terminations to manufacturer’s recommended values.
4. Perform continuity test on power and equipment branch circuit conductors. Verify proper phasing connection.
5. Megger test all wiring #8 AWG and larger, regardless of voltage.

D. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

**END OF SECTION**

# SECTION 26 05 23

# CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 27 15 00 Communications Horizontal Cabling.

1.2 SUMMARY

A. Section Includes:
1. RS-232 cabling.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Identification products.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of galvanized steel wire mesh bottom and side rails.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

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

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each cable for open and short circuits.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Provide a (1) one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: U.L. labeled for support of low voltage cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.
   4. Cable trays.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

## 2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 inch sized. Comply with requirements for plywood backing panels.

## 2.3 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   4. Fluorinated ethylene propylene jacket.
   5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
   6. Flame Resistance: Comply with NFPA 262.

## 2.4 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Overall shielded.
   4. Fluorinated ethylene propylene jacket.
   5. Flame Resistance: NFPA 262, Flame Test.

## 2.5 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.
   5. Flame Resistance: Comply with NFPA 262.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.
   5. Flame Resistance: NFPA 262, Flame Test.

## 2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway or power-limited cable, concealed in building finishes, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

D. All cables shall be plenum rated, unless installed in conduit.

2.7 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables according to TIA/EIA-568-C.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows if possible.

E. Pathway Installation in Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering room from overhead.
4. Extend conduits 3 inches above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards for all wall-mounted electronic equipment. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

G. Furnish and install sleeves through walls and floors where exposed cabling is allowed. Refer to Division 26 Section 26 05 00 "Common Work Results for Electrical" for additional information.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-C.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
9. Install end bushing/fittings on all conduit sleeves/stubs to protect cabling.

C. Installation of Control-Circuit Conductors:
1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 48 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. DO NOT route cables above top chord of bar joists and within 6 inches of roof deck to avoid roofing nail damage.

E. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Re-support any loose cables.

## 3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits, No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits, No. 12 AWG.

B. Where open cabling is allowed above accessible ceilings it shall be plenum rated.

## 3.5 FIRESTOPPING

A. Comply with requirements.

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.6 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-C.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

**END OF SECTION**

# SECTION 26 05 26

# GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

B. Related Sections include the following:
   1. Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Grounding arrangements and connections for separately derived systems.
   3. Grounding devices.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports. Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
      a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. ANSI/IEEE 32 – Requirements, terms, and test procedures for neutral grounding devices.

B. ANSI/IEEE C2 – National Electrical Safety Code.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with UL 467 for grounding and bonding materials and equipment.

F. Comply with NEC Article 250 and local code requirements.

1.5 WARRANTY

A. Provide a (1) one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. Apache Grounding/Erico Inc.
      b. Boggs, Inc.
      c. Chance/Hubbell.
      d. Copperweld Corp.
      e. Erico Inc.; Electrical Products Group.
      f. Framatome Connectors/Burndy Electrical.
      g. Harger Lightning Protection, Inc.
      h. Ideal Industries, Inc.
      i. ILSCO.
      j. Kearney/Cooper Power Systems.
      k. O-Z/Gedney Co.; a business of the EGS Electrical Group.
      l. Raco, Inc.; Division of Hubbell.
      m. Robbins Lightning, Inc.
      n. Superior Grounding Systems, Inc.
      o. Thomas & Betts, Electrical.
      p. Thompson Lightning Protection.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, green insulation.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

D. Grounding Electrode Conductor: Stranded cable.

E. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators; mounted on 3/4-inch fire-rated backboard.

2.3 CONNECTORS

A. Comply with IEEE 837 and UL 467.

B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts, or compression type.
   1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by 10 feet in diameter.

## PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid copper conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated; mount on 3/4-inch fire-rated backboard.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

C. 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.

D. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

E. In raceways, use insulated equipment grounding conductors.

F. Bond conductors together using thermoweld process.

## 3.2 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductors with all feeders and branch circuits.

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

E. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12 inches deep, with cover.
   1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. 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.

E. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
   4. Bond mechanical system piping to the building’s grounding system, minimum #6 insulated copper ground in conduit.
   5. Bond all metal coolers and freezers to the building’s grounding system, minimum #6 insulated copper ground in conduit.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Fence Grounding (When fencing is noted on drawings):
   1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
      a. Gates and Other Fence Openings: Ground fence on each side of opening.
         1) Bond metal gates to gate posts.
         2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
   2. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
   3. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
   4. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

## 3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

## 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
   4. Pad-Mounted Equipment: 5 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Maintain restored surfaces. Restore disturbed paving as indicated.

**END OF SECTION**

# SECTION 26 05 29

# HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.
   3. Requirements when devices are installed in corrosive atmospheres.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

D. Corrosive Environment: Any area subject to chlorine, salt water, or other corrosive agent that causes deterioration and fatigue of materials.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

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

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. Hot Dipped Galvanized Surfaces: Clean welds, bolted connections, cut and abraded areas and apply zinc rich galvanizing-repair paint to comply with ASTM A 780. Comply with manufacturers recommendations for hot dipped galvanized coating repair.

F. Duplex Coating Surfaces: Clean welds, bolted connections, cut and abraded areas and apply zinc rich galvanizing-repair paint to comply with ASTM A 780. Finish with

provided paint. Comply with manufacturers recommendations for hot dipped galvanized coating repair.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Special fasteners/devices designed for corrosive type atmospheres.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.
   5. Special fasteners/devices designed for corrosive type atmospheres.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

C. Hot Dipped Galvanized Coating: After fabrication, minimum 3 mil thickness; ASTM A123.

D. Duplex Coating: After fabrication, consists of a minimum 3 mil thickness, hot dipped galvanized coating; ASTM A123, followed by a painted finish (ASTM D 6386).

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements as specified.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 WARRANTY

A. Provide a (1) one year warranty on all parts and labor.

## 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. 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. Power Fasteners.
f. Thomas & Betts Corporation.
g. Unistrut; Tyco International, Ltd.
h. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized steel after fabrication and applied according to MFMA-4. To be used in all exterior, damp, wet locations.
3. Nonmetallic Coatings: Manufacturer's standard corrosion-resistant coating with electro-deposition AC04416 coating with rust protection and fade resistant finish, acceptable to authority having jurisdiction. Applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4, unless used in corrosive environment; see Notes 6 and 7 as follows.
5. Channel Dimensions: Selected for applicable load criteria.
6. Hot Dipped Galvanized Coating (For Corrosive Environment): After fabrication, minimum 3 mil thickness; ASTM A123.
7. Duplex Coating (For Corrosive Environment): After fabrication, consists of a minimum 3 mil thickness, hot dipped galvanized coating; ASTM A123, followed by a painted finish (ASTM D 6386).

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
a. 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 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. 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.
8. Utilize anchoring devices suitable for corrosive environments when identified or encountered.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements for steel shapes and plates.

C. For corrosive environments, follow Paragraph 2.1, for coating requirements.

## PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter. Maximum spacing for supports shall be 8 feet-0 inches on center and within 3 feet-0 inches of each junction box unless code requires more stringent spacing. Support wireways at intervals not to exceed 5 feet-0 inches.

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.

D. All materials installed in corrosive environments shall follow hot dipped galvanized process and duplex coatings.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70. Requirements must be coordinate with structural engineer prior to installation.
   1. Conduit Supports:
      a. Single run hangers: Conduit straps or clamps.
      b. Group run hangers: Performed U-channel rack with conduit fittings, provide 25 percent spare capacity.
      c. Hanger rods: Threaded steel, 1/4 inch diameter minimum.
      d. Vertical run supports: Preformed U-channel struts with conduit fittings.
      **e. Perforated straps and spring steel clips and clamps will not be permitted.**

C. Equipment and Lighting Supports:
   1. U-channel: Preformed U-channel struts with fixture and conduit fittings, as applicable.
   2. Loose steel angles, channels, plates and tubing.

D. For exterior roof applications utilize B-line C-port series supporting devices so as not to damage roof system.

E. 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 25 percent.

F. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: 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.

G. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

H. Install supports, anchors, sleeves and seals to rigidly fastened conduit, wireway and equipment.

I. Welding supports to building structural members or fastening supports to roof deck or other conduit or pipe will not be permitted.

J. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

K. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

L. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

M. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

N. Support individual horizontal raceways with separate hangers or clamps.

O. Fasten hanger rods, conduit clamps, outlets and junction boxes to building structure using beam clamps.

P. Do not fasten supports to piping, ductwork, mechanical equipment or conduit.

Q. In wet locations, install free-standing electrical equipment on concrete pads.

R. Install surface mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall.

S. Bridge studs top and bottom with channels in support flush mounted cabinets and panelboards in stud walls.

T. Paint out systems where exposed in finished areas as directed by Architect.

U. Do not install conduits above top chord of bar joists, in web of roof decking, or within 6” of deck. This is to prevent roofing nails from puncturing conduits.

V. Support conduits and trapeze hangers from top chord of bar joists. Do not fasten to lower chord of bar joists.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements as specified.

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Hot Dipped Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780. Comply with manufacturers recommendations for hot dipped galvanized coating repair.

C. Duplex Coating Surfaces: Clean welds, bolted connections, cut and abraded areas and apply zinc rich galvanizing-repair paint to comply with ASTM A 780. Finish with provided paint. Comply with manufacturers recommendations for hot dipped galvanized coating repair.

**END OF SECTION**

# SECTION 26 05 33

# RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for devices installed in boxes.
2. Division 26 Section "Identification for Electrical Systems" for identification requirements and products.
3. Division 26 Section "Hangers and Supports for Electrical Systems."

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. RGS: Rigid galvanized steel.

G. RNC: Rigid nonmetallic conduit. Not to be used unless strictly specified on drawings.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: UL listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. UL 870 electrical wireways, auxiliary gutters and associated fittings.

C. Comply with NFPA 70 and local code requirements for electrical materials and components.

D. Federal Specifications:
   1. W-F406b fittings for cable, power, electrical and conduit, metal flexible.
   2. W-F408c fittings for conduit, metal, rigid thick wall and thin wall (EMT) type.
   3. WW-C-563A conduit, metal rigid: Electrical thin wall steel type (EMT); straight lengths, elbows and bends.
   4. WW-C-566C conduit, metal flexible.
   5. WW-C-581E conduit, metal, rigid and intermediate; and coupling, elbow, and nipple, electrical conduit: Steel zinc coated.
   6. W-C-582 conduit, raceway, metal and fitting: Surface.

E. National Electrical Manufacturer Association NEMA:
   1. NEMA 250 – 1985 enclose for electrical equipment (1000 V maximum).

F. American National Standard Institute (ANSI):
   1. ANSI C80.1 – Rigid steel conduit zinc coated.
   2. ANSI C80.3 – Electrical metallic tubing (EMT), zinc coated.
   3. ANSI C80.6 – Intermediate metal conduit (IMC).
   4. ANSI/MEMA OS – Sheet steel galvanized boxes, device boxes, covers and box supports.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Provide a (1) one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 METAL CONDUIT, TUBING AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Available metal conduit and tubing manufacturers:
      a. RGS, IMC, and EMT:
         1) Allied Tube and Conduit Co.
         2) Republic Steel Corp.
         3) Triangle PWC, Inc.

4) Wheatland Tube Co.
b. FMC:
1) Alflex Corp.
2) American Flexible Conduit Co.
3) Anaconda Metal Hose, Anamet, Inc.
4) Electric Flex Co.
5) Grinnel Co./Tyco International; Allied Tube and Conduit Division.
2. Available metal conduit and tubing fittings manufacturers:
a. RGS, IMC, EMT, and FMC Fittings:
1) Appleton Electric Co.
2) Cooper/Crouse-Hinds Co.
3) O-Z/Gedney Co.
4) Raco, Inc.
5) Regal Manufacturing Co.
6) Ilsco
7) Allied
8) Wheatland
b. Expansion Fittings:
1) Appleton Electric Co.
2) Cooper/Crouse-Hinds Co.
3) O-Z/Gedney Co.
4) Regal Manufacturing Co.
5) Spring City Electrical Manufacturing Co.
6) Thomas & Betts
c. Smoke and Fire-Stop Fittings:
1) O-Z/Gedney Co.
2) Spring City Electrical Manufacturing Co.
3) Thunderline Corp.
4) Anixter.
d. Sealing and Drainage Fittings:
1) Appleton Electric Co.
2) Cooper/Crouse-Hinds Co.
3) O-Z/Gedney Co.
4) Thomas & Betts
5) 3M
e. Wall and Floor Seals:
1) O-Z/Gedney Co.
2) Spring City Electrical Manufacturing Co.
3) Thomas & Betts
4) Appleton
5) Cooper/Crouse-Hinds
6) Anixter.

B. Aluminum Rigid Conduit: Not allowed, except for special applications when noted on drawings.

C. Minimum conduit size: 3/4 inch except minimum 1 inch for underground conduit; 1/2 inch conduit will not be allowed unless approved by Owner in writing. Utilize red conduit for fire alarm conduit. Utilize green conduit for all raceways for dedicated grounding conductors. Colored conduits in "WHITE" shall not be used unless treated as a primer coating and then shall be painted out to match area per Architect's direction.

D. Rigid galvanized steel conduit (RGS) and intermediate metal conduit (IMC): FS WW-C-581; hot dip galvanized; ANSI C80.1, ANSI C80.6 zinc coated, standard threaded conduit couplings.

E. RGS and IMC fittings: FS W-F-408; hot dip galvanized. Utilize insulated throat connectors/bushings where raceway enters box or other fitting to protect wires, i.e., utilize malleable iron type fittings with molded-on high impact insulation. Include grounding bushing when required. Utilize case hardened lock nuts. **High impact phenolic threaded type bushings are not acceptable.**

F. Electrical Metallic Tubing (EMT): FS WW-C-563; ANSI C80.3 zinc coated, electro-galvanized. Utilize red conduit for fire alarm conduit.

G. EMT Fittings: FS W-F-408; electro-galvanized; steel compression type; rain and concrete tight; insulated throat connectors and case hardened locknuts. Set screws not allowed. Utilize insulated throat connectors/bushings where raceway enters box or other fitting to protect wires. Utilize case hardened lock nuts.

H. Flexible metal conduit (FMC): FS WW-C-566; hot dip galvanized steel.

I. FMS Fittings: FS W-F-406, Type 1, Class 1, Style A; hot dip galvanized or zinc or cadmium electro-plated; connectors compatible with conduit. Utilize insulated throat connectors/bushings where raceway enters box or other fitting to protect wires. Utilize case hardened lock nuts.

J. LFMC: Constructed of single strip, flexible continuous, interlocked, and double-wrapped steel; hot dip galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride.

K. LFMC Fittings: FS W-F-406, Type 1 Class 3, Style G; hot dip galvanized or zinc or cadmium electroplated; connectors compatible with conduit. Utilize insulated throat connectors/bushings where raceway enters box or other fitting to protect wires. Utilize case hardened lock nuts.

L. Provide plenum rated FMC for all plenum environments required per local codes.

M. Fittings: NEMA FB 1, compatible with conduit and tubing materials. Utilize insulated throat connectors/bushings where raceway enters box or other fitting to protect wires. Utilize case hardened lock nuts.

N. 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.

O. Expansion Fittings: Specifically designed to permit 4 inches linear movement in conduit runs, and to make with adjoining conduit; iron or steel body, hot dip galvanized or zinc electroplated; with bonding jumper.

P. Sealing and Drainage Fittings: Corrosion resistant case metal body with openings for filling, inspection and drainage; corrosion resistant opening plugs; female hub, top and bottom; specifically designed for sealing vertical runs of conduit to restrict the passage of gases, vapors, and flames and to limit explosions; sealing compound as required and recommended by fitting manufacturer to provide a complete seal.

Q. Wall and Floor Seals: Factory assembled watertight seals suitable for sealing around conduit passing through concrete foundations, walls and floors; constructed

with steel sleeves, iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.

R. Concrete: As specified.

2.2 NONMETALLIC CONDUIT (ONLY TO BE USED WHEN STRICTLY SPECIFIED ON DRAWINGS)

A. 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.

B. RNC: NEMA TC 2, SCH-80 PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.\

D. RNC type conduits will not be allowed inside of building interiors and will be solely used for underground applications. All risers out of ground shall be RGS type conduit.

2.3 Fittings for LFNC: UL 514B

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Wiremold.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 Indoors, Type 3R Outdoors, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type – NEMA Type 1; flanged-and-gasketed type – NEMA Type 3R

E. Finish: Manufacturer's standard enamel finish.

F. Construction: In accordance with UL 870.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

B. Description: FS W-C-582; sheet metal channel with fitted cover, suitable for use as surface metal raceway.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell.
      b. Walker Systems, Inc.; Wiremold Company (The).

C. Surface Nonmetallic Raceways *(Only To Be Used When Indicated on Drawings and Allowed By Authorities Having Jurisdiction)*: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Panduit Corp.
      c. Walker Systems, Inc.; Wiremold Company (The).

D. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

E. Fittings: Couplings, elbows, and connectors designed for use with raceway system.

F. Boxes and Extension Rings: Designed for use with raceway systems.

G. Do not use wiremold raceway on exterior of buildings.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. 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.

B. Provide boxes compatible with conduit and of types, shapes, and sizes including box depths, to suit each respective location.

C. Provide box covers of same material as box, unless otherwise indicated, and of types, shapes, and sizes to suit each respective location. Utilize non-magnetic stainless steel brushed satin finish Type 302/304 (0.040 inch thick) in all finished areas.

D. Provide box accessories as required for mounting at each respective location including mounting brackets, wallboard hangers, extension rings, fixture studs, clamps, and straps.

E. Provide boxes equipped with plaster rings where applicable. Provide access panels in all concealed junction box locations.

F. Pull and Junction Boxes: Galvanized sheet steel; NEMA OS 1; welded seams; screw-on covers; equipped with stainless steel nuts, bolts, screws, and washers.

G. Interior Outlet Boxes: Galvanized sheet steel; NEMA OS 1; stamped knockouts in back and sides; threaded screw holes with corrosion resistant screws for securing box covers and wiring devices.

H. Exterior Outlet Boxes: Corrosion resistant cast metal; NEMA FB 1 threaded conduit ends; weatherproof/gasketed.

I. Conduit Bodies (Condulets): Galvanized cast metal; threaded conduit entrance ends; removable covers, corrosion resistant screws.

J. Bushings, Knockout Closures and Locknuts: corrosion resistant punched steel box knockout closures and conduit locknuts; 150 deg C plastic bushings.

K. Strain Relief Grip: Woven steel mesh with connection fitting, designed to absorb pull, flexure and vibration exerted on cord or cable and prevent disconnection at wired terminals.

L. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat flanged, surface mounted junction box, UL listed as rain-tight. Cast aluminum box and cover with ground flange, neoprene gasket and stainless steel cover screws.

M. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, outside flanges, recessed cover box for flush mounting, UL listed as rain-tight. Cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

N. Provide plenum rated/listed boxes for all plenum rated areas required by local code.

O. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

P. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

Q. Provide enclosures for terminal blocks, motor starters, switches, contactors, relays, control stations, controllers, transformers, and panel boards complying NEMA 250 and suitable for surface mounting, as follows:
   1. Exterior Locations: NEMA Type 3R
   2. All Other Locations: NEMA Type 1, unless otherwise indicated.

2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified.

2.8 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

C. Refer to Section 26 05 00 "Common Work Results for Electrical" for additional information and requirements.

## PART 3 - EXECUTION

3.1 GENERAL

A. Determine exact route and location of all electrical materials prior to installation.

B. Verify exact locations and elevations of electrical materials with project and field engineer prior to installation, where dimensions are not indicated.

C. Install electrical materials as indicated with offsets, fittings and changes in elevations as required to make adjustments for obstacles or interferences.

D. Do not allow electrical materials installation to cause any equipment to be unserviceable or inoperable.

3.2 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: Rigid steel conduit or Rigid Nonmetallic Conduit as indicated on drawings.
4. In Slab Aboveground: Not allowed.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT or IMC or RGS.
2. Exposed, Not Subject to Severe Physical Damage: EMT or IMC or RGS.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
   a. Loading dock and warehouse where potential damage exists from fork lifts.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT or IMC or RGS.
5. Install IMC and fittings except as follows:
   a. Install EMT conduit and fittings if conduit size is 2 inches or smaller, unless another type of conduit and fittings are indicated.
   b. Install RGS and fittings where noted or required by NFPA 70 or by federal state, and local governments or agencies having jurisdiction.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid steel conduit.
8. Raceways for Optical Fiber or Communications Cable. Plenum-type, optical fiber/communications cable raceway or metallic conduit as indicated.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R in damp or wet locations. Use NEMA Type 4x in Kitchens and areas subject to corrosion.
10. For coolers and freezers (inside locations), utilize IMC conduit with threaded fittings. Utilize seal-off fittings for all cooler and freezer wall penetrations to stop condensation in conduits from forming. Install seal-off on warm side. Utilize bell type boxes with threaded hubs and sealed coverplates for all junction boxes and for wiring devices.

C. Minimum Raceway Size: 3/4-inch trade size for power and 1-inch for data/voice/AV cabling. Size conduit for conductors installed per NEC fill requirements.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. EMT: Use compression fittings. Set screw type not allowed.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz when noted on drawings. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Aluminum conduits not allowed.

3.3 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Route all exposed conduit parallel or perpendicular to building lines and above accessible ceiling as required. Exposed conduit shall not be installed in finished areas unless permitted by the Owner and architect
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
   3. All raceways and conduit shall be run concealed. Fish through existing walls and ceilings as required. For new devices placed on existing drywalls, contractor shall cut and install raceway and box flush behind the wall. Patch the existing drywall and paint to match surrounding areas. In the event concealed conduit is impossible, surface mounted metallic raceways (wiremold) shall be used. Surface mounted conduit shall also be used when specifically designated on the drawings in locations where exposed conduit is the predominant wiring method currently in use. Contractor may modify or add to that system with exposed conduit necessary to achieve design results. Exposed conduit in finished areas shall not be installed unless approved by the architect. Conduit installation shall be accomplished in a neat workmanlike manner. Run tight to walls at ceiling edge. Coordinate final routings in the field with the architect prior to installation. All exposed conduits shall be painted to match surrounding area. See **Paragraph 3.6 – SURFACE RACEWAY** for additional information.

C. Route conduit runs above the bottom chords of steel roof support joists. **Do not install conduits above top chord of bar joists, in web of roof decking, or within 6” of deck.** This is to prevent roofing nails from puncturing conduits.

D. Maintain minimum of 6 inches clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances. Install horizontal raceway runs above water and steam piping.

E. Complete raceway installation before starting conductor installation.

F. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

G. Ensure conduit is aligned in a neat, uniform manner and arranged to maintain headroom

H. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

I. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent addition conduit.

J. Do not fasten conduit with wire, perforated pipe straps or from ceiling grid support wires. Remove all wire used for temporary conduit support during construction, before conductors are pulled.

K. Support conduits and trapeze hangers from top cord of bar joists. Do not support from bottom chord of bar joists.

L. Install conduit free from dents and bruises. Plug ends to prevent entry of dirt, debris, and moisture during installation.

M. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plan and keep straight legs of offsets parallel, unless otherwise indicated.

N. Install raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

O. Arrange stub-ups so curved portions of bends are not visible above the finished slab. Protect stub-ups from damage where conduits rise through floor slabs.

P. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

Q. Conceal conduit within finished walls and ceilings, unless otherwise indicated.

R. Cut ends of conduit square. Ream ends of field-cut conduit and remove burrs.

S. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Join conduit butt-tight in couplings.
   2. Use insulating bushings to protect conductors.

T. Tighten nuts of threadless fittings/compression fittings with suitable tools.

U. Use conduit bodies to make sharp changes in direction, around beams.

V. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2-inch size.

W. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

X. Raceways Embedded in Slabs: Not allowed.

Y. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

Z. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.
   3. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

AA. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

BB. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inches of slack at each end of pull wire.

CC. Raceways for Communications Cable: Install raceways as follows:

1. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

DD. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.
3. Where conduit passes through concrete foundations, walls, and floors, to prevent the passage of water by hydrostatic pressure.
   a. Tighten wall and floor sleeve seal nuts until sealing grommets have expanded to form watertight seal.

EE. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; and fill sleeve with fire-resistive intumescent compound. Fire-stop installation shall be UL listed equal to or exceeding rating of wall, floor, or ceiling.

FF. Route conduit through roof opening for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.

GG. Use PVC-coated rigid steel factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length.

HH. Install expansion fittings complete with boding jumpers where conduits cross building expansion joints.

II. Install smoke and fire-stop fittings where required by code.

JJ. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

KK. All conduit stubs installed for communication cabling/technology cabling shall have bushing and end fittings installed so as to protect cables from being damaged when being pulled.

LL. Install conduit sleeves, J-hooks and other supports for communication/technology cabling contractor.

MM. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections. Utilize plenum rated raceways when required by local codes.

NN. For exterior roof applications utilize B-line C-port series supporting devices so as not to damage roof system.

OO. All cooler and freezer conduits installed within these enclosures shall be held off all walls and ceilings by 1/2 inch unless otherwise dictated by the Health Department.

3.4 BOXES INSTALLATION

A. Rigidly fasten boxes or solidly embed boxes in concrete or masonry as applicable.

B. Do not install round boxes where conduit must enter side of box.

C. Install knockout closure to cap unused knockout holes where blanks have been removed.

D. Provide electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connection and code compliance.

E. Electrical box locations shown on contract drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

F. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors with general contractor.

G. Locate and install to maintain headroom and to present a neat appearance.

H. **Do not install boxes back-to-back in walls.** Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls. Fill conduit openings with "duct seal" in acoustic-rated walls.

I. Locate boxes in masonry walls, at center of cell, and install box flush with surface of wall. Coordinate masonry, cutting to achieve neat openings for boxes. Patch all over-cuts.

J. Support junction boxes and pull boxes independently of conduit. Utilize junction boxes listed for ceiling fans/supporting method where ceiling fans are indicated. Support per manufacturer's direction.

K. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems and where 277 volt light switches are used. Provide separate conduit feeds for each gang section.

L. Install boxes in walls without damaging wall insulation.

M. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

N. Position junction boxes to located luminaires as shown on reflected ceiling plans.

O. In accessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

P. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

Q. Align wall mounted outlet boxes for switches and similar devices.

R. Provide cast outlet boxes in exterior locations exposed to the weather and wet locations.

S. Set floor boxes level and flush with finish flooring material.

T. Use cast iron floor boxes for installation in slab on grade.

U. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

## 3.5 WIREWAY INSTALLATION

A. Install wireway at lighting transformers and panel boards to allow for the neat and workmanlike arrangement of conduits.

B. Install wireway system in accordance with manufacturer's installation instructions.

C. Route wireway parallel or perpendicular to building lines.

D. Maintain minimum of 12 inches clearance at flues and heat sources.

E. Install wireway system with allowance for expansion and contraction.

F. Ensure wireway is aligned in a neat uniform manner.

## 3.6 SURFACE RACEWAY (ON EXISTING CMU WALLS, RATED WALLS, OR OTHER WALLS WHERE IT IS NOT POSSIBLE TO CONCEAL RACEWAY)

A. Use in finished areas where exposed conduit is not acceptable.

B. Use flat-head screws to fasten channel to surfaces, mount plumb and level.

C. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

D. Maintain grounding continuity between raceway components to provide a continuous grounding patch.

E. Fastener Option: Use clips and straps suitable for the purpose.

## 3.7 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified.
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting

strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified.

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.
7. Install underground tracer lines in trench above raceway.
8. Finish grade area disturbed and return to condition found. Seed/sod areas as required and water as necessary until root growth has occurred.

## 3.8 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls. If above accessible ceiling, sleeves can extend 1 inch out of wall.

F. Extend sleeves installed in floors to above accessible ceiling.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. 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.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

N. Furnish and install sleeves for all low voltage cabling, including Data, Voice, Video, Intercom/Paging, Clock, Thermostat, Fire Alarm, Security, etc. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 3/4 inch conduit. Use minimum of 1-1/4 inch conduits for low voltage data/voice cabling.

## 3.9 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.

## 3.10 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements as specified.

## 3.11 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

## 3.12 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

**END OF SECTION**

# SECTION 26 05 53

# IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

D. Submit a complete nameplate listing for Owner approval.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance

Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 WARRANTY

A. Provide a (1) one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

## 2.4 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
   1. Where floors are unfinished, i.e., concrete, utilize paint striping or tape as directed by Owner. For finished floors, i.e., VCT tile, tape shall be used.

## 2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

C. Tag: All locations use Type indicated below:
   1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   2. Overall Thickness: 5 mils.
   3. Foil Core Thickness: 0.35 mil.
   4. Weight: 28 lb/1000 sq. ft..
   5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi. Utilize 6-inch for duct banks.

## 2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. Potential Arc Flash Warning: "DANGER - ARC FLASH PROTECTION REQUIRED WHEN WORKING ON EQUIPMENT." Identify level of PPE protection required per ARC flash and Fault Current Coordination Study.
4. Final Label type to match Owner's current format.

## 2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.8 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

B. Fasteners for Nameplates and Signs: Self-tapping, rivets, stainless steel screws or No. 10/32, stainless steel machine screws with nuts and flat and lock washers (for NEMA-1 locations only). Utilize appropriate fixtures for wet locations.

## 2.9 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black.

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

## 2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior). All paint types to be reviewed/approved by the Architect before use.
   1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
      a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior concrete and masonry primer.

2) Finish Coats: Exterior semigloss acrylic enamel.

2. Exterior Concrete Unit Masonry:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Exterior semigloss acrylic enamel.
3. Exterior Ferrous Metal:
   a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior ferrous-metal primer.
      2) Finish Coats: Exterior semigloss alkyd enamel.
4. Exterior Zinc-Coated Metal (except Raceways):
   a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior zinc-coated metal primer.
      2) Finish Coats: Exterior semigloss alkyd enamel.
5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
   a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior concrete and masonry primer.
      2) Finish Coats: Interior semigloss alkyd enamel.
6. Interior Concrete Unit Masonry:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Interior semigloss acrylic enamel.
7. Interior Gypsum Board:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior gypsum board primer.
      2) Finish Coats: Interior semigloss acrylic enamel.
8. Interior Ferrous Metal:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.
9. Interior Zinc-Coated Metal (except Raceways):
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior zinc-coated metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Painted Identification: Comply with requirements for surface preparation and paint application.

## 3.2 SWITCH AND RECEPTACLES COVER PLATES

A. Install identification label on all switch and receptacle coverplates. Identify power panel and circuit information for each device (i.e. "PP1-#15").

B. Label shall be clear, 3/8" Kroy or Brothers self-laminating vinyl label with black letters, font size to be determined by Owner and type "Swiss 721 Bold". Embossed Dymo-Tape labels are not acceptable. Permanently affix label to the coverplate, centered above receptacle opening or switch.

C. Also include identification inside of receptacle or switch box. Utilize permanent marker/Sharpie and neatly print panel and circuit information as noted above.

## 3.3 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 30-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Fire Alarm System: Red.
2. Normal Power Distribution System: Silver.
3. Optional Standby Emergency Power Distribution System: Yellow.
4. Life Safety Emergency Power Distribution System: Orange.
5. Security System: As requested by the Owner.
6. Mechanical and Electrical Supervisory System: As requested by the Owner.
7. Telecommunication System: As requested by the Owner.
8. Ground: Green.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Power-Circuit Conductor Identification: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

E. Branch-Circuit Conductor Identification: Label outside of all junction boxes above ceiling with panel and circuit information. Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts for all power panels and equipment requiring working clearances. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to power panels, disconnect switches, transformers and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/4-inch-high letters on 1-1/2-inch-high label; where two or more lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, 4 inches high.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Pull boxes and junction boxes: 3/8” Kroy tape or Brothers self-laminating vinyl label, color coded same as conduits or permanent magic marker/Sharpie (color coded) and neatly hand labeled/printed with all Capital Letters. In rooms that finished/painted with exposed boxes, install information on inside of coverplate.
      e. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
      f. Include the following system information on each laminate tag for control equipment (starters, VFDs, contactors, control switches).
         1) Equipment type and tagging from drawings.
         2) Location of equipment being served if not located within line of sight.
         3) Voltage and phasing of equipment.
         4) Panel and circuit numbers serving equipment.
         5) Method of control (auto or manual) and controlled from where.
         6) Example of mechanical device feed:

a) EXHAUST FAN EF-1 (LOCATED ON ROOF OVER TOILET ROOM 222).
b) 208V, 3-PHASE.
c) FED FROM PPH-1, #1,3,5.
d) TIED TO BMS SYSTEM, AUTO CONTROL.

g. Include the following system information on each laminate tag for power distribution equipment:
1) Equipment type and tagging from drawings.
2) Voltage and phasing of equipment.
3) Name of upstream equipment and location if not within line of sight.
4) Rating and type of OCP device serving the equipment it is not withing line of sight.
5) Example of distribution panel device:
a) DISTRIBUTION PANEL DP-H1.
b) 480Y/277V
c) FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELECTRICAL ROOM).

h. Include the following system information on each laminate tag for transformer equipment:
1) Equipment type and tagging from drawings.
2) Name of the upstream equipment and rating.
3) Voltage and phasing and kva rating of equipment.
4) Location of the upstream equipment and location if not within line of sight.
5) Example of distribution panel device:
a) TRANSFORMER TR-07.
b) 480V: 208Y/120V, 75KVA.
c) FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELECTRICAL ROOM).

2. Color Coding of Systems:
a. Black letters on white face for normal power.
b. White letters on red face for emergency power.
c. White letters on green face for grounding.
d. Black letters on yellow face for Caution or UPS.

3. Equipment to Be Labeled:
a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved or engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchboards.
e. Emergency system boxes and enclosures.
f. Enclosed switches.
g. Enclosed circuit breakers.
h. Enclosed controllers.
i. Push-button stations.
j. Power transfer equipment.
k. Contactors.
l. Remote-controlled switches, dimmer modules, and control devices.
m. Voice and data cable terminal equipment.

n. Security systems.
o. Intercom and clock systems.
p. Fire-alarm control panel and annunciators.
q. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

**END OF SECTION**

# SECTION 26 09 23

# LIGHTING CONTROL DEVICES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 26 27 26 Wiring Devices.

C. Section 26 51 00 Interior Lighting.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Indoor occupancy/vacancy sensors.
   2. Daylight Harvesting Sensors
   3. Power Packs.
   4. Emergency Power Packs
   5. Emergency lighting control relays
   6. Low voltage control switches/dimmer switches.

1.3 DEFINITIONS

A. DT: Dual technology.

B. LED: Light-emitting diode.

C. PIR: Passive infrared.

1.4 REFERENCES

A. FCC Rules and Regulations, Part 15, Subpart J – Radio frequency Interference.

B. FS W S 896 Switch Toggle

C. International Energy Conservation Code (IECC).

D. NEMA WD 1- General Color requirement for wiring devices.

E. NEMA WD 7- Occupancy Motion Sensors.

F. NFPA 70- National Electrical Code (NEC).

G. UL Standard 916- Energy Management Equipment.

H. UL 924- Emergency Lighting and Power Equipment.

I. UL 1472- Solid State Dimming Controls.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated and used on the project.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring for all devices.
   2. Sensor coverage patterns for all locations. Include additional sensors for areas without overlapping coverage as part of this scope of work.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All sensors must be NEMA WD-7 listed; otherwise the manufacturer and contractor will be liable for all expenses associated with the installation of additional sensors, power packs, conduit and wiring to provide adequate coverage of area identified.

B. All sensor manufacturers need to provide certification that their products (microphonic/ultrasonic sensors) do not interfere with hearing aids and are A.D.A. compliant.

C. All sensor manufacturers need to provide certification that their products (ultrasonic sensors) do not interfere with Smart Board or other Media type electronic devices. Contractor is responsible for replacing all devices (at their expense) to conform to these requirements. Coordinate devices with Owner's Information Services Department prior to ordering.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.8 EXTRA MATERIALS

A. Furnish extra materials described as follows for each product used:
   1. One (1) occupancy/vacancy sensors of each type and size.
   2. One (1) daylight harvesting sensor of each type and size.
   3. One (1) power packs of each type and size.
   4. One (1) emergency lighting control relays of each type and size.
   5. One (1) low voltage lighting control switches of each type.
   6. One (1) low voltage lighting control dimmer switches of each type.
   7. One (1) low voltage replacement buttons of each type.

1.9 WARRANTY

A. Provide a five (5) year comprehensive warranty. Warranty shall cover all parts and labor.

## PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 SWITCH-BOX OCCUPANCY SENSORS (SEE DRAWINGS FOR ADDITIONAL INFORMATION)

A. Available Manufacturers:
   1. Acuity/Sensor Switch, Inc.

B. Description: Programmable occupancy/vacancy type sensor, PIR and dual tech type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1200 W at 277-V ac, suitable for incandescent light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.
   1. Include ground wire.
   2. Time Delay, Selectable: Automatic adjust and fixed adjustable in steps from 5 to 30 minutes.
   3. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.
   4. Color: Utilize White for color of devices unless otherwise directed by the Architect and Owner.

2.3 INDOOR OCCUPANCY/VACANCY SENSORS (SEE DRAWINGS FOR ADDITIONAL INFORMATION)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity/Sensor Switch, Inc.

B. General Description: Wall- or ceiling-mounting, solid-state occupancy/vacancy type units with a separate relay unit.
   1. The Acuity nCM xx RJB family of nLight ceiling/surface mount occupancy sensors provide a range of networked sensor solutions for applications with finished ceilings (e.g. ceiling tiles, sheetrock, plaster). nCM xx RJB family sensors utilize 100% digital Passive Infrared (PIR) detection and are available with several lens options, providing flexibility for multiple mounting height and coverage pattern requirements. Dual technology occupancy detection can also be added as an option for applications where occupants are stationary for long periods of time. nCM xx RJB family sensors are also available with an optional auxiliary low voltage relay for simple integration with a BMS system

or other building system. nCM xx RJB family sensors are powered via the nLight network bus. These configurations work standalone and do not require a connection to a larger nLight network.

2. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 30 seconds to 20 minutes. Also capable of vacancy type operation requiring manual on and auto off.
3. Sensor Input: 15-24VDC, 3mA, Class 2 (nLight network power)
4. Sensor Output: 24 VAC/VDC, 1A - Resistive (AR option).
5. Connection type: RJ-45 nLight Network Port or Low-Voltage Leads (AR option).
6. Include option for dimming photocell (ADCX) when required and meets project requirements.
7. Include optional auxiliary low voltage relay (AR option) when required for dry contact output – relay only tracks occupancy by default, ignoring switch and photocell commands.
8. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
10. Adjustable settings (e.g. occupancy time delays, photocell set-points) via push-button or SensorView software application
11. Bypass Switch: Override the on function in case of sensor failure.
12. Color: Utilize White for color of devices unless otherwise directed by the Architect and Owner.
13. Standards/Ratings: ROHS and System Component to aid in compliance with Title 24, ASHRAE 90.1, IECC.
14. **All sensor manufacturers need to provide certification that their products (microphonic/ultrasonic sensors) do not interfere with hearing aids and are A.D.A. compliant.**
15. **All sensor manufacturers need to provide certification that their products (ultrasonic sensors) do not interfere with Smart Board or other Media type electronic devices. Contractor is responsible for replacing all devices (at their expense) to conform to these requirements. Coordinate devices with Owner's Information Services Department prior to ordering.**

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
   1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
   2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
   3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

## 2.4 DAYLIGHT HARVESTING SENSORS

A. Manufacture must match occupancy sensor and power pack manufacture used.
1. Acuity/Lithonia, Inc. (BASIS OF DESIGN)

B. Overview:
1. The nCM ADCX RJB photocell sensors are ceiling/surface mount devices that provide a range of daylight harvesting features for nLight Control System installations with finished ceilings (e.g. ceiling tiles, sheetrock, plaster). The nCM ADCX RJB provides automatic dimming photocell control by default. Ideal for spaces with windows, such as vestibules, corridors, classrooms, or offices, these sensors work by first monitoring daylight conditions in a room. They then signal networked nLight control devices to adjust their dimming outputs (and/or turn lighting off) to obtain maximum energy savings while ensuring adequate lighting levels are maintained.
2. The nCM ADCX RJB sensor can also be used together with nLight occupancy sensors. Manual override or adjustment of the dimming level is possible via WallPod dimmers or through the SensorView software.
3. The sensor is powered via the nLight network bus and can control fixtures. These configurations work standalone and do not require a connection to a larger nLight network.

C. DLH senor shall provide continuous dimming control for 2-wire 0–10V dimming LED drivers based on natural daylight. The nCM ADCX RJB sensor continuously adjusts a space’s lighting to achieve maximum daylight harvesting while maintaining a minimum light level, referred to as the set-point. When no daylight is available, the sensor allows the controlled dimmable lighting to operate at its full bright level. As

daylight increases and begins to contribute to the overall light level of the room, the Automatic Dimming Control (ADC) feature starts dimming the room proportionally, eventually reaching the full dim level (or optionally switching off, see paragraph below). As the daylight levels fall, the ADC feature will again take control of the lights; reducing the dim level (increasing the brightness) in order to achieve the necessary total light level. At the point when all daylight contribution is gone, lighting will be back at its full bright level.

D. Features:
1. Controls connection: RJ-45 nLight Network Ports (2 ports via included RJ-45 splitter) or Low-Voltage Leads (AR option).
2. Set Point of 0-200fc.
3. Sensor type- blue enhanced photodiode.
4. Accuracy, +/-1% @ 70°F.
5. Operating temperature, -4°F to 185°F pending option selected.
6. Selectable 3- or 8-second dimming rate.
7. Multiple calibration options.
8. Low-profile design.
9. Color: Utilize White for color of devices unless otherwise directed by the Architect and Owner.
10. Five-year limited warranty.
11. Low voltage device: 24 Vdc, 22 gauge wire.
12. Certification by ETL/UL 916.
13. Input Ratings 15-24VDC, 3mA, Class 2 (nLight network power).
14. Output Ratings 24 VAC/VDC, 1A - Resistive (AR option).
15. Relay Type Latching (AR option).
16. Standards/ Ratings Energy Management Equipment, UL916 (E167435), and System Component to aid in compliance with Title 24, ASHRAE 90.1, IECC.

## 2.5 OUTDOOR LISTED SENSORS

A. Where shown. Refer to drawings for additional information.

## 2.6 STANDARD nLIGHT POWER PACK

A. Manufacture must match occupancy sensor and power pack manufacture used.
1. Acuity/Lithonia, Inc.

B. The nLight nPP16 EFP family of power packs is the workhorse of an nLight system, delivering robust system performance and design versatility for commercial and industrial lighting control applications. The nPP16 EFP family is capable of switching loads via an internal latching relay designed with robust protection from the harsh switching requirements of LED loads. These power packs also provide nLight system bus power - up to 40mA from each of its two RJ-45 ports - by transforming Class 1 line voltage (120/277 VAC or 347 VAC) to Class 2 low voltage (15 VDC). This power is typically utilized by other nLight devices within the power pack’s local control zone; however, remaining power is also made available over the network for Bridges and devices in other zones to utilize.

C. Power Packs: Robust and reliable mechanically held latching relay device compatible with multiple sensor types, both occupancy and vacancy type.
1. Complies with current Energy Codes, ASHRAE 90.1, CA Title 20/24.

2. Work in conjunction with Daylight Harvesting, bi-level switching, plug load control and local on/off manual switching.
3. Fail safe operation to return to close circuiting for turning fixture on for emergency egress.
4. Photocell ready.
5. Plenum rated, Class II wires, Teflon coated per U.L. 2043.
6. U.L. listed for Energy Management Equipment.
7. Power supply output short circuit protection.
8. Tested for over 1,500,000 cycles.
9. Compatible with all lamp types FL, HID, LED, etc. Has high inrush capability, factory calibrated zero cross over for extended life.
10. Voltage regulated.
11. Mounts inside of junction box.
12. Operating Temperature: Warrantied Operating Temperature Standard: 14°F to 122°F. Standard: 14°F to 113°F if enclosed within a junction box. LT option: -4°F to 122°F.
13. Relative Humidity: 0 to 90 percent non-condensing.
14. Input: 120/277volt AC.
15. Output: 120/277volt AC. 16A - Tungsten, Standard Ballast, Electronic Ballast. General Purpose 120VAC, 50/60 Hz, 1/2 HP -Motor. SCCR rating equal to 5KA. Has 100mA, 0-10VDC Dimming Sink Current.
16. Relay type: Latching.
17. Low Voltage Output Ratings 15VDC, 40mA per RJ-45 Port (80mA total).
18. Class Rating: 0-10V Dimming can be wired Class 1 or 2.
19. EFP: With external fault protection.
20. Connection Type: RJ-45 nLight Network Ports (2). Non-Dimming Model has Line Voltage Leads. Dimming Model has Line and Low Voltage Leads.

2.7 EMERGENCY nLIGHT POWER PACK

A. Manufacture must match occupancy sensor and power pack manufacture used.
   1. Acuity/Lithonia, Inc.

B. The nLight nPP16 ER EFP family of power packs is the workhorse of an nLight system, delivering robust system performance and design versatility for commercial and industrial lighting control applications. The nPP16 ER EFP switches loads via an internal latching relay designed with robust protection from the harsh switching requirements of LED loads. Optional 0-10V dimming outputs (D or DS options) are designed with circuit isolation and provide up to 100mA of current sinking capability. The nLight nPP16 ER EFP Series relay pack is used to switch luminaires powered via an emergency circuit. The nLight nPP16 ER EFP relay pack is ideally suited for use in conjunction with a standard nnPP16 EFP power/relay pack that controls a zone's normal powered lighting.

C. Emergency Power Packs: Robust and reliable mechanically held latching relay device compatible with multiple sensor types, both occupancy and vacancy type.
   1. Automatically Overrides Emergency Lights On To Full Brightness Upon Normal Power Loss.
   2. Complies with current Energy Codes, ASHRAE 90.1, CA Title 20/24.
   3. Complies with Life Safety Emergency Power Equipment UL924 and Energy Management Equipment, UL916 (E167435).

4. Work in conjunction with Daylight Harvesting, bi-level switching, plug load control and local on/off manual switching.
5. Photocell ready.
6. Plenum rated, Class II wires, Teflon coated per U.L. 2043.
7. U.L. listed for Energy Management Equipment.
8. Power supply output short circuit protection.
9. Tested for over 1,500,000 cycles.
10. Compatible with all lamp types FL, HID, LED, etc. Has high inrush capability, factory calibrated zero cross over for extended life.
11. Voltage regulated.
12. Mounts inside of junction box.
13. Operating Temperature: Warrantied Operating Temperature Standard: 14°F to 122°F. Standard: 14°F to 113°F if enclosed within a junction box. LT option: -4°F to 122°F.
14. Relative Humidity: 0 to 90 percent non-condensing.
15. Input: 120/277volt AC.
16. Output: 120/277volt AC. 16A - Tungsten, Standard Ballast, Electronic Ballast. General Purpose 120VAC, 50/60 Hz, 1/2 HP -Motor. SCCR rating equal to 5KA. Has 100mA, 0-10VDC Dimming Sink Current.
17. Relay type: Latching.
18. Low Voltage Output Ratings 15VDC, 40mA per RJ-45 Port (80mA total).
19. Class Rating: 0-10V Dimming can be wired Class 1 or 2.
20. Connection Type: RJ-45 nLight Network Ports (2). Non-Dimming Model has Line Voltage Leads. Dimming Model has Line and Low Voltage Leads.

2.8 EMERGENCY LIGHTING CONTROL RELAY (For non-nLIGHT devices)

A. Unit is based on Leviton, Inc. model #ECS00-110 or IOTA ETS20 equivalent. ECS00-110 to be used for non-dimmer controlled light fixtures. For 0-10VDC dimmer controlled light fixtures, use Leviton model #ECS00-DDW and install device flush mounted in ceiling system.

B. In the past, emergency lights were kept on 24 hours a day to meet life safety codes. Now, you can use a UL 924 listed Emergency Power Control, Model ECS00-110, to convert regular light fixtures into approved emergency lights. The ECS00-110 saves energy and money while ensuring compliance with both life safety and energy codes.

C. During normal operation, the same room switch, occupancy sensor, relay panel, or lighting control switches regular and emergency fixtures on and off simultaneously.

D. During a utility power interruption, the ECS00-110 automatically bypasses the regular lighting controls, turning the emergency lights ON, regardless of switch position.

E. The ECS00-110 is ceiling or wall mounted in a junction box with a single gang plaster ring and is usually located in the area where the emergency fixtures are installed.

F. The unique feature of the ECS00-110 is the ability to place the unit above the accessible ceiling tile because the unit does not require an accessible test switch. Instead, when the room switch is turned off, the emergency luminaires stay on for 2.5 seconds and indicate that an emergency power source was available and that

the ECS00-110, ballast/LED, and lamp(s) are all functioning correctly. This feature replaces a test switch and is approved for this purpose.

G. Unit has power indicator LED for utility power (green).

H. Mount in 4-11/16" box with extension/mud ring and install device in ceiling tile or gyp ceiling. Refer to manufacture installation instructions for additional information. Label outside of coverplate with unit information.

I. All units shall be tested and certified as operational in writing and results included in close out documents.

J. ECS00-DDW or IOTA ETS20 DR provides the same features, but also includes an isolated 0-10V relay contact ensure full brightness during utility power interruption, regardless of dimmer model.

K. UL 924 listed.

L. 5 year warranty.

## 2.9 LOW VOLTAGE LIGHTING CONTROL SWITCHES/DIMMER SWITCHES

A. Manufacture must match occupancy sensor and power pack manufacture used.
   1. Acuity/Lithonia, Inc.

B. Refer to drawing notes and details for additional information.

C. Low voltage lighting control dimmer switches shall be based on Acuity/Lithonia nPODMA Family of switches:
   1. The nPODMA Series WallPods are single gang nLight-enabled decorator wall switches that enable toggle/ raise/lower/scene control of lighting zones. Equipped with soft-click push-buttons, and a green LED indicator for each button, these devices allow field replaceable and custom engraved button options. nPODMA WallPods communicate with other nLight devices, via CAT-5e cable, through RJ-45 connectors and can be daisy-chained to work with nLight power packs to provide switch control operations. The scene control option presents a convenient method of selecting a custom lighting control scene for spaces in which installed, or requesting a global profile scene be run across several remote zones. By default, scene control wall switches are configured as on/off toggle switches and are to be customized programmatically through the SensorView software
   2. Communicates with nLight network.
   3. Remotely configurable/upgradeable
   4. Soft-click push-button control
   5. Sets lights to one of two or four preset levels with single button push (nPODMA xL versions only)
   6. Scene controllers run locally stored scenes or global scenes (stored on gateway)
   7. Capable of Programming 4 Different Scene Types.
      a. Local "Profile" Scene — Modifies the operational configuration of up to 80 devices in the local zone. Stopping scene will revert devices to default settings.
      b. Local "Preset" Scene — Modifies on/off/dim levels for up to 16 local switch groups. Exit scene through additional "preset" scene or WallPod control.

c. Global "Profile" Scene — Modifies the operational configuration of any devices on the system. Stopping scene will revert devices to default settings. Scene is stored on the system Gateway.
d. Global "Preset" Scene — Modifies on/off/dim levels for up to 128 global switch groups. Exit scene through additional "preset" scene or WallPod control.
e. Easy-to-install screwless wall plate design offers a clean, uninterrupted aesthetic for a more refined look in the space.
f. A full range of color options provides a variety of choices for your building designs with the assurance that the housing and the wall plate match.
g. 1, 2, or 4 channel on/off.
h. 1, 2, or 4 channel raise/lower.
i. "Dynamic" options for custom button names when pairing with Acuity Brands nTUNE fixtures.

8. Include custom engraving to match Owner's requirements.
9. Input Ratings 15-24VDC, 5mA, Class 2 (nLight network power).
10. Standards/Ratings Energy Management Equipment, UL916 (E167435).
11. Mounting, single and multi-gang junction box as required.
12. Connection Type RJ-45 nLight Network Ports (2).
13. Warrantied Operating Temperature 32°F to 140°F, LT Option: -4°F to 140°F.
14. Relative Humidity Up to 90%, Non-Condensing.
15. Color: Utilize White for color of devices unless otherwise directed by the Architect and Owner.

D. Low voltage lighting control toggle on/off switches.
1. Switches will be compatible with the above referenced dimmer switches and be able to integrate with system for 3-way and 4-way switching. Refer to Wiring Device specifications for additional information on standard toggle switch devices.
2. Refer to drawing notes and details for additional information.
3. The nPODM xS Series WallPods are single gang nLight-enabled devices that provide one, two, and four scene control. These units provide a convenient method of selecting a custom lighting control scene for the room in which it is installed, or requesting a global profile scene be run across several remote zones. By default, however, the buttons of an nPODM xS are configured as on/off toggle switches. Scenes are programmed to these units utilizing available SensorView software. The nPODM xS has soft-click push-buttons with a green LED indicator for each button. These button are field replaceable and can be custom engraved. Two RJ-45 connectors allow the nPODM xS to be daisy-chain wired with CAT-5e cabling to other nLight network devices. The nPODM xSB offers individual on/off buttons for each scene. Pressing the "on" button will reset the expiration time of a scene back to the original programmed time.
4. Input Ratings 15-24VDC, 5mA, Class 2 (nLight network power).
5. Mounting, single and multi-gang junction box as required.
6. Connection Type RJ-45 nLight Network Ports (2).
7. Warrantied Operating Temperature 32°F to 140°F, LT Option: -4°F to 140°F.
8. Relative Humidity Up to 90%, Non-Condensing.
9. Color: Utilize White for color of devices unless otherwise directed by the Architect and Owner.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Plenum rated Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Plenum rated Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Network Control Cable: Plenum rated Cat-5e or greater. T568B wiring convention recommended for nLIGHT systems. Include associated jacks as required for a complete installation.

## PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions. Install additional sensors as required to meet coverage requirements at no additional cost to the Owner.

3.2 POWER PACK INSTALLATION

A. Mount all power packs in junction box for containment of device and associated wiring. Nipple into adjacent power junction box for lighting control switch legs. Refer to drawing details for additional information.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch. All exposed wiring in finished spaces shall be installed in metallic wiremold raceway.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

G. All 0-10volt wiring and control wiring shall be separated from line voltage power circuits and shall be plenum rated; otherwise installed in a raceway system with cabling insulation rated for 600volts. Do not install low voltage wiring that is partially not in raceway and also contained in raceway with other line voltage circuits. Once installed with line voltage circuits, it must remain entirely within a raceway system per code.

H. Install all wiring in conformance with Division 26 and 27 specifications.

I. Do not install any cable above top chord of bar joists or within 6” of roof deck to prevent damage caused by roofing nails.

J. Support all cabling independently of other systems.

## 3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting system.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
   3. Identify all power circuits with panel and circuit information.

B. Provide custom engraving on all low voltage control switches as selected by the Owner and/or as designated on project drawings.

C. Label any time switches and contactors with a unique designation.

## 3.5 COMMISSIONING (COORDINATE ALL WORK WITH THE OWNER)

A. Provide factory-certified field service engineer to ensure proper system installation and operation under following parameters:
   1. Certified by the equipment manufacturer on the system installed.
   2. Site visit activities:
      a. Verify connection of power feeds and load circuits.
      b. Verify connection of controls.
      c. Verify system operation control by control, circuit by circuit.
      d. Obtain sign-off on system functions.
      e. Demonstrate system capabilities, operation and maintenance and educate Owner’s representative on the foregoing.
   3. At least three site visits to accomplish the following tasks:
      a. Prior to wiring.
         1) Review and provide installer with instructions to correct any errors in the following areas:
            a) Low voltage wiring requirements.
            b) Separation of high and low voltage wiring runs.
            c) Wire labeling.
            d) Load schedule information.
            e) Switching cabinet locations and installation.
            f) Physical locations and network addresses of controls.
            g) Ethernet connectivity.

h) Load circuit wiring.
i) Connections to other systems and equipment.
j) Placement and adjustment of Occupancy Sensors (when specified).
k) Placement and adjustment of Photocells (when specified).

b. After system installation:
1) Check and approve or provide correction instructions on the following:
a) Connections of power feeds and load circuits.
b) Connections and locations of controls.
c) Connections of low voltage inputs.
d) Connections of the data network.
2) Turn on system control processor and upload any pre-programmed system configuration.
3) Verify device address(es).
4) Upload pre-programmed system configuration and information to switching and/or system devices.
5) Check load currents and remove bypass jumpers.
6) Verify that each system control is operating to specification.
7) Verify that each system circuit is operational according to specification.
8) Verify that manufacturers' interfacing equipment is operating to specification.
9) Verify that software supplied by the manufacturer are performing to specifications.
10) Have an owner's representative sign off on the above-listed system functions.

c. Before project completion and hand-off:
1) Demonstrate system capabilities and functions to owner's representative.
2) Train owner's representative on the proper operation, adjustment, and maintenance of the system.

B. Notification: Upon completion of the installation, the contractor shall notify the manufacturer that the system is ready for formal checkout. Notification shall be given in writing a minimum of 21 days prior to the time factory-trained personnel are required on site. Each field installed RJ45 connection must be tested prior to system interconnection. A test report must be furnished to manufacturer prior to scheduling commissioning activity. Manufacturer shall have the option to waive formal turn-on.

C. Turn-On: Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's Certified Technician shall completely check the installation prior to energizing the system. Each installed device shall be tested for proper ON/OFF/dimming operations, and proper LED illumination. Each installed device shall be tested verifying that each controlled load adjusts to the selected setting and that all switch LED's illuminate properly.

D. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.6 ADJUSTING

A. Manufacturer’s Representative shall be on site to work with contractor in setting up and adjusting all sensors prior to completion of project. Manufacturer’s Representative will certify in writing that work was performed for each device installed.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

B. The manufacturer’s representative shall provide system training for up to four people as selected by the Owner. Training manuals will be provided for each person. The session will last at least two hours and be video recorded for the Owner’s future use. Training video to be saved to USB memory stick, coordinate exact format with Owner. Contact the Owner at least two weeks prior to training for proper scheduling of the event. The contractor will provide to the Owner a typed outline of the events at the training session and the list of who attended.”

**END OF SECTION**

# SECTION 26 22 00

# LOW-VOLTAGE TRANSFORMERS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.
   2. Control and signal transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

G. Output Settings Report: Record of tap adjustments specified in Part 3.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) (UL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Comply with EPACT 2005/CFR 10 part 431 compliant efficient transformers.

F. Energy-Efficient Transformers Rated 15 kVa and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2. Label with Energy Star Logo per NEMA TP-3. All transformers shall be DOE Compliant.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

C. Coordinate transformer size with fault current coordination study.

1.6 WARRANTY

A. Provide two years warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel, one leg per phase.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, drip-proof, NEMA 250, Type 2, Interior Dry Locations.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: ANSI 49 gray.

E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.
3. 98.3% efficient rating.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

K. Wall Brackets: Manufacturer's standard brackets.

L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

B. Install ARC Flash warning labels and identify level of PPE protection required.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

C. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
   1. Utilize isolating pads suitable for reducing transformer noise throughout the building.
   2. Provide minimum 6” between back of transformer and wall for ventilation; more when required by manufacturer or codes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Utilize Liquidtight flexible metal conduit for final make up connection to transformer. Ground as required using jumper across flexible connection.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

**END OF SECTION**

# SECTION 26 24 16

# PANELBOARDS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. SPD: Surge Protective Device.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment. (All devices shall be sized in accordance with overcurrent protective device coordination study per Division 26 Section "Overcurrent Protective Device Coordination Study.")
1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of U.L. listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:
1. Test procedures used.

2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

G. All devices to be U.L. listed.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

## 1.7 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg Fto plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's, Construction Manager's and Owner's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate all panelboard and circuit breaker size and type with fault current coordination study prior to ordering equipment.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two (2) years from date of Substantial Completion for all parts and labor.
2. Warranty Period for SPD Devices: Five (5) years from date of Substantial Completion.

1.10 EXTRA MATERIALS (Per School)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Six spares for each type of panelboard cabinet lock.
2. Card Directory with all Room and Devices serving; filled out in typed format (shall not be hand-written). Include in panelboards and copies must be included in close out documentation.

## PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Enclosures: Flush- and surface-mounted cabinets as indicated on drawings.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1. When installed in dry kitchen environments, use stainless steel covers.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Utilize NEMA 4X covers/enclosures with stainless steel covers in kitchen and other area environments with wash down requirements.
   2. Hinged Front Cover: Heavy duty, entire front trim hinged to box front and with standard door within hinged trim cover (door within door). Provide locks for both, flush mounted tumbler style. For flush-mounted fronts, overlap box.
   3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   5. Finishes:
      a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel and same finish as panels and trim.
   6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
   7. In remodeling work, no existing tubs will be allowed to be reused with new interiors without Owner’s prior approval. If approved by the Owner, the assembly of an exiting tub and new interior will require a combination U.L. listing by the new interior manufacturer.

C. Incoming Mains Location: Top or bottom as job conditions dictate.
   1. Main lug only or main breaker as noted on drawing panel schedule.

D. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity, 1000 amps per square inch.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. All lugs shall be listed for cabling type/applications.

F. Service Equipment Label: U.L. labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by UL. (Refer to drawings for additional information.)

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. (Refer to drawings for additional information.)

J. Provide circuit breakers for SPD devices specified (as noted on drawings).

K. All breakers shall be bolt on.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating or full interrupting capacity to meet available fault currents (as noted on drawings).
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip) (when noted on drawings) for Life Safety protection.
   3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip) (when noted on drawings) for Ice Melt systems.
   4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
         PROVIDE THE FOLLOWING WHERE NOTED ON THE DRAWINGS:
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.3 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in Division 26 Sections.

D. Mount top of trim 74 inches above finished floor unless otherwise indicated. All switches must be kept to mounting height that does not exceed NEC requirements.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

K. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

L. Label all branch neutral and phase conductors with circuit number.

M. Surge protection devices shall not be integrated into panelboards. All surge protection must be stand alone devices. Include branch breakers to service surge protection devices.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

E. Install arc flash warning labels and level of PPE protection required.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as required.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
   5. Tighten all bolted connections/bus joints, breakers and torque to manufacturers' recommendation.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

**END OF SECTION**

# SECTION 26 27 26

# WIRING DEVICES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, special receptacles and associated device plates.
   2. Snap switches.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 REFERENCES

A. NFPA 70 National Electrical Code.

B. DSCC W-C-896D- General Specification for Electrical Power Connector.

C. WD 1-1979 general-purpose wiring devices.

D. WD 5 specific-purpose wiring devices.

E. W-C-596 electrical power connector, plug, receptacle and cable outlet.

F. W-S-896 switch, toggle.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
1. Cord and Plug Sets: Match equipment requirements.

1.8 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Switches: Two (2) of each type and size.
2. Receptacles: Two (2) of each type and size.
3. Keys: Minimum of 10 percent, but no fewer than ten (10).

1.9 WARRANTY

A. Provide minimum (1) one year warranty on all parts and labor unless manufacturer’s warranty is greater.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2. Leviton Mfg. Company Inc. (Leviton).
3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
4. Cooper.

2.2 STRAIGHT BLADE RECEPTACLES (TAMPER RESISTANT)

A. Tamper Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, DSCC W-C-596G and UL 498, NEMA

heavy duty spec grade class (federal specification listed); 2-pole, 3-wire one piece integral grounding strap with green hexagonal equipment ground screw; ground terminal and poles internally connected to mounting yoke; rated at 20 amperes, 125 volts; back and side wiring, metal plaster ears; NEMA configuration 5-20R, unless otherwise indicated. Terminals must accept #10 AWG wire.

1. Hubbell #5352-TR series, Leviton 5362 series, P&S 5362 series and Cooper 5362 series. Color-White.
2. For emergency power receptacles (fed from generator system) utilize Hubbell #SNAP8300WLTR Snap connector receptacle with Snap connector. Receptacles to be 120volt, 20amp tamper resistant, red in color with illuminated face and include red coverplate engraved with emergency. Utilize GFCI devices of the same type when installed outdoors or near water sources per NEC. Other manufacturers to provide equivalent product.
3. For controlled receptacles utilize Legrand TR5362 series. Color-White. **Controlled receptacles must have factory markings indicating which side is controlled.**

2.3 STRAIGHT BLADE RECEPTACLE WITH USB CHARGING (TAMPER RESISTANT)

A. USB Charging Convenience Receptacles, 125V, 20A: heavy-duty Spec grade, NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, tamper resistant. Receptacle shall incorporate USB Type A & C charging ports with a 5.0Amp output at 5VDC, compatible with USB A & C devices, including Apple products.
   1. Typical to Legrand TR5362USB series. Color-White. Provide appropriate junction box size to fit receptacles. Other manufacturers to provide equivalent product. **Verify final USB charging port type with Owner prior to ordering.**

2.4 GFCI RECEPTACLES (TAMPER RESISTANT)

A. Tamper Resistant straight blade, duplex. 125V, 20A, GFCI, heavy duty spec grade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped, and meeting UL GFCI July 28, 2006, lock-out requirements and incorporates automatic self testing. Provide appropriate junction box size to fit receptacles.
   1. Typical to Hubbell #GFTRST20 series. Color-White. Other manufacturers to provide equivalent product.

B. Receptacles used outdoors and/or in damp locations shall also be listed as "WR" (weather resistant). All exterior receptacles shown on drawings as WP-GFI shall utilize weather resistant, tamper resistant, GFCI type receptacles per code. Equivalent to Hubbell #GFTWRST20 series. Color-White. Other manufacturers to provide equivalent product.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1, W-C-896F and UL 20.

B. Wall switches: NEMA heavy-duty spec grade class (federal specification listed); rated at 20 amperes, 120/277 volts; AC quiet quick make, quick break design; toggle handle with totally enclosed case; mounting yoke insulated from mechanism

with stainless steel grounding clip; single pole, side wiring, metal plaster ears. Terminals must accept #10 AWG wire. Motor rating – 80%, tungsten rating – 100%.

1. Hubbell #HBL1221, Leviton 1221-2, P&S PS20AC1, Cooper AH1221 Series. Color-White.
2. For 3-Ways: Hubbell 1223, Leviton 1223-2, P&S PS20AC3, Cooper AH1223. Color-White.

C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   1. Switch: 20 A, 120V ac.
   2. Receptacle: NEMA WD 6, Configuration 5-20R.
   3. Color-White.

D. Pilot light switches: NEMA heavy-duty spec grade class (federal specification listed); rated at 20 amperes, 120/277 volts, AC quiet quick make, quick break design; lighted red polycarbonate toggle handle, when switch in on position; neon lamp; mounting yoke insulated from mechanism with stainless steel group clip; single pole; side wring. Terminals must accept #10 AWG wire. Motor rating – 80%, tungsten rating – 100%:
   1. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
   2. Hubbell HBL1221PL, Leviton 1221-PLR, P&S PS20AC1-RPL, Cooper AH1221PL.
   3. Color-White.

E. Key-Operated Switches, 120/277 V, 20 A:
   1. Description: Single pole, with factory-supplied key in lieu of switch handle.
   2. Hubbell HBL1221L, Leviton 1221-2L, P&S PS20AC1-L, Cooper AH1221L.
   3. Color-White.

F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Color-White.

G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
   1. Color-White.

## 2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: UL Listed High impact, self-extinguishing smooth nylon material, Color-White. Coordinate exact finish/type with architect prior to ordering.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover. Receptacle covers to be of the in-use type.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: Utilize "White" for color of devices unless otherwise directed by the Architect and Owner or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
   5. Install devices and assemblies level, plumb, and square with building lines.
   6. Install wall dimmers 48 inches to top of cover plate above floor, derate ganged dimmers as instructed by manufacturer; do not use common neutral.
   7. Mount receptacles horizontally with bottom of plate cover 16 inches above floor, unless otherwise indicated.
   8. Mount wall switches vertically with top of plate cover 48 inches above floor, unless otherwise indicated.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Clean dirt and debris from electrical boxes and remove moisture prior to installing wiring devices.
   2. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
   6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   7. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections, unless device is rated for #10 wire.
   9. Tighten unused terminal screws on the device.
   10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
   11. When using stranded wires (when allowed) on receptacles and light switches, avoid fraying of wires around terminals. Wrap sides of devices with electrical tape when complete.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
   2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates:
   1. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
   2. Remove wall plates and protect devices and assemblies during painting.
   3. Install blank finished coverplates over all abandoned openings in finished areas.
   4. Install blank finished coverplates over all telecommunication (voice data), video and other technology related junction boxes that are not activated with cabling.

G. Arrangement of Devices: Unless otherwise indicated, mount flush. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. **Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes. Coordinate with Owner prior to making up labels.**
2. Identify all circuitry information on all above ceiling junction boxes and within outlet and switch boxes. Black permanent marker labeling is acceptable.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Bond all junction box ground wire pigtails to grounding wire and wiring device grounding screw.

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

**END OF SECTION**

# SECTION 26 28 16

# ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Fuses Specification Section 26 28 13.

1.2 SUMMARY

A. Section Includes:
1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of UL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified, include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL, such as UL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

F. All devices shall be U.L. listed.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Architect's, Construction Manager's and Owner's written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizing of switches, breakers and fuses with mechanical contractor and other tradesman equipment shop drawings prior to ordering equipment.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.
2. Fuse Pullers: Two for each size and type.
3. All exterior disconnect switches shall be provided with a weatherproof padlock, all with matching tumblers/keys. Provide a minimum of six (6) keys to the Owner.

1.9 WARRANTY

A. Provide (1) one year warranty on all parts and labor.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; a brand of Schneider Electric.
2. All other manufacturers require Owner approval to bid on project.

2.2 FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Quick Make-Quick Break, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position, with load interrupter enclosed visible blade knife switch.

B. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Quick Make-Quick Break, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position, with load interrupter enclosed visible blade knife switch.

B. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS (ALL BREAKERS SHALL BE COORDINATED WITH FAULT CURRENT COORDINATION STUDY)

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. To be used with motor starters and VFC’s, which are furnished with overload protection.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings (For breakers 1200 amps or more):
1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and $I^2t$ response.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip) for Life Safety protection.

F. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits. Type HACR for heating, air conditioning and refrigeration equipment.

PROVIDE THE FOLLOWING WHERE INDICATED ON DRAWINGS:

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Accessory Control Power Voltage: Integrally mounted, self-powered.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

2.6 FUSES

A. Fuses 600 amperes and less: Dual element, current limiting, time delay, UL class RK 1, 600 volt Type LPS-RK or 250 volt type LPN-RK as required, UL listed, 200,000 AIC (RMS), Bussmann low-peak dual element fuses.

B. Fuses 601 amperes and larger: Current limiting, time delay, UL class L, 600 volt Type KRP-C, UL listed, 200,000 AIC (RMS), Bussmann hi-cap time delay fuses.

C. All fuses shall be of the same manufacturer. See Division 26 Section 26 28 13 "Fuses" for additional information.

D. The over current device coordination was based on the fuse sizes and types specified. Any substitution of brand, size or type of fuse from that specified, must be preceded by the submittal of a complete coordination study for the substitute over current protection scheme.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Provide concrete bases where required and anchor all equipment.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1, NEMA PB 1.1 and PB 2.1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

B. Install arc flash warning labels and identify level of PPE protection required.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

3.7 TRAINING

A. Provide one hour training session for Owner's personnel on electrical breakers when used. Provide Operation and Maintenance Manuals for each person. At completion of training, provide certification letter to Owner stating completion of training and attach copy of sign-in sheet showing all personnel present.

**END OF SECTION**

# SECTION 26 29 13

# ENCLOSED CONTROLLERS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
      d. Short-circuit current rating of integrated unit.
      e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL (U.L.) acceptable to authorities having jurisdiction.
      f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For qualified testing agency.

E. Field quality-control reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified, include the following:
1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Agency, within 50 miles of project site, capable of providing training, parts and emergency maintenance and repair.

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

C. Comply with NFPA 70.

D. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical systems.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with interruption of electrical systems without Architect's, Construction Manager's and Owner's written permission.
   4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements as specified.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

F. Coordinate unit sizes with mechanical contractor prior to ordering.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Indicating Lights: Two of each type and color installed.

3. Auxiliary Contacts: Furnish one spare for each size and type of magnetic controller installed.
4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.
5. Coils: Equal to 10 percent, but not less than one of each type and size.

1.10 WARRANTY

A. Provide (1) one year warranty on all parts and labor unless manufacturer's standard warranty is for greater period of time.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D.
2. All other manufacturers require Owner approval prior to bidding.

2.2 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Rated Manual Controllers: NEMA ICS 2 Heavy Duty, Class A, "Quick-make, quick-break" toggle action; marked to show whether unit is off, on, or tripped.
1. Configuration: Nonreversing.
2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
3. Surface mounting.
4. Red pilot light.
5. Nameplates: Identifying unit name and number serving.

C. Integral Horsepower Manual Controllers: NEMA ICS 2 Heavy Duty, Class A, "Quick-make, quick-break" toggle action; marked to show whether unit is off, on, or tripped.
1. Configuration: Nonreversing.
2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
3. Surface mounting.
4. Red pilot light.
5. Additional Nameplates: Identifying unit name and number serving.
6. N.O./N.C. auxiliary contact convertible.

D. Magnetic Controllers: Full voltage, across the line, electrically held, NEMA ICS 2, Class A.

1. Configuration: Nonreversing.
2. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 100 VA.
5. **Solid-State Overload Relay**:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 10/20 selectable tripping characteristic adjustable and selected to protect motor against voltage and current unbalance and single phasing.
   d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
   e. Analog communication module.
6. Two (2) N.C./N.O, NEMA ICS 2, isolated overload alarm convertible contact.
7. External overload reset push button.
8. Red pilot run light.
9. With hand-off-auto selector switch.
10. Control Relays: Auxiliary and adjustable time-delay relays as required.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means. (To be used on all multi-pole phase motors requiring automatic starting means unless otherwise indicated.)
   1. Includes all components of magnetic controllers plus the following devices listed below.
   2. MCP Disconnecting Means:
      a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
      c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
      d. N.C./N.O. alarm contact convertible that operates only when MCP has tripped.
      e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

## 2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   3. Other Wet or Damp Indoor Locations: Type 4.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard Gray paint with corrosion resistant primer coated applied to factory-assembled and -tested enclosed controllers before shipping.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.
      a. Push Buttons: Shrouded types; momentary as indicated.
      b. Pilot Lights: LED types; colors as indicated; push to test.
      c. Selector Switches: Rotary, hand-off, auto type.
   2. Elapsed Time Meters: Heavy duty, vibration proof, with digital readout in hours; resettable.

B. Reversible N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

E. Cover gaskets for Type 1 enclosures.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall (especially if walls are damp or susceptible to becoming wet). For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

D. Select heaters based on actual nameplate full-load amperes after motors have been installed. Adjust all electronic thermals to actual nameplate full-load amperes after motors have been installed.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

G. Coordinate all equipment with mechanical/equipment contractor prior to ordering equipment to ensure proper sizes/H.P. ratings.

H. Motor data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor and voltage/phase rating. Provide plastic laminate label on front on motor starter as called for in electrical identification section.

## 3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Install ARC Flash PPE labels on all starters.

## 3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system connection point. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables." Coordinate work with control systems contractor control point.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors. DO NOT BYPASS SAFETY DEVICES.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect, Construction Manager and Owner before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed controllers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect, Construction Manager and Owner before increasing settings.

C. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

## 3.7 PROTECTION

A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

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

B. Schedule training with Owner through Architect with at least seven day advance notice. Provide minimum of one hour of training with approved training manuals and video record session for Owner's future use.

**END OF SECTION**

# SECTION 26 43 13

# SURGE PROTECTIVE DEVICES

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Sections:
   1. Division 26 Section "Panelboards."

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. VPR: Voltage Protection Rating.

C. SPD: Surge Protective Device(s)

1.4 SUBMITTALS

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

B. Qualification Data: For qualified testing agency (U.L.).

C. Product Certificates: For SPD, from manufacturer, signed by Manufacturer's authorized representative indicating that:
   1. SPD system is listed under the following titles:
      a. UL 1449 4th Edition without use of an external overcurrent device.
      b. UL 1283 EMI/RFI.
   2. The transient capacity of all internal fusing ahead of the primary surge suppression elements meet or exceeds the specified surge current capacity of the SPD, and warranty the continuous operation under successive surges without degradation its surge rating more than $\pm$10%.

D. UL 1449 4th Edition Voltage Protection Rating (VPR) is assigned to each mode of protection using a combination wave generator at a setting of 6kV, 3kA. SPD shall have a Nominal Discharge Current rating (In) of 10kA or 20kA.
   1. VPR for wye and single phase (L-N, L-G and N-G):
      a. 800-1000V for 120V systems.
      b. 1200-1400V for 277V systems.

c. 1800-2200V for 347V systems.
2. SVR clamp levels for delta circuits (L-L and L-G):
a. 1200-1400V for 240V systems.
b. 2000-2200V for 480V systems.
c. 2400-2600V for 600V systems.

E. Field quality-control reports. Written reports of tests specified in Part 3 of this section. Include the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

F. Operation and Maintenance Data: For SPD to include in emergency, operation, and maintenance manuals.

G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Underwriter Laboratories 1449 (UL 1449 4th Edition is current safety standard for Surge Protective Devices).

E. Canadian Standards Association (CSA).

F. National Electrical Code (NEC Article 285 SPD Installation Practice/NEC Article 250.56 Grounding):
1. Article 100, SPD must limit transient voltage by diverting or limiting surge current; it also should prevent continued flow of follow current while remaining capable of repeating these functions. SPD that utilize fuses must have repetitive surge capability that can survive its surge rating and meet UL 1449.
2. Article 285.6, SPD must be marked with a short circuit current rating and shall not be installed at a point on the system (example, service, distribution or branch panels) where available fault current (AIC rating) is in excess of that rating.

G. NFPA-78 and CSA (National Fire Protection Association and Canadian Standards Associations).

H. ISO 9001: 2000 Quality Standard.

I. Military Standards: MIL-STD-220A.

J. ANSI/IEEE C62.41.1 and C62.41.2 2002: System shall be designed to meet National Standards American Institute/Institute of Electrical and Electronic Engineering Inc.

K. ANSI/IEEE C62.45 1992: System shall be tested to meet the C62.45.
   1. Category A & B: 0.5μs x 100kHz ring wave.
   2. Category B3 Biwave: 8 x 20μs at 3000A and 1.2 x 1.5μs at 6000V.
   3. Category C3 Biwave: 8 x 20μs at 10000A and 1.2 x 50μs at 20000V.

L. The fusing element must be capable of allowing the suppressor's rate single impulse current to pass through the suppressor. The system shall be tested to 1,000 sequential ANSI/IEEE C62.41 Category C3 combination wave transients. The Category C3 combination is defined as a 1.2 x 50 microseconds at 20,000V open circuit voltage wave form, and 8 x 20 microseconds at 10,000 ampere short circuit current wave form. In addition, the system components shall be tested respectively 1,000 times testing based on an IEEE C62.33 (SAD test) without failure or degradation exceeding $\pm$10%.

M. CBEMA (ITIC) and IEC: Computer Business Equipment Manufacturers Association or ITIC, and International Electromechanical Commission define clamping voltage tolerance guidelines for sensitive equipment.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed electrical service interruptions.
   2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's and Owner's written permission.

B. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
   1. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system operating voltage.
   2. Operating Temperature: 30 to 120 deg F.
   3. Humidity: 0 to 85 percent, noncondensing.
   4. Altitude: Less than 20,000 feet above sea level.

C. Placing into Service: Do not energize or connect equipment (service entrance, panelboards, data terminals) to their sources until surge protective devices (SPD) are installed and connected.

1.7 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance. **DO NOT EXCEED MANUFACTURER'S REQUIRED WIRING LEAD LENGTH.**

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Minimum of ten years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

C. All units requiring service shall be rectified within 48 hours of notification.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: One of each size and type installed.

## PART 2 - PRODUCTS

2.1 BRANCH PANEL SUPPRESSORS (NOT INTEGRAL IN PANELBOARD, SPD #1)

A. Acceptable Manufacturers and Models: No other manufacturers will be accepted.
   1. Current Technology: CG 60 series (120/208-3Y)
   2. LEA International Inc.: SP100 series (120/208-3Y)
   3. Liebert: ACVIII-RKE (120/208-3Y)
   4. THOR Systems: TnSc (120/208-3Y)

B. Devices shall meet specification requirements in 2.1 sections B through K listed above except as follows:
   1. All units to have the following qualities:
      a. EMI/RFI filtering.
      b. Visual fault displays.
      c. Form C-contacts. Coordinate with building power monitoring and control system.
   2. Equipment shall be a multi-stage parallel protector rated for 120/208VAC, 3 phase, 4 wire plus ground. The equipment’s minimum surge current capacity shall be 120kA per phase (L-N plus L-G) and 60kA per mode (L-N, L-G, L-L, and N-G).
   3. Unit shall be non-modular design, but modular units will be accepted at Engineer’s discretion.

C. Furnish and install 3Pole breaker in panelboard to service new surge protection unit.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. The specified external branch panelboard (Section 2.1) system shall be installed with the shortest lead length possible not to exceed one and half of electrical feet (1.5') from the power conductor(s) it is protecting; must have a grounding of 25 Ohms (NEC Article 250.56) or less; and shall avoid any unnecessary or sharp bends.

B. NEC Article 285 – "The surge protective device shall be connected on the load side of a service disconnect overcurrent device."

C. NEC Article 285 – "Conductor size. Line and Ground connection conductors shall not be smaller than 10 AWG copper for branch panelboard devices and 6 AWG copper for switchboard devices."

D. SPD device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:
   1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
   2. Complete startup checks according to manufacturer's written instructions.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

### 3.4 STARTUP SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals and data terminals to their sources until SPD devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protective devices.
   1. Train Owner’s maintenance personnel on procedures and schedules for maintaining suppressors.
   2. Review data in maintenance manuals. Refer to Division 1 Section “Closeout Procedures.”
   3. Review data in maintenance manuals. Refer to Division 1 Section “Operation and Maintenance Data.”
   4. Schedule training with Owner with at least seven days’ advance notice.

B. Provide one hour training session for Owner’s personnel. Provide Operation and Maintenance Manuals for each person. At completion of training, provide certification letter to Owner stating completion of training and attach copy of sign-in sheet showing all personnel present.

**END OF SECTION**

# SECTION 26 51 00

# INTERIOR LIGHTING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All LED light fixtures must be DLC (DesignLights Consortium) approved.

1.2 SUMMARY

A. This Section includes the following:
   1. LED lighting fixtures
   2. Exterior LED wall packs attached to building.
   3. Emergency lighting units.
   4. Exit signs.
   5. Lighting fixture supports.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including occupancy sensors and power packs.
   2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

C. The Electrical/Lighting Contractor must hold an ICC – Energy Efficiency Installer Certification in order to bid on this project and perform lighting work that will allow the Owner to obtain Energy Efficiency incentives. No exceptions.

D. The Electrical/Lighting Contractor will be required to survey all existing lights after school hours in areas of construction no later than one week after award of contract in order to assist the Owner in developing Energy Incentive Worksheets to obtain funding. Refer to paragraph 1.6 for additional requirements.

E. Review all lighting incentive requirements with Owner and utility company.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CEE: Consortium for Energy Efficiency.

C. CRI: Color-rendering index.

D. CU: Coefficient of utilization.

E. DCEO: Department of Commerce and Economic Opportunity.

F. DLC: Design Lights Consortium.

G. EISA 2007: Energy Independence and Security Act of 2007.

H. IEMA: Illinois Municipal Electric Agency

I. IESNA: Illuminating Engineering Society of North America.

J. LED: Light emitting diode.

K. LER: Luminaire efficacy rating.

L. Luminaire: Complete lighting fixture, including ballast housing if provided.

M. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. LED drivers.
   4. Lens types.
   5. Energy-efficiency data.
   6. Life, output, and energy-efficiency data for lamps.
   7. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, drivers, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. For specialized fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
      b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
   1. Wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Structural members to which suspension systems for lighting fixtures will be attached.
   4. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Sprinklers.
      d. Smoke and fire detectors.
      e. Occupancy sensors.
      f. Access panels.
   5. Perimeter moldings.

D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. LED fixtures must be certified by DLC (Design Lights Consortium).

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All fixtures shall be U.L. listed.

D. Comply with NFPA 70 and local code requirements.

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

G. Reference ANSI C78.377-2008- Specifications for the Chromaticity of Solid State Lighting Products.

H. Reference ANSI C82.77-2002- Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Complete an inventory of all existing light fixtures (survey to be conducted after school hours) scheduled to be removed with the same information as identified in Paragraph-C below so that Owner can apply for Energy Incentives. Include pictures of all fixture lamp and ballast combination for each type of fixture to be removed.

C. All new light fixtures shall be audited and a report provided to the Owner so that they may apply for any available energy incentives. Provide spreadsheet showing fixture type, fixture quantity and fixture wattages on a per room basis. Include breakdown on each fixture type for ballast/driver type wattage, lamp type/wattage and overall fixture wattage. Refer to Energy Incentive Worksheets for all documentation required. Include pictures of all fixture LED lighting engine and driver combination (including fixture energy label) for each type of fixture to be installed.

1.7 WARRANTY

A. Standard Warranty: (1) one year parts and labor on all fixtures unless manufacturer's standard warranty is greater.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: Five (5) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four (4) years.

C. Special Warranty for LED Fixtures: Manufacturer's standard form, made out to Owner and signed by fixture manufacturer and contractor agreeing to replace lamps/LEDs and drivers that fail in materials or workmanship, within specified warranty period indicated below.
   1. Warranty Period: Minimum five (5) years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: (2) of each type and rating installed.
   2. Plastic Diffusers and Lenses: (2) of each type and rating installed.
   3. Emergency Light Battery: (1) for each emergency lighting unit type installed.
   4. Exit Light Battery: (1) for each emergency lighting unit type installed.
   5. LED Driver: (2) of each type and size installed.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
   1. Where fire rated ceilings or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

B. LED Fixtures: Comply with UL 1598 and UL 8750. Test in accordance with IESNA LM-79 and LM-80 standards, and DLC certified.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging. Include integral junction box compartment.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

G. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

H. All new light fixtures (and associated drivers) must comply with lighting control requirements and any dimming capability.

## 2.3 LIGHTING FIXTURES

A. Refer to drawings for lighting schedule.

B. Acceptable Manufacturers – LED Luminaries.
   1. Acuity/Lithonia (USED AS BASIS OF DESIGN)
   2. Axis Lighting
   3. Other manufacturers as specified on drawings.

## 2.4 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs: LEDs for AC Operation: LEDs, 70,000 hours minimum rated lamp life, 25 year.

C. Self-Powered Exit Signs (**Battery When Noted**): Integral automatic charger in a self-contained power pack.
   1. Battery: Sealed, maintenance-free, nickel-cadmium type, 15 year prorated warranty; lead calcium type, 5 year prorated warranty. Full 2 year coverage warranty.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

## 2.5 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type, 5 year prorated warranty; nickel-cadmium type, 15 year prorated warranty. Full 2 year coverage warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Lamp: LED MR16 LED engine or equivalent.

## 2.6 LED LAMPS AND DRIVERS

A. Acceptable Manufacturers:
1. CREE
2. G.E.
3. Lighting Science.
4. Equivalent lighting manufacture "brand name" equivalent. Must be branded with lighting manufacturer's name only.

B. All lamps shall be from one manufacturer and shall be Energy Star listed.

C. Low-Temperature Driver Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F and higher.

D. Driver/LED Characteristics:
1. All lighting systems must be listed by DLC and by U.L
2. Power- multitap voltage for LED Class-I drivers with high performance heat sinks.
3. Power Factor: > 0.9 at full load.
4. Operating at universal voltage from 120-277v, auto detecting or independent leads as provided by manufacture.
5. Total Harmonic Distortion: < 20% at full load.
6. Integral weathertight electrical box with terminal strips (12Ga–20Ga) for easy power hookup.
7. Integral 10kV surge suppression protection standard.
8. To address inrush current, slow blow fuse or type C / D breaker should be used.
9. Patented NanoOptic Product Technology

10. ***CCT 4000K (+/- 300) as selected by the Owner during shop drawing process.***
11. CRI- Minimum 82.
12. LED rated for minimum of 50,000 hours and minimum of 80%LED lumen maintenance at that point.
13. Minimum of 89% efficiency and low EMI.
14. Efficacy of at least 115 lumens/watt.
15. Capable of dimming from 100% - 0% (or as noted) flicker free and compatible with dimming system specified (line voltage and/or 0-10 volt as specified.)

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer and provided by manufacturer to support their fixture. Cable support shall be anchored to structural steel and not ceiling system.

I. Do not support fixtures from conduit or from ceiling grid system. All fixtures to be supported from structure above ceiling. Fixtures can be clipped to grid for preventing lateral movement.

2.8 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Refer to drawings for light fixture schedule.

2.9 FINISHES

A. Fixtures: Manufacturers' standard, unless otherwise indicated.
   1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
   2. Troffers to be painted after fabrication.

2.10 SOURCE QUALITY CONTROL

A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor will be required to inventory all existing lights in rooms under construction and provide a spreadsheet to the Owner with the following for each room: fixture type, quantity, number of lamps (type) and wattage for each fixture. The contractor will then need to do the same for all new room lighting fixtures including the amount of occupancy/vacancy sensors installed. This is required so the Owner can apply for a lighting energy grant based on overall reduced power consumption.

B. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

C. Where fire rated ceilings or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

D. Where recessed fixtures are installed in gypsum board ceilings, include plaster frames and include support wires to structure above.

E. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings or gypsum ceilings:
   1. Install a minimum of four ceiling support system rods or wires for each fixture, minimum #12 gauge. Locate not more than 6 inches from lighting fixture corners. Rods/wire must be installed from structure and sized in order to support each fixture independently of grid. Wire shall have breaking strength of the weight of the fixture at a safety factor of 3 times units weight. Provide no more than 2” of slack in each fixture support cable after fixtures have been installed within grid.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application, per NEC 410-16-C.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees. Install at least one independent support rod or wire from structure to a tab on each end of lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

F. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Utilize uni-strut in order to keep individual fixtures in a row uniform in mounting heights. Refer to drawings for additional information. Paint out to match surrounding area.
4. Continuous Extruded Rows: Suspend from structure with aircraft cable listed by manufacturer for application. Do not fasten to grid ceiling.

G. Adjust aimable lighting fixtures to provide required light intensities.

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

I. All junction boxes used for supporting light fixtures will be heavy duty UL listed for the application. Do not support from ceiling grid. Support from structure and use grid to stabilize unit.

J. All flexible metal conduit connections shall be 6 feet 0 inches or less. Utilize plenum rated raceways when required per local code.

K. All conduit shall be supported from structure independently from grid ceiling and/or support wires. Do not anchor to ceiling or light fixture support wires.

L. Provide flange kits for all fixtures recessed mounted in gypsum ceilings.

## 3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## 3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

D. Five (5) months and eleven (11) months after fixture installation, contractor shall walk the building and replace all failed devices. DO NOT USE OWNER’S ATTIC STOCK. Provide documentation to Owner showing all fixtures that were worked on for the Owner’s records. This procedure does not relieve the contractor from performing warranty work that is brought to their attention by the Owner.

## 3.4 ENERGY GRANTS

A. All existing and new light fixtures shall be audited and a report provided to the Owner so that they may apply for any available energy grants. Provide spreadsheet showing fixture type, fixture quantity and fixture wattages on a per room basis.

B. Assist the Owner with all requested documentation to obtain energy grants.

C. Provide proof of contractor ICC Certification with bid documents.

D. Provide company information, lighting drawings and lighting calculation spreadsheet documentation as requested by energy incentive requirements to obtain all lighting incentives available.

**END OF SECTION**

# SECTION 27 05 00

# COMMON WORK RESULTS FOR COMMUNICATIONS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Communications equipment coordination and installation.
   2. Sleeves for pathways and cables.
   3. Grout.
   4. Common communications installation requirements.

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

D. Coordinate sleeve selection and application with selection and application of firestopping specified.

## PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for all penetrations. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls. If above accessible ceiling, sleeves can extend 1 inch out of wall.

F. Extend sleeves installed in floors 2 inches above finished floor level in MDF/IDF closets. All other locations to be stubbed to above accessible ceiling space.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway (and raceways). All other sleeves for cabling shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry on both sides of wall.

1. Promptly pack grout solidly between sleeve and wall (on both sides of wall) so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements.

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Furnish and install sleeves for all low voltage cabling. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 1-1/4 inch conduit. Install removable firestopping material (on both ends of conduit) after installing all cables.

N. Where walls do not extend all the way up to the building deck, the contractor will continue to install cabling conduit sleeves as if the walls exist. This will aid in future wall construction without damaging cables.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements as specified. Install removable firestopping material in sleeves after cables have been pulled.

**END OF SECTION**

# SECTION 27 11 00

# COMMUNICATIONS EQUIPMENT ROOM FITTINGS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Telecommunications mounting elements.
   2. Backboards.
   3. Telecommunications equipment racks and cabinets.
   4. Telecommunications service entrance pathways.
   5. Cable Tray.
   6. Grounding.

B. Related Sections:
   1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
   2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications (Minimum of Three Years Experience): Cabling Installer must have personnel certified by BICSI on staff.
1. Contractors Company must be licensed by the State of Illinois.
2. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
3. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
4. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. All devices shall be U.L. listed.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

D. Grounding: Comply with ANSI-J-STD-607-B.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

## 1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, telephone switch, LAN equipment and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.8 WARRANTY

A. Provide a one year warranty on all parts and labor unless manufacturer standard warranty is for greater period of time.

## PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-D.

B. Manufacturers shall be ISO-9001 compliant.

C. Cable Support: U.L. labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.
5. Cable tray.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high and 3 inches deep. Verify wall thickness and notify architect if problems encountered with installation of this box size prior to rough-in. Boxes must match coverplates used/specified. Include appropriate mud rings as required. See drawings for details.
2. All new wall construction to have recessed boxes and raceway system. No exposed raceway will be allowed on new wall construction unless otherwise permitted by the Architect under special conditions.
3. Comply with TIA/EIA-569-D for maximum length of conduit and bends between pull points, and for pull-box sizing.
4. Use manufactured conduit sweeps and long-radius ells whenever possible.
5. In telecommunications rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of plywood) or in the corner of room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead.
6. Install minimum 1-1/4-inch conduit stubs for all workstation devices. Stub out to above accessible corridor ceiling/to cable tray or J-hooks; otherwise, provide J-hooks and sleeves. Install end bushings and fittings for each stub. Install minimum of 3-1/2” sleeves for all penetrations into MDF/IDF closets.

## 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 inches, sized as needed. Comply with requirements for plywood backing panels specified. Paint out white, but DO NOT COVER FIRE LABEL.

## 2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products equivalent to the following, as approved by Owner.
   1. Commscope/Systimax
   2. Owner preapproved equivalent.

B. General Frame Requirements:
   1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
   3. Finish: Manufacturer's standard, black baked-polyester powder coat.
   4. With ground bar.

C. Floor-Mounted Racks: Modular-type, steel construction.
   1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
   2. Black, baked-polyester powder coat finish.
   3. With ground bar.

D. Cable Management for Equipment Frames:
   1. Metal, with integral wire retaining fingers.
   2. Baked-polyester powder coat finish.
   3. Vertical cable management panels shall have front and rear channels, with covers.
   4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

E. Wall Cabinets:
   1. Metal, black in color with hinged back and hinged front locking door with clear plexiglass window.
   2. 19” mounting rails front and back for supporting equipment.
   3. With ceiling fan, low speed, high volume, low noise fan with thermostat switch.
   4. With ground bar.
   5. With power outlet/surge strip.
   6. Mount to fire rated backboard.
   7. With multiple raceways to above accessible ceiling for cabling access.

## 2.4 CABLE TRAY

A. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by hot-dip galvanizing, color-black, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch thick. Include waterfalls, jointers, wall mounts, pendent mounting kit and ground lug for a complete installation.

1. Basket Cable Trays: Size as noted on drawings. Wire mesh spacing shall not exceed 2 by 4 inches.
2. Ladder Cable Trays: Size as noted on drawings, and a rung spacing of 12 inches.
3. Refer to drawings for other types of cable trays.
4. Manufacturers:
   a. Commscope/Systimax
   b. Panduit
   c. Cablofil.
   d. Cooper B-Line, Inc.
   e. GS Metals Corp.
   f. Mono-Systems, Inc.

B. Install cable tray in all new IDF closets to support IDF rack cabling pathway requirements.

C. Bond cable tray to TMGB in IDF closet.

2.5 POWER STRIPS (For each type of rack/cabinet)

A. Power Strips: Comply with UL 1363.
1. Rack mounting.
2. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
5. Cord connected with 15-foot line cord.
6. Rocker-type on-off switch, illuminated when in on position.
7. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
8. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

2.6 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-B.

C. Grounding Points:
1. **Locate grounding bus bar in each data rack as shown.**

D. Bonding Conductors:
1. Where a panelboard for telecommunications is located in same room or space as a grounding busbar, bond to equipment ground bus of electrical panelboard.
2. Extend from grounding busbars to ground terminals in equipment racks and cabinets.

E. Special Requirements:
1. Bonding conductors shall be insulated copper, No. 6 AWG minimum.
2. Install metallic conduit and conductors shall be bonded at each end of conduit.

3. Bonding conductors shall be installed without splices unless approved by Engineer because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.

2.7 LABELING

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 FIRESTOPPING

A. Comply with requirements. Comply with TIA/EIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as

it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 2 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

**END OF SECTION**

# SECTION 27 13 00

# COMMUNICATIONS BACKBONE CABLING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pathways.
   2. 50/125-micrometer, optical fiber cabling.
   3. Cable connecting hardware and patch panels.
   4. Cabling identification products.

B. Related Sections:
   1. Division 27 Section "Communications Horizontal Cabling."

C. System shall be a complete operational 1 GIG, Category-6 local area network data cabling system, with a 10 GIG fiber optic backbone, excluding active devices. System shall be certified to this degree. See drawings for part/model numbers.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms and main terminal space in the telecommunications cabling system structure. Cabling system consists of backbone cables, mechanical terminations, and patch cords used for backbone-to-backbone and network switch cross-connection.

B. Backbone cabling cross-connects will be located in communications equipment rooms. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568.3-D, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For all cable, include the following installation data for each type used:
      a. Cable cut sheet with electrical characteristics.
      b. Minimum bending radius.
      c. Maximum pulling tension.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics including the following:
      a. Patch panels.
      b. Patch cords (Provided by the Owner).
      c. Fiber optic boxes.
   4. Patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   5. **The data cabling contractor shall provide shop drawings showing the desired cabling routes (through the building) to each area's respective MDF/IDF rack. Routings shall follow primary pathways (i.e. corridors), shortest distance possible and be concealed above lay-in ceilings. Alternate pathways (special conditions) shall be coordinated in the shop drawing stage with the Engineer. Please note that zoning of building is shown on the drawings identifying MDF/IDF rack location serving area**

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector. Provide certification for each.
   1. Installer shall be a certified competent installer with a minimum of three years experience installing Category-6/6A 1/10 GIG UTP and 10 GIG fiber optic cabling for data system. Installer shall be certified by Systimax/Commscope manufacturer of communication devices being installed.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Operation and Maintenance Data: All cabling to include operation and maintenance manuals.

H. Systimax/Commscope 20 Year Extended Product Warranty certificate.

I. Drawing Data: Include layout drawing of all devices and their labeling scheme.

1.7 QUALITY ASSURANCE

A. Installer Qualifications (Minimum 3 Years Experience Required installing 10 GIG UTP Cabling and 10 GIG Fiber Optic Cabling): Cabling Installer must have RCDD personnel certified by BICSI on staff.
   1. Contractors Company must be licensed by the State of Illinois.
   2. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   3. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   4. Testing Supervisor: Currently certified by BICSI Level 2 Installer to supervise on-site testing.
   5. Installing contractor must have prior experience with at least two projects utilizing Category-6/6A (1/10 GIG), UTP cabling and 10 GIG fiber optic cabling systems.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. All devices shall be U.L. listed.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

E. Grounding: Comply with ANSI-J-STD-607-A.

F. Source Limitations: Obtain all products through one source from single manufacturer (Systimax/Commscope or equivalent, as approved by Owner).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Do not allow cables to be painted.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
   1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute to other participants.
   3. Adjust arrangements and locations of distribution frames and cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch Cords: NA, (Provided by the Owner).

1.12 WARRANTY

A. Provide a comprehensive cable/premise wiring device warranty from manufacturer of communication device system for no less than 20 years. This shall include a warranty on all parts and labor:
   1. The cabling/premise wiring device warranty and system performance guarantee program shall warrant the structured cabling system is free from defects in material and workmanship and will support any current or future Category-6 system applications ratified by IEEE, ANSI or ISO that is developed for an ANSI/TIA/EIA-568.3-D compliant structured cabling system for a 20-year period from date of registered installation. This warranty shall also include a warranty covering all components (work area outlets, horizontal cable, connecting hardware in the horizontal cross-connect, the equipment cord at the work area, and the patch cord in the horizontal cross-connect). All devices must be manufactured by warranty provider.
   2. Contractor must be a Certified Installer and accredited Certified Installer for the manufacturer of product being installed, as approved by Owner.

B. Provide a one-year warranty on all other associated equipment not covered under warranty indicated above.

## PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-D.

B. Manufacturers shall be ISO-9001 compliant.

C. Cable Support: U.L. labeled for support of Category-6/6A (1/10 GIG) UTP cabling and 10 GIG fiber optic cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high and 3 inches deep. Verify wall thickness and notify engineer if problems encountered with installation of this box size prior to rough-in. Boxes shall match faceplates used/specified.
2. Comply with TIA/EIA-569-D for maximum length of conduit and bends between pull points, and for pull-box sizing.
3. Use manufactured conduit sweeps and long-radius ells whenever possible.
4. In telecommunications rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of fire-rated plywood) or in the corner of room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead.
5. Install minimum 1-1/4-inch conduit stubs for all workstation devices. Stub out to above accessible corridor ceiling/to cable tray or J-hooks; otherwise, provide J-hooks and sleeves. Install end bushings and fittings for each stub. Where multiple cables are installed, follow NEC 40% fill requirements with additional 50% spare capacity.

## 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 inch, sized as needed. Comply with requirements for plywood backing panels. Paint out white, but DO NOT COVER FIRE LABEL.

## 2.3 OPTICAL FIBER CABLE (REFER TO DRAWINGS FOR CABLE SCHEDULE)

A. Manufacturers: Subject to compliance with requirements, provide product equivalent to the following, as approved by Owner:
1. Commscope/Systimax
2. Owner preapproved equivalent.

B. Description: OM3/OM4 Multimode, 50/125-micrometer, (X-strands as noted on drawings) strand-fiber armored cable, tight buffer, plenum rated, optical fiber cable capable of supporting 10 GIG systems.
1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-D for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   b. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262, when armored cable is specified.
5. Maximum Attenuation: 3.00 dB/km at 850 nm; 1.0 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

7. Operating Temperature Range: Minus 20 deg C to plus 70 deg C.

C. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

D. Install non-armored plenum rated fiber cable in plenum rated innerduct, minimum size of 1-1/4” when armored cable type is not specified. Install and maintain pull strings. Refer to drawings for fiber model type to be used.

E. Refer to Section 27 15 00 "Communications Horizontal Cabling" for additional cabling requirements and performance requirements.

## 2.4 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products equivalent to the following, as approved by Owner:
1. Commscope/Systimax
2. Owner preapproved equivalent.

B. Patch Panels: Modular panels housing multiple-numbered, “LC” style duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Panel shall have protective hinge front cover and slide out tray with fiber spools for organization and protection.

C. Patch Cords:(Provided by the Owner) Factory-made, dual-fiber cables in lengths and color selected by Owner, minimum of 36 inches, refer to drawings for quantity, length and color.

D. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568.3-D.
2. Quick-connect, duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
3. Armored grounding kit to be installed on all armored cables at rack locations.

## 2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

C. All telecommunication grounding conductors to be installed in raceways. Conduits shall be GREEN in color. Bond both ends of conduit with appropriate bushing. Conduits do not have to be GREEN when installed in a finished space where visible. Install GREEN conduits above accessible ceilings.

D. All armored fiber optic cabling shall be grounded and bonded to TMGB/TGB telecommunication ground bars in MDF/IDF closets, otherwise to ground bars in data racks if TMGB/TGB is not present per NEC 770.100.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568.3-D.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-B and TIA/EIA-568.3-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces, unless subject to damage; i.e., Gymnasiums, Locker Rooms, Mechanical Rooms, areas subject to damage, etc.
   1. Install plenum cable in environmental air spaces, including plenum ceilings. Utilize plenum rated innerduct for installing fiber optic cables; otherwise, use plenum rated armored fiber optic cabling. Include pull string in each innerduct when used.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Examine pathway elements intended for cables.
   1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements. Proceed with installation only after unsatisfactory conditions have been corrected.

2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that surfaces are ready and clean to receive work.

C. Verify that quantity and sizes of boxes/conduit are acceptable for installation of jacks and cabling.

D. Make general contractor and architect aware of any condition on-site that may interfere or cause damage to installation of system.

E. Beginning installation means installer accepts existing conditions.

F. Installer shall coordinate work with all tradesmen.

G. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

H. Comply with TIA/EIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

J. Install manufactured conduit sweeps and long-radius elbows whenever possible.

K. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits above finished floor to devices indicated.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

L. Backboards: Install backboards at locations indicated on drawings.

## 3.3 APPLICATION OF MEDIA

A. Backbone Cable for Data Service: Use fiber-optic cable for runs between equipment rooms and wiring closets and for runs between wiring closets. Use plenum rated armored fiber optic cable.

## 3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. Furnish and install sleeves for all low voltage cabling. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40

percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 1-1/4 inch conduit. Utilize multiple 3-1/2 inch sleeves for penetrations into MDF/IDF closets. Install removable fireproofing (on both ends of conduit) after installing cables.

C. General Requirements for Cabling:
   1. Comply with TIA/EIA-568.3-D.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Comply with NECA 1.
   4. Wiring Method: Install cables in raceway except within consoles, cabinets, and accessible ceiling spaces where unenclosed wiring method may be used. Support cabling with J-hooks or cable tray above accessible ceilings. **DO NOT SUPPORT FROM CEILING SUPPORT WIRES.** Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables in all new construction. Install cabling in raceway where subject to damage: locker rooms, gyms, boiler rooms, mechanical rooms, loading docks, etc. and paint out to match area. In finished areas that have no ceilings and are occupied by staff and students, all cabling shall be installed in raceway and painted out to match area. Raceways and boxes are specified in Division 26 Section "Raceways and Boxes for Electrical Systems."
   5. Install 110-style IDC termination hardware unless otherwise indicated.
   6. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   7. Install cables using techniques, practices, and methods that are consistent with Category-6/6A/fiber rating of components that ensure Category-6/6A/fiber performance of completed and linked signal paths, end to end.
   8. Install cables without damaging conductors, shield, or jacket.
   9. **Do not paint cables as this will void the warranty.**
   10. All horizontal cabling shall terminate back at each area's respective rack. Terminate on patch panel.
   11. All cabling shall be routed through cable tray or J-hook assembly (as noted on drawings) above accessible corridor ceilings. **DO NOT SUPPORT FROM CEILING SUPPORT WIRES.**
   12. All Category rated cables must be within the distance of 295 feet, not required for analog voice. The contractor shall notify the Owner of any locations that exceed this distance limitations prior to installation.
   13. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   14. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   15. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
   16. Contractor shall core floors as required for installation of data cabling. Radar scan floors prior to coring to determine any contents that would be damaged by making these penetrations. Call out any issues encountered to the Architect and Engineer. Verify all locations of cores with architect/engineer in field as possible abatement may be required. All cores shall be sleeved and

fire proofed, as required. Field verify all equipment and piping locations before making cores. Under no circumstances will any structural member be cut in this process.

17. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
18. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Do not install consolidation points. Do not splice cables.
19. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
21. Secure and support cables at intervals not exceeding 48 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Utilize J-hooks or cable tray. **DO NOT SUPPORT FROM CEILING SUPPORT CABLES.**
22. Maintain a maximum UTP cable bend radius of four times the cable diameter, six times if in conduit.
23. Apply plenum rated cable ties loosely and at random intervals.
24. Minimize the amount of jacket twisting and avoid stretching the cable.
25. Use an appropriate method for dressing and securing cables (i.e., cable ties – wide type, wire management panels, cable support bards and velcro straps).
26. Do not exceed a 90 degree bend.
27. Do not over tighten cable ties.
28. Do not over twist cables.
29. Do not exceed 25 lbs. of pulling tension. Pull cables simultaneously if more than one is being installed in same raceway. Use manufacturer listed/approved (Category-rated) pulling compound or lubricant if necessary. Use compounds that will not damage conductor insulation. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
30. Do not use staple guns to position or fasten cables.
31. When installing fiber optic cables, maintain minimum bend radius of 20 times cable diameter when pulling and 10 times when installed. Do not kink cable. Install dust cover/caps at both ends of cable when not being terminated.

D. UTP Cable Installation:
   1. Comply with TIA/EIA-568-C.2-1.
   2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry. Strip back only as much cable jacket as required for termination.

E. Optical Fiber Cable Installation:
   1. Comply with TIA/EIA-568.3-D.
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
   3. Install in plenum rated innerduct.

F. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 48 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. **Do not install cabling above top chord of bar joists or within 6 inches of roof deck so as to avoid damage caused by roofing nails.**

G. Wiring within Wiring Closets and Enclosures:
1. Install fire-rated plywood backboards on walls of equipment rooms and wiring closets.
2. Mount patch panels, terminal strips, and other connecting hardware on wall-mounted racks, floor-mounted racks or cabinets as shown on drawings.
3. Group connecting hardware for cables into separate logical fields.
4. Train conductors to terminal points with no excess.
5. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.5 FIRESTOPPING

A. Comply with requirements. Comply with TIA/EIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

C. Install sleeves as required for cabling access install end bushing and fitting to protect cabling. Fireproof (both sides of sleeve) after cabling is installed.

## 3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

D. Grounding Points:
   1. Locate grounding terminals in each equipment rack and cabinet.

E. Bonding Conductors:
   1. Where a panelboard for telecommunications is located in same room or space as a grounding busbar, bond to equipment ground bus of electrical panelboard.
   2. Extend from grounding busbars to ground terminals in equipment racks and cabinets.

F. Special Requirements:
   1. Bonding conductors shall be insulated copper, No. 6 AWG minimum.
   2. Install in conduit. Metallic conduit that exceeds 36 inches in length, conductors shall be bonded at each end of conduit.
   3. Bonding conductors shall be installed without splices unless approved by Engineer because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.

## 3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 2.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-C for Class 2 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Provide electronic copy on memory stick to Owner in electronic format compatible with Owner's equipment.

G. Cable and Wire Identification (**For Oakton Community College**) (Refer to Drawings for Additional Information):
   1. Tag all Cat 6 cables at both Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
      a. Each cable run should have 4 labels. Two wrap around labels on the cable itself, a label on the patch panel and a label on the wall plate.
      b. The cable labels should be printed on a flexible wrap around white label with black text, using the format (single line, spaces around the slash): IDF-Rack#-Patch Panel#-Patch Panel Port# / Room-port.
         1) Example: 0509-1-1-23 / 1530-01
      c. The wall port labels should be printed on a white label with black text, using the format (Two lines, no slash):
         IDF-Rack#-Patch Panel#-Port#
         Room-port
         1) Example:
            a) 0509-1-1-23
            b) 1530-01
      d. The Patch panel labels should be printed on a white label with black text and should include just the Room-port (i.e. 1530-01).
      e. For all the label types, The IDF is the Communications Equipment Room, the Rack# and Patch Panel# are sequential numbers beginning with the next sequential number based on the marked existing patch panels and racks. The patch panel port # is the position within the patch panel (1-48). For the Room-Port, the Room is the room number. For hallways, it is the room number of the closest adjacent room followed by an H (i.e. 1542H). The port number starts at one with each additional outlet in each room numbered sequentially. If a port is located in the ceiling. (Security camera's, Wireless AP's, projector, etc,) the port should be preceded by a C (for example 1530-C13). All ports, both wall, ceiling and floor should be in the same sequence, i.e. 1530-01, 1530-C02, 1530-03, ...).
      f. For wall ports, the label should be placed directly on the faceplate and not on the removable paper card under the window.
      g. All proposed labels must be reviewed by the owner prior to installation.

2. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-C, for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

I. Contractor shall bear all costs associated with walking each room/area for verification of actual room numbers prior to labeling, no exceptions. Please note that room numbers could change under this construction project.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Fiber-Optic Cable Tests:
   1. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568.3-D. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Link End-to-End Attenuation Tests:
      a. Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-B, Method B, One Reference Jumper.
      b. Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568.3-D.
         1) < 2.0 dB for links < 90m.
         2) < 2.6dB @ 850nm for links > 90m.
         3) < 2.0dB @ 1300nm for links > 90m.
         4) All splices shall be no more than 0.3dB.
      c. Required test data for backbone fiber optic cabling shall include optical attenuation at both 850nm and 1300nm wavelengths. Measurements must be done at both ends of the cable run. Use two-jumper method. Attenuation will vary depending on cable lengths. Maximum link attenuation shall equal connector attenuation plus cable attenuation plus splice attenuation. Maximum connector attenuation shall be 0.75

dB. Maximum splice attenuation shall be 0.3 dB per splice. Maximum cable attenuation coefficient shall be as follows:
1) 3.5 dB / km @ 850nm for 507 / 125um
2) 1.25 dB / km @ 1300nm for 50 / 125um

d. All power meters shall have an accuracy of + / - 0.5 dB or better. Light source shall be capable of generating light at all appropriate wavelengths.

e. All testing shall prove operation of 10 GIG copper system capability on a 10 GIG fiber optic plant.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

3.9 MANUFACTURER'S FIELD SERVCIE

A. Upon acceptance of installation registration form, manufacturer will provide at a minimum 20 year Systimax/Commscope Extended Product Warranty on all parts/cabling and labor to repair and/or replace any non-performing device.

B. Manufacturer's representative shall visit the site to determine if the system complies with all requirements.

3.10 CLEANING

A. Clean all devices of dust and debris.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and extending wiring to establish new workstation outlets.

B. Provide system demonstration. Show Owner as-builts and how all cabling was routed. Demonstrate method of tagging. Identify what rooms are fed from each rack. Identify spare capacity.

C. Describe wiring of system and functionality of all jacks and related devices.

**END OF SECTION**

# SECTION 27 15 00

# COMMUNICATIONS HORIZONTAL CABLING

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pathways.
   2. UTP Cat-6 cabling.
   3. Cable connecting hardware, patch panels, and cross-connects.
   4. Telecommunications outlet/connectors.
   5. Cabling system identification products.
   6. Cable management system.

B. Related Sections:
   1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

C. System shall be a complete operational 1 GIG, Category-6 local area network data cabling system, with a 10 GIG fiber optic backbone, excluding active devices. System shall be certified to this degree. See drawings for part/model numbers.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. LAN: Local area network.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
   1. TIA/EIA-568-C.2-1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
   2. Bridged taps and splices shall not be installed in the horizontal cabling.
   3. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable link length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.2-1, when tested according to test procedures of this standard.

B. Manufacturer products must be ISO-9001 compliant.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For all cables, include the following installation data for each type used:
      a. Cut sheet specifications.
      b. Minimum bending radius.
      c. Maximum pulling tension.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords (Provided by the Owner).
      d. Distribution racks/cabinets.
      e. Terminal racks/cabinets.
      f. Workstation outlets.
   4. Patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   5. Cable tray layout when specified, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.

b. Clearances for access above and to side of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

6. **The data cabling contractor shall provide shop drawings showing the desired cabling routes (through the building) to each area's respective MDF/IDF rack to meet distance limitation of 90 meters. Routings shall follow primary pathways (i.e. corridors), shortest distance possible and be concealed above lay-in ceilings. Alternate pathways (special conditions) shall be coordinated in the shop drawing stage with the Engineer. Please note that zoning of building is shown on the drawings identifying MDF/IDF rack location serving area.**
7. **Please note that the quantity of new patch panels shown are for the contractor's convenience and that final quantity will need to be determined by the contractor prior to bidding. Quantities shall be based on the zoning shown. Should the contractor wish to revise the zoning, quantity of patch panels will need to be revised accordingly.**

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector. Provide Certification for each.
1. Installer shall be a certified competent installer with a minimum of three years experience installing Category-6 1 GIG UTP and 10 GIG fiber optic cabling for data system. Installer shall be certified by Systimax/Commscope manufacturer of communication devices being installed.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Drawing Data: Include layout drawing of all devices and their labeling scheme.

1.7 QUALITY ASSURANCE

A. Installer Qualifications (Minimum 3 Years Experience Required): Cabling Installer must have personnel certified by BICSI on staff.
1. Contractors Company must be Licensed by the State of Illinois.
2. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
3. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
4. Testing Supervisor: Currently certified by BICSI Level 2 Installer to supervise on-site testing.
5. Installing contractor must have prior experience with at least two projects utilizing Category-6 (1 GIG) UTP cabling systems and 10 GIG fiber optic cabling systems.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. All devices shall be U.L. listed.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-D.

E. Grounding: Comply with ANSI-J-STD-607-A.

F. Source Limitations: Obtain all products through one source from single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. DO NOT ALLOW CABLES TO BE PAINTED.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

C. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute to other participants.
3. Adjust arrangements and locations of distribution frames and cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Device Plates: One (1) of each type and size.
2. Connectors: Five (5) of each type and color.
3. Patch Cords: NA, (Provided by the Owner).

1.12 WARRANTY

A. Provide a comprehensive warranty (cabling/premise wiring device of product manufacturer as approved by Owner) approved for no less than 20 years. This shall include a warranty on all parts and labor:
   1. The cabling/premise wiring device warranty and system performance guarantee program shall warrant the structured cabling system is free from defects in material and workmanship and will support any current or future Category-6 1-Gig cabling system and 10-GIG fiber optic cabling system applications ratified by IEEE, ANSI or ISO that is developed for an ANSI/TIA/EIA-568-C.2-1 compliant structured cabling system for a 20-year period from date of registered installation. This warranty shall include a warranty covering all components (work area outlets, horizontal cable, connecting hardware in the horizontal cross-connect, the equipment cord at the work area, and the patch cord in the horizontal cross-connect). All devices must be manufactured by warranty provider.
   2. Contractor must be a Certified Installer and Accredited Installer for the manufacturer of product being installed, as approved by Owner

B. Provide a one-year warranty on all other associated equipment not covered under warranty indicated above.

## PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-D.

B. Cable Support: U.L. labeled for support of Category-6/6A (1/10 GIG) cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays (When Noted):
   1. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch thick.
      a. Basket Cable Trays: Size as noted on drawings. Wire mesh spacing shall not exceed 2 by 4 inches.
      b. Ladder Cable Trays: Size and type as noted on drawings, and a rung spacing of 12 inches.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 4 inches wide, 4 inches high and 3 inches deep. Verify wall thickness and notify engineer if problems encountered with installation of this box size prior to rough-in. Boxes must match faceplates used/specified. Install mud rings to match drywall thickness and match coverplate size/type used.

2. Comply with TIA/EIA-569-D for maximum length of conduit and bends between pull points, and for pull-box sizing.
3. Use manufactured conduit sweeps and long-radius ells whenever possible.
4. In telecommunications rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of plywood) or in the corner of room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead.
5. Install minimum 1-inch conduit stubs for all workstation devices. Stub out to above accessible corridor ceiling/to cable tray or J-hooks; otherwise, provide J-hooks and sleeves. Install end bushings and fittings for each stub. Where multiple cables are installed, follow NEC 40% fill requirements.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 inch by size needed. Comply with requirements for plywood backing panels. Paint out white; DO NOT COVER FIRE LABEL.

2.3 UTP CABLE (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Systimax/Commscope.
2. Owner preapproved equivalent.

B. Description: 100-ohm, 4-pair UTP, covered with a low smoke plenum rated thermoplastic jacket.
1. Comply with ICEA S-102-700 for mechanical properties.
2. Comply with TIA/EIA-568-C.2-1 for 1 GIG performance specifications.
3. Listed and labeled by UL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
4. Operating Temperature Range: -20 deg C to 60 deg C.

C. Horizontal Cabling: Data, Category-6: (**Based on Systimax #2071E Series**)
1. All cables shall be Category-6, four pair, unshielded twisted pair (UTP) 23 AWG, rated for 250 MHz sweep tested up to 300 MHz. Provide plenum type cables in all plenum environments.
2. Cables shall be approved manufacturer (listed by the communication device manufacturer) to maintain the extended product warranty requirement.
3. Cable shall be 23 AWG solid bare copper, FEP insulated and isolated pairs (flex web), twisted pairs, unshielded, ripcord, **(Color-White)** plenum rated jacket and third party verified to EIA/TIA 568.C-2 Category-6 standards.
4. Cable shall meet or exceed the following standards:
a. ANSI/TIA-568-C.2 and ISO/IEC 11801 Class-E component compliance.
b. IEEE 802.3af (PoE), IEEE 802.3at (PoE+), IEEE 802.3bt (4PPoE Type 3 and 4).
c. 10BASE-T through 1GBASE-T Ethernet at 100 meters.
d. NEC Article 800 compliant.
e. Third party verified.

f. UL/c (UL) Listed, LP Listed for product safety in high heat/high power PoE applications.
g. HDASE-T Certified.
h. RoHS/RoHS 2 Compliant.
i. REACH Compliant.
j. IEEE 802.11ac high bandwith/high power wireless access point applications.
k. Tested to 80 watts.

5. The cable shall meet the following electrical transmission characteristics:
   a. Mutual Capacitance (CM) – 5.6 nF/100m @1Khz.
   b. DC resistance unbalance, maximum: 5%
   c. DC resistance, maximum: 7.71 ohms/100m.
   d. Nominal velocity of propagation: 71%.
   e. Cable manufacturer must be certified under ISO-9001.

D. UTP Plenum Cable: Listed for use in air-handling spaces. Features are as specified for cables, conductors, and UTP cable except materials are modified as required for listing.

2.4 UTP CABLE HARDWARE (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Manufacturers: Subject to compliance with requirements, provide products equivalent to the following, as approved by Owner:
   1. Systimax/Commscope.
   2. Owner preapproved equivalent.
      NOTE: Manufacturer must be recognized member of cabling device manufacturer's cabling/premise wiring device warranty program.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2-1, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher and of type consistent throughout project.

C. Patch Panel: Cat-6 UTP 48port patch panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. (**Based on Systimax #360-IPR-1100-E-GS-2U-48**):
   1. Number of Jacks per Field: Install one for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
   2. Mounting: Rack as noted on drawings.
   3. Include rear wire management rail system.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals. (Category-6) (**Based on Systimax #MGS400 Series Jacks**)
   1. All jacks shall be eight position, balanced high density Category-6, RJ-45 modular jacks with 110 terminations with T568B (AT&T) wiring configuration; coordinate with Owner.
   2. Jack shall have the ability to accept color coded icons and include color coded wiring instructions on label.
   3. Jacks shall be UL 1863 listed and CSA certified. File numbers shall be made available.

4. Jack contacts shall be beryllium copper with a precious metal plating with nickel under plating. Jacks must be capable for operating under 802.11ac, PoE+ requirements.
5. 110 contacts shall be phosphor bronze with 100 micro inch tin plating over nickel.
6. Jacks shall meet FCC part 68.5
7. Jacks shall meet TIA/EIA-568-C.2-1 and TSB40 standards.
8. Jack housing shall be high impact 94 V-0 rated thermoplastic.
9. Jack shall be suitable for wire sizes ranging from 22 – 24 AWG.
10. Insulation on conductors shall be no larger than 0.050 inches O.D.
11. Provide dust covers on all jacks.
12. Jacks shall be stamped Category-6 on face and be visible once installed in coverplate.
13. **Color of jacks-White.**

E. Patch Cords: (Provided by the Owner).

F. Wire Management: High-capacity horizontal wire cable managers shall be capable of managing high performance cable on the front and rear of any 19” EIA rack (**Based on Panduit #NMF Series**):
1. Include molded unit with bend radius fingers that protect the cables.
2. Include standard pass through holes that incorporate bend radius control.
3. Include dual hinged covers.
4. Size of unit to be coordinated with Owner prior to ordering.

2.5 CONSOLIDATION POINTS

A. NOT ALLOWED.

2.6 TELECOMMUNICATIONS OUTLET (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Workstation Outlets: Quantity as noted on drawings, -port-connector assemblies mounted in single or multigang faceplate as required to match conditions.
1. Faceplate: Nylon, complying with requirements in Division 26 Section "Wiring Devices." Refer to drawings for additional information.
a. Utilize **white coverplates** unless otherwise directed by the Architect and Owner.
2. For use with snap-in jacks accommodating any combination of UTP and other audio/video system components. Refer to drawings.
a. Flush mounting jacks as noted on drawings.
3. Legend Field: Snap-in, clear-label covers and machine-printed paper inserts.
4. When installing above accessible ceilings, label ceiling grid with jack information.

2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-C and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.9 DRAWING DOCUMENTATION

A. Description: Computer-based cable management system, with integrated database and graphic capabilities, that is compatible with AutoCAD.

B. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.
1. AutoCAD drawing software shall be used as drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:
1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

E. Incorporate testing results for permanent documentation.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.2-1 and TIA/EIA-568.3-D.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568.3-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, and except in accessible ceiling spaces, where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces, unless subject to damage: Gymnasiums, Locker Rooms, Mechanical Rooms, etc.
1. Install plenum cable in environmental air spaces and plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. No exposed raceway will be allowed in new wall construction. All new walls will be required to have recessed boxes and raceway. Surface mounted raceway will only be allowed if permitted by the Architect under special conditions.

## 3.3 INSTALLATION OF PATHWAYS

A. Examine pathway elements intended for cables.
1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that surfaces are ready and clean to receive work.

C. Verify that quantity and sizes of boxes/conduit are acceptable for installation of jacks and cabling.

D. Make general contractor and architect aware of any condition on-site that may interfere or cause damage to installation of system.

E. Beginning installation means installer accepts existing conditions.

F. Installer shall coordinate work with all tradesmen.

G. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-D.

H. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

I. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

J. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

K. Install manufactured conduit sweeps and long-radius elbows whenever possible.

L. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits above finished floor to devices indicated.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

M. Backboards: Install backboards at locations indicated on drawings.

3.4 APPLICATION OF MEDIA

A. Horizontal Cable for Data Service: Use UTP Category-6 cable for runs between wiring closets and workstation outlets.

B. Horizontal Cable for WAP Service: Use UTP Category-6 cable for runs between wiring closets and WAP outlets.

C. Horizontal Cable for voice VoIP Service: Use UTP Category-6 cable for runs between wiring closets and workstation outlets.

3.5 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. Furnish and install sleeves for all low voltage cabling. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 1-1/4 inch conduit. Utilize multiple 3-1/2 inch sleeves for penetrations into MDF/IDF closets. Install removable fireproofing (on both ends of conduit) after installing cables.

C. Where walls do not extend all the way up to the building deck, the contractor will continue to install cabling conduit sleeves as if the walls exist. This will aid in future wall construction without damaging cables.

D. General Requirements for Cabling:
1. Comply with TIA/EIA-568-C.2-1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Comply with NECA 1.
4. Wiring Method: Install cables in raceway except within consoles, cabinets, and accessible ceiling spaces where unenclosed wiring method may be used. Support cabling with J-hooks or cable tray above accessible ceilings. **DO NOT SUPPORT FROM CEILING SUPPORT WIRES.** Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables in all new construction. Install cabling in raceway where subject to damage: locker rooms, gyms, boiler rooms, mechanical rooms, loading docks, etc. and paint out to match area. In finished areas that have no ceilings and are occupied by staff and students, all cabling shall be installed in raceway and painted out to match area. Raceways and boxes are specified in Division 26 Section "Raceways and Boxes for Electrical Systems."
5. Install 110-style IDC termination hardware unless otherwise indicated.

6. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
7. Install cables using techniques, practices, and methods that are consistent with Category-6/6A rating of components and that ensure Category-6/6A performance of completed and linked signal paths, end to end.
8. Install cables without damaging conductors, shield, or jacket.
9. **Do not paint cables as this will void the warranty.**
10. All horizontal cabling shall terminate back at each area's respective rack. Terminate on patch panel. **DO NOT SUPPORT FROM CEILING SUPPORT WIRES.**
11. All cabling shall be routed through cable tray or J-hook assembly (as noted on drawings) above accessible corridor ceilings.
12. All Category-6 UTP cables must be within the Category-6 distance of 295 feet. The contractor shall notify the Owner of any locations that exceed this distance limitations prior to installation.
13. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
14. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
15. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
16. At workstation location include 15 feet service loop above ceiling for possible future relocation. Support from structure as required, do not lay on ceiling system. Utilize plenum rated Velcro fasteners as required.
17. Contractor shall core floors as required for installation of data cabling. Radar scan floors prior to coring to determine any contents that would be damaged by making these penetrations. Call out any issues encountered to the Architect and Engineer. Verify all locations of cores with architect/engineer in field as possible abatement may be required. All cores shall be sleeved and fire proofed, as required. Field verify all equipment and piping locations before making cores. Under no circumstances will any structural member be cut in this process.
18. Install exposed cables above accessible ceilings parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
19. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Do not install consolidation points. Do not splice cables.
20. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
21. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
22. Secure and support cables at intervals not exceeding 48 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Utilize J-hooks or cable tray. **DO NOT SUPPORT FROM CEILING SUPPORT WIRES.**

23. Maintain a maximum UTP cable bend radius of four times the cable diameter, six times if in conduit.
24. Apply cable ties loosely and at random intervals.
25. Minimize the amount of jacket twisting and avoid stretching the cable.
26. Use an appropriate method for dressing and securing cables, every 12 inches (i.e., cable ties – wide type, wire management panels, cable support bards and velcro straps), per cable manufacturer's recommendation. DO NOT OVER-TIGHTEN CABLE SUPPORTS.
27. Do not exceed a 90 degree bend.
28. Do not over tighten cable ties.
29. Do not over twist cables.
30. Do not exceed 25 lbs. of pulling tension. Pull cables simultaneously if more than one is being installed in same raceway. Use manufacturer listed/approved (Category-6/6A) pulling compound or lubricant if necessary. Use compounds that will not damage conductor insulation. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
31. Do not use staple guns to position or fasten cables.
32. When installing fiber optic cables, maintain minimum bend radius of 20 times cable diameter when pulling and 10 times when installed. Do not kink cable. Install dust cover/caps at both ends of cable when not being terminated.

E. UTP Cable Installation:
1. Comply with TIA/EIA-568-C.2-1.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry. Strip back only as much cable jacket as required for termination.
3. Install in raceway where shown.

F. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 48 inches apart.
3. **Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Do not route above top chord of bar joists or within 6 inches of deck due to damage caused by roofing nails.**

G. Wiring within Wiring Closets and Enclosures:
1. Install fire-rated plywood backboards on walls of equipment rooms and wiring closets.
2. Mount patch panels, terminal strips, and other connecting hardware on wall-mounted racks, floor-mounted racks and cabinets.
3. Group connecting hardware for cables into separate logical fields.
4. Train conductors to terminal points with no excess.
5. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.6 FIRESTOPPING

A. Comply with requirements.

B. Comply with TIA/EIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

D. Install sleeves as required for cabling access; install end bushing/fitting to protect cabling. Fireproof (on both sides of sleeves) after cabling is installed.

## 3.7 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

D. Grounding Points:
   1. Locate grounding terminals in each rack and cabinet.

E. Bonding Conductors:

1. Where a panelboard for telecommunications is located in same room or space as a grounding busbar, bond to equipment ground bus of electrical panelboard.
2. Extend from grounding busbars to ground terminals in equipment racks and cabinets.

F. Special Requirements:
1. Bonding conductors shall be insulated copper, No. 6 AWG minimum.
2. Install in conduit. Metallic conduit that exceeds 36 inches in length, conductors shall be bonded at each end of conduit.
3. Bonding conductors shall be installed without splices unless approved by Engineer because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.
4. All grounding/bonding conduits to be GREEN in color; when exposed in finished spaces, paint out to match existing area.

## 3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-C. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
1. Administration Class: 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Backbone Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-C for Class 2 level of administration including optional identification requirements of this standard.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Provide electronic copy on memory stick to Owner in electronic format compatible with Owner’s equipment.

F. Cable and Wire Identification (**For Oakton Community College**) (Refer to drawings details for additional information):
1. Tag all Cat 6 cables at both Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

a. Each cable run should have 4 labels. Two wrap around labels on the cable itself, a label on the patch panel and a label on the wall plate.
b. The cable labels should be printed on a flexible wrap around white label with black text, using the format (single line, spaces around the slash):
    1) DF-Rack#-Patch Panel#-Patch Panel Port# / Room-port.
    2) Example:
        a) 0509-1-1-23 / 1530-01
c. The wall port labels should be printed on a white label with black text, using the format (Two lines, no slash):
    1) IDF-Rack#-Patch Panel#-Port#
    Room-port
    2) Example:
        a) 0509-1-1-23
        1530-01
d. The Patch panel labels should be printed on a white label with black text and should include just the Room-port (i.e. 1530-01 ).
e. For all the label types, The IDF is the Communications Equipment Room, the Rack# and Patch Panel# are sequential numbers beginning with the next sequential number based on the marked existing patch panels and racks. The patch panel port # is the position within the patch panel (1-48). For the Room-Port, the Room is the room number. For hallways, it is the room number of the closest adjacent room followed by an H (i.e. 1542H). The port number starts at one with each additional outlet in each room numbered sequentially. If a port is located in the ceiling. (Security camera's, Wireless AP's, projector, etc.,) the port should be preceded by a C (for example 1530-C13). All ports, both wall, ceiling and floor should be in the same sequence, i.e. 1530-01, 1530-C02, 1530-03, ...).
f. For wall ports, the label should be placed directly on the faceplate and not on the removable paper card under the window.
g. All proposed labels must be reviewed by the owner prior to installation.

2. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Label all Wireless Access Point jacks above ceiling and on ceiling grid below with same information.
    a. Ceiling Grid Label font type/size shall be **Calibri 16 pt bold.**
    b. Provide sample to Owner before formal labeling begins.
6. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-C, for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.

H. Contractor shall bear all costs associated with walking each room/area for verification of actual room numbers prior to labeling, no exceptions. Please note that room numbers could change under this construction project.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Category-6 UTP Cabling Tests (up to 500 MHz):
   1. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2-1. Perform tests with a tester that complies with performance requirements in Annex I, complying with measurement accuracy specified in Annex H. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      a. Conduct tests and inspections after installation has been completed to assure the Owner's requirements for installation have been met. Upon request, prior to Owner's acceptance, allow access by Owner to test the equipment and wiring system. The contractor shall be responsible for testing each run "end-to-end" (both ways) and certifying, in writing, that the cabling meets Category/Level-6 UTP specifications and is in proper working condition. Each UTP cable shall be fully tested with a level IV tester (i.e., Lantek II-500 and Fluke DTX-1800 series or equal). The output from each UTP cable test/certification shall be printed out and provided to Owner in as-built/close-out documentation.
      b. Required test data for UTP horizontal cables shall include: wire map, length attenuation, link test, plug de-embedding, ANEXT, AFEXT, PSA NEXT, PSAFNEXT, ACR, ACRF, PSACR, and PSACRF.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Wire-map test that reports open circuits, short circuits, crossed pairs, reversed pairs, split pairs, and improper terminations.
   4. Permanent link tests for cable length, insertion loss, near-end crosstalk loss, power sum near-end crosstalk loss, equal-level far-end crosstalk loss, power sum equal-level far-end crosstalk, return loss, propagation delay, and delay skew. Performance shall comply with minimum criteria in TIA/EIA-568-C.2-1 for Category-6 cable and as required by Systimax/Commscope 20 year Extended Product Warranty.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

3.10 MANUFACTURER'S FIELD SERVICE

A. Upon acceptance of installation registration form, manufacturer will provide at a minimum 20 year warranty on all parts/cabling and labor to repair and/or replace any non-performing device.

B. Manufacturer's representative shall visit the site to determine if the system complies with all requirements.

3.11 CLEANING

A. Clean all devices of dust and debris.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and extending wiring to establish new workstation outlets.

B. Provide system demonstration. Show Owner as-builts and how all cabling was routed. Demonstrate method of tagging. Identify what rooms are fed from each rack. Identify spare capacity.

C. Describe wiring of system and functionality of all jacks and related devices.

**END OF SECTION**

# SECTION 27 51 16

# PUBLIC ADDRESS SYSTEM

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes extension of existing system:
   1. Power amplifiers.
   2. Volume limiter/compressors.
   3. Loudspeakers.
   4. Conductors and cables.
   5. Raceways.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 SUBMITTALS

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

B. Shop Drawings: For supports and for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Console layouts.
   3. Control panels.
   4. Rack arrangements.
   5. Calculations: For sizing backup battery.
   6. Calculations: For voltage drop based on wire size used.
   7. Wiring Diagrams: For power, signal, and control wiring and associated electrical connection of devices.
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.

c. Cabling diagram showing cable routing.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

D. Qualification Data: For qualified Installer and testing agency.

E. Field quality-control reports.

F. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. The manufacturer shall have minimum (10) ten years of documented experience in the design and manufacture of paging system devices and equipment.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project and have minimum of (3) three years documented experience.
1. Personnel certified by NICET as Audio Systems Level II Technician.
2. The contractor shall have InfoComm International (ICIA) Certified Technology Specialist (CTS) on staff and supervising the project. This service shall not be subcontracted.

C. The CTS shall review all submittals and oversee the project installation including documenting all on site observations, confirm installation meets document requirements, review all testing requirements and approve final testing and calibration of all equipment. All information to be included with close-out documentation.

D. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

E. Source Limitations: Obtain public address system from single source from single manufacturer.

F. Service representative must be located withing 60 miles of the project site and be able to provide service withing 4 hours of notification.

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

H. Comply with NFPA 70.

I. Comply with U.L. 50.

1.6 REFERENCES
1. ADA- Americans with Disability Act.
2. ADAAG- Americans with Disabilities Accessibility Guidelines.
3. NFPA 70 (NEC) National Electrical Code

4. UL 813 Standards for Commercial Audio Systems
5. UL 1480 Speakers for fire Alarm, Emergency and Commercial and Professional Use.
6. 2010 FGI Guidelines Part 2.1-8.3.1.3 Acoustics Considerations
7. Illinois Administrative Code Title 77 Chapter I Subchapter b part 250 Section 25 0. 2500 Electrical Requirements.
8. ISO R 266- 1997
9. ANSI S1.6- 1984

1.7 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 EXTRA MATERIALS (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One (1) of each type and size.

1.9 WARRANTY

A. Provide one year warranty on all parts and labor.

B. Standard service must be within 24 hours of notification and Emergency Service must be provided within four hours of notification unless otherwise accepted by the Owner.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Speakers:
   1. Atlas Sound LP.
   2. Bogen

C. Cables:
   1. Belden.
   2. West Penn.
   3. Carol Cable.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:
   1. Selectively connect any zone to any available signal channel.
   2. Selectively control sound from microphone outlets and other inputs.

3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Include live and pre-recorded emergency voice messages. This shall have a priority over all other types of messages or program material.
5. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
6. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
7. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

2.3 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Utilize 120volt emergency power sources for connecting all new amplifiers.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 POWER AMPLIFIERS

A. Mounting: Rack.

B. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected wattage for each station and speaker connected in all-call mode of operation, plus an allowance of 25% for future stations. **Please note 70V systems will need to be installed in metallic raceway.**

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

D. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

E. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

## 2.5 TRANSFER TO STANDBY AMPLIFIER

A. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

## 2.6 VOLUME LIMITER/COMPRESSOR

A. Minimum Performance Requirements:
   1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
   2. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
   3. Distortion: 1 percent, maximum.
   4. Rated Output: Minimum of plus 14 dB.
   5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
   6. Rack mounting.

## 2.7 LOUDSPEAKERS

A. Cone-Type Loudspeakers:
   1. Comply with TIA/EIA SE-103.
   2. Minimum Axial Sensitivity: 95 dB at one meter, with 1-W input.
   3. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
   4. Size: 8 inches with 1-inch voice coil and minimum 10-oz. ceramic magnet.
   5. Minimum Dispersion Angle: 100 degrees.
   6. Rated Output Level: 10 W.
   7. Matching Transformer: 70volt input, full-power rated with four taps. Maximum insertion loss of 0.5 dB.
   8. Recessed integral volume control.
   9. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
   10. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel. Include T-Bar grid/tile bridge support system. **Speaker shall be Atlas-SD72W series or approved equal.**

## 2.8 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.
   1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick rated at 300volts minimum.
   2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   3. Plenum Cable: Listed and labeled for plenum installation.
   4. Backbone cable:
      a. Minimum 14/2 shielded with drain wire, plenum rated.
      b. Basis of Design Belden 6100FE (CMP)
   5. Speaker Cable:

a. Minimum of 18/2 shielded with drain wire, plenum rated.
b. Basis of Design Belden 6300FE (CMP)

2.9 RACEWAYS

A. Conduit and Boxes: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems."
1. Outlet boxes shall be not less than 2 inches wide, 3 inches high and 2-1/2 inches deep.
2. Include raceways for all locations required including for areas with non-accessible ceilings. Minimum size, 3/4” trade size.
3. Flexible metal raceway can be used between junction box and speaker assembly with length not to exceed 48 inches.

## PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways except within consoles and cabinets.

B. All cables are to be installed in raceway.
1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
2. All exposed raceways installed in finished areas shall be of the metallic wiremold type.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

C. Install conduit stubs in new construction out to above accessible ceiling.

D. Please note all 70V systems will need wiring installed in a metallic raceway system.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:
1. Please note all 70V systems will need wiring installed in a metallic raceway system.
2. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
3. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.

4. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.
8. Install all cables from device to device. Do not splice in between devices.
9. Speaker cable sizes noted are minimum allowed and the contractor shall maintain proper wire size in order to maintain a maximum of 10% voltage drop or 0.5dB insertion loss on any speaker zone. Upsize cables as required to achieve this requirement.

C. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
   1. 12 inches from power lines <5 KVA.
   2. 18 inches from high voltage lighting including fluorescent fixtures.
   3. 29 inches from power lines of 5KVA or greater.
   4. 39 inches from transformers and motors.

D. Control Circuit Wiring: Install number and size of conductors as recommended by system manufacturing for control functions indicated.

## 3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams. Permanent markers/Sharpies are not allowed for identifying cables or systems.

C. Equipment Cabinets and Racks:
   1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
   2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
   4. Label all controls for ease of identification.

D. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

E. Wall-Mounted Outlets: Flush mounted, label all jacks.

F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas. Label all jacks.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Match existing paging system input voltage and output taps to match wattage level required based on room size. Please note all 70V systems will need wiring installed in a metallic raceway system.

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

K. Provide muting relay and connect to main intercom sound system.

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Insulate all microphone and 600 Ohm lines from each other and from conduit. Verify that conduits have been mechanical and electrically connected to boxes and grounded. Do not splice lines in conduit.

E. Do not ground microphone line shields, except at microphone frame and at console input connectors.

F. Ground other shields of two (2) conductor cables only at one (1) end, as appropriate. Terminate “floating” ends with wedge-on collars, plastic tape or heat shrinkable tubing.

G. Maintain continuity of shields at all connecting points.

H. Connect all audio grounds in an equipment rack to common point.

I. Head end equipment grounds shall be minimum of #6 copper and bonded to nearest telecommunications grounding bar.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Schedule tests with at least seven days' advance notice of test performance.
   2. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
   4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
      a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
      b. Repeat test for each separately controlled zone of loudspeakers.
      c. Minimum acceptance ratio is 50 dB.
   5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
   6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
   7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
   8. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

E. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
   2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

B. Provide system training for up to eight people. Training shall last at least two hours and be video recorded for the Owner’s future use. Training video shall be saved to flash drive; coordinate exact format with Owner. Provide training manual for each person.

**END OF SECTION**

# SECTION 27 51 19

# LOCAL AUDIO AND VIDEO SYSTEMS

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. Section includes installation of new local sound, video distribution and control system for classroom type spaces:
   1. **Refer to drawing schedules for quantity and requirements for each system and space.**

B. Section includes the following audio components:
   1. Speakers.
   2. Conductors and cables.
   3. Raceways.
   4. Patch cords.
   5. Other components (refer to drawing schedules)

C. Section includes the following video components:
   1. Input and output device plates.
   2. Raceways.
   3. Wall mounted monitor system.
   4. Installation of projectors and monitors.
   5. Patch cords.

D. Include all associated system licenses and subscriptions for operation of all system components.

E. Projector and Monitors will be furnished and installed by the contractor. All final connections and patch cords for equipment will be furnished and installed by the contractor for a complete working system. Include all AV patch cords for input/output plates, lengths to be coordinated in field prior to ordering.

F. Manual Projection screens will be furnished and installed by the contractor. Refer to Architectural drawings for final location.

G. Section requires the contractor to include all required parts and accessories to complete the working operation of the Audio/Video System as specified. The contractor shall follow this performance specification document as the basis for a complete system. All additional equipment required and not specifically specified shall be included in the contractor's bid. No additional costs will be incurred by the Owner for devices required to make this system operational as intended. Coordinate all system components with audio/video system suppliers prior to bidding.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for equipment racks, monitors and projectors and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

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

B. Shop Drawings: For supports and for racks and components including monitors and projectors. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Console layouts.
   3. Sound and Video Equipment.
   4. Sound and Video Equipment locations and their respective input and output locations on drawing plans. Must be reviewed and accepted by the Owner prior to ordering equipment and rough-in.
   5. Rack arrangements.
   6. Labeling scheme for racks, cabling and switch/controls.
   7. Wiring Diagrams: For power, signal, and control wiring.
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.
      c. Cabling diagram showing cable routing.

C. Delegated-Design Submittal: For supports and racks and components including monitors and projectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of supports for control equipment racks and components.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including speakers, monitors and projectors, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

E. Qualification Data: For qualified Installer and testing agency.

F. Field quality-control reports.

G. Close-Out Documents and Operation and Maintenance Data: For sound systems to include information in, minimum three (3) sets. Include the following in binder:
   1. As-Built drawings and final block diagrams in Revit and on flash drive.
   2. Manuals on all system components.
   3. System installation start-up certification and testing report.
   4. Warranty Cards
   5. Training video and attendee sign-in sheet.
   6. Attic stock inventory letter and Authorized Owner’s Personnel sign off of receipt of devices.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Must have minimum three (3) years experience and at least five (5) Sound and Video System installations completed successfully.
   1. Personnel certified by NICET as Audio Systems Level II Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
   1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

C. Source Limitations: Obtain sound system product from single manufacturer or as noted on drawings.

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

E. Comply with NFPA 70.

F. Comply with U.L. 50.

1.7 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. All AV devices, cabinets, data jacks, associated power receptacles, monitors, projectors and projection screen locations shall be coordinated with Owner, Architect and Engineer prior to rough-in/installation and ordering of equipment. Refer to Architectural drawings and elevations for approximate monitor, projector and screen locations and mounting heights. The contractor will be held responsible for roughing in any device at the wrong location and relocating these devices at their own expense to comply with the Owner’s requirements. A preconstruction meeting with the Architect, Owner and Engineer shall take place to coordinate all locations at the beginning of the project and be noted on the shop drawings.

1.8 EXTRA MATERIALS (FOR EACH SYSTEM) (REFER TO DRAWINGS FOR ADDITIONAL INFORMATION)

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. System Patch Cords (both audio and video), see drawings.

1.9 WARRANTY

A. Provide two (2) year warranty (or greater if standard on Manufacturers' equipment) on all parts and labor unless standard warranty coverage is for longer period of time. Provide 11th month and 23rd month re-inspection before warranty expires. If manufacturer's standard warranty is greater than 2 years, they shall have their equipment re-inspected one (1) month prior to warranty expiration. Devices shall be repaired or replaced as needed under warranty.

B. Service must be provided within four hours of notification.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: As directed by owner's requirements (refer to drawings). Substitutions must be preapproved by owner and design team prior to purchase and installation.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Audio Visual System Functions:
   1. AUDIO VISUAL SYSTEM INSTALLED BY OTHER
   2. CONTRACTOR IS RESPONSIBLE FOR 'ROUGH-IN' AT LEGRAND WALL BOXES AND FLOOR BOXES/POKE THRUS TO INCLUDE HDBASET CABLING BETWEEN INPUT AND OUTPUT LOCATIONS.
   3. CONTRACTOR SHALL INSTALL OWNER FURNISHED WALL MOUNTS AND ASSOCIATED DISPLAYS.
   4. CONTRACTOR SHALL INSTALL OWNER FURNISHED CEILING MOUNTED SPEAKERS.

2.3 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS (*REFER TO DRAWINGS FOR ADDITIONAL INFORMATION*)

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D. Provide rack mounting kits, ears and shelves for equipment as needed.

D. Provide space for all required equipment and include at least 20% spare capacity for future equipment.

E. See additional rack information in paragraph this section.

F. All wall back boxes and raceways in new construction shall be flush mounted and concealed. All wall back boxes and raceways at existing drywall locations shall have boxes and raceway cut into the wall for access. Walls shall be patched and painted to match surrounding area. All wall back boxes on existing CMU block/masonry wall locations shall have boxes surface mounted. Utilize prefinished Wiremold multichannel divided raceway for concealing all cabling when combining both power and low voltage systems. Where existing walls/area are predominately conduit type raceways, with the approval of the Architect, conduit may be used and painted out to match area. All colors to be selected by the Architect.

2.4 WALL AND CEILING MONITOR MOUNT REQUIREMENTS

A. Furnish and install all wall monitors and required wall mounts. Coordinate final location in field so rough-in complies with Owner's desired mounting height.
1. Coordinate in-wall backing requirements with Architectural drawings.
2. Include patch cords for making up final connection.
3. Coordinate final monitor model with Owner prior to ordering mounts.

B. sInstall power receptacle, Cat-6A data jacks and AV devices in wall box to support wall mounted monitor. Verify exact mounting height/location in field, coordinate with Architectural drawings. Include all patch cords to connect to monitor.

C. Refer to drawings for installation details and additional requirements.

2.5 RECESSED CEILING MOUNTED SPEAKERS

A. Specifications:
1. Install powered ceiling speakers. Do not install exposed power cables above ceiling. Install all 120volt wiring in raceway.
2. Mounting hardware should be included and installed to secure speakers in place. Utilize steel tile bridge ensuring rapid and secure installation in any sheetrock or drop-tile application.
3. Adjust speaker volume per Owner's direction.
4. Speakers shall come standard with a 5-year warranty.
5. Color will be selected by the Architect and Owner.
6. Include tile bridge as required for lay-in ceiling systems.

2.6 LECTERN (wheeled podium)

A. No Lectern in scope.

2.7 HDMI CABLES (Refer to drawings for additional information)

A. None

2.8 RS-232 CABLES

A. Install for ceiling mounted speakers as required by owner. Coordinate this requirement with owner prior to bidding.

2.9 NETWORK COMMUNICATION CABLES

A. UTP Series: plenum series or follow Div. 27, Horizontal Cabling requirements. Cables to be plenum rated.

2.10 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multi-pair, untinned solid copper.
   1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
   2. Microphone Cables: Neoprene jacketed, not less than 2/64-inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
   3. Speaker cables to be minimum 12 AWG copper UL listed for the application.
   4. Plenum Cable: Listed and labeled for plenum installation.
   5. All cables shall be installed in raceways in exposed areas.

2.11 RACEWAYS

A. Conduit and Boxes: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems."
   1. Outlet boxes shall be not less than 2 inches wide, 3 inches high and 2-1/2 inches deep (coordinate with Extron device actual depth). Adjust gang type to match specified coverplates.
   2. Include large capacity raceways in wall to handle all interconnect cabling between devices and control system. Size as required to support any cable that have pre-terminated connectors.
   3. Include conduit stubs from low voltage devices to above ceiling for current and future cabling access to system.
   4. All raceway stubs to above ceiling to include end bushings.
   5. All exposed raceways to be painted out to match surrounding area. Coordinate with Architect.

## PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

B. All cables to be installed in a complete dedicated raceway when installed in wall and when exposed in room. Paint out to match area when exposed.

C. All cabling above ceilings to be plenum rated and supported with J-Hooks.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
   2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
   3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Control Circuit Wiring: Install number and size of conductors as recommended by system manufacturing for control functions indicated.

3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Wall-Mounted Outlets: Flush mounted, professionally label all jacks and faceplates. Provide custom silk screening as required.

D. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG (do not exceed 2 percent voltage drop) and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

E. Speaker-Line Matching Transformer Connections: verify rating with amplifier settings prior to connection.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

A. n/a

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
1. Testing required for contractor installed speakers, coordinate this requirement with owner and engineer in field.
2. Schedule tests with at least seven days' advance notice of test performance.
3. After installing sound system and after electrical circuitry has been energized, test for compliance with requirements.
4. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
   b. Repeat test for each separately controlled zone of loudspeakers.
   c. Minimum acceptance ratio is 50 dB.
6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
8. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
9. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

E. Sound system will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

## 3.7 STARTUP SERVICE

A. At shop drawing stage of project, coordinate all system programming requirements with the Owner. Include up to 2 hours per system to identify Owner’s desired operation, control, presets, scenes, recording/playback capability, remote control capability and other levels of adjustment capabilities using mobile devices. Include written documentation to organize and record Owner’s requirements and nomenclature for system settings. Prior to system programming, verify with Owner if any changes are required.

B. Engage a factory-authorized service representative to perform startup service.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
   2. Complete installation and startup checks according to manufacturer's written instructions.
   3. Record all final system settings and save to flash drive for Owner’s future use.
   4. Obtain network IP settings from Owner and program as required for all equipment requiring IP addresses.

## 3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting video, sound levels, resetting transformer taps, and adjusting controls to meet occupancy and Owner conditions. Coordinate final system programming with Owner to determine all preset levels for each type of event.

B. Contractor will program system per Owner’s input while on site with Owner to review all settings. Contractor will then be required to come back during business hours or after hours as requested to readjust all settings as requested by the Owner. All modifications will be recorded in writing and saved to flash drive and given to the Owner as part of the close out documentation process.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits (up to 2 hours each) for each system during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. None

END OF SECTION

# SECTION 28 05 00

# COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Electronic safety and security equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common electronic safety and security installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels as specified.

D. Coordinate sleeve selection and application with selection and application of firestopping specified.

## PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for all penetrations. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls. If above accessible ceiling, sleeves can extend 1 inch out of wall.

F. Extend sleeves installed in floors to above accessible ceiling.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway. All other sleeves for cabling shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

N. Furnish and install sleeves for all low voltage cabling, including Data, Voice, Video, Intercom, Clock, Thermostat, Fire Alarm, Security, etc. All sleeves shall be provided with end bushing/fitting to protect cabling. Sleeves shall be sized based upon 40 percent NEC fill rate and allow for minimum of 50 percent expansion for future cables. Utilize multiple sleeves as required. Minimum sleeve size is 3/4 inch conduit.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements as specified.

**END OF SECTION**

# SECTION 28 05 13

# CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Category-6A UTP cabling.
2. RS-232 cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Fire alarm wire and cable.
7. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

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

E. Open Cabling: Passing telecommunications cabling through open space (above accessible ceilings).

F. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For cables, include the following installation data for each type used:
a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.
d. Electrical characteristics.

B. Shop Drawings: Cable layout, showing cable route, with relationship between adjacent structural, electrical, and mechanical elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified, include the following:
   1. Allowable pulling tension of cable.
   2. Cable connectors and terminations recommended by the manufacturer.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL – U.L.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of cables for open and short circuits.

1.7 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
   1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

C. Do not allow cables to be painted.

1.8 WARRANTY

A. One Year parts and labor unless manufacturer’s standard warranty is for greater length of time.

B. Refer to other Divisions 26, 27 and 28 for additional warranty requirements.

## PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: U.L. labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

B. Cable Trays (when specified on drawings):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cablofil.
      b. Cooper B-Line, Inc.
      c. GS Metals Corp.
      d. Mono-Systems, Inc.
      e. Panduit.
      f. Hubbell.
   2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M Grade 0.55, not less than 0.002165 inch thick.
      a. Basket Cable Trays: Dimensions as specified on drawings. Wire mesh spacing shall not exceed 2 by 4 inches.
      b. Ladder Cable Trays: Nominally 12 inches wide, and a rung spacing of 12 inches. Refer to drawings for additional information.
      c. All fire alarm cabling to be installed in dedicated raceway.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

D. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 inches by size required. Comply with requirements for plywood backing panels. Paint out white, do not cover fire label.

2.3 CATEGORY-6A CABLE

A. Refer to Division 27 Section "Communications Horizontal Cabling" for requirements.

2.4 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

4. Fluorinated ethylene propylene jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.5 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Overall shielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway and power-limited cable, complying with UL 83, concealed in building finishes.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

D. All cabling installed in plenum areas will be installed in raceway and will be plenum rated.

2.8 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Comtran Corporation.
2. Helix/HiTemp Cables, Inc.; a Drake Company.
3. Rockbestos-Suprenant Cable Corp.
4. West Penn Wire; a brand of Belden Inc.
5. Allied Wire and Cable.
6. Coleman Cable Inc.
7. Belden Cable.

B. General Wire and Cable Requirements: U.L. listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair (or as required by Alarm Panel Manufacturer), not less than No. 18 AWG, 300volt rated and as recommended by system manufacturer.

D. Notification circuits: Solid copper conductors, 2 conductors, not less than No. 16 AWG, 300volt rated and sized for voltage drop so that notification device voltage does not drop below 18volts.

E. Audio Circuits: Solid-copper conductors, 2 conductors not less than No. 18 AWG, 300volt rated and as recommended by system manufacturer. Size as required to minimize audio circuit voltage drop. Utilize shielded cable when specified by fire alarm panel manufacturer.

F. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   1. Low-Voltage Circuits: No. 16 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.

G. **All fire alarm cabling to be plenum rated, fire protection listed and installed in raceway.**

2.9 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. HellermannTyton.
   3. Kroy LLC.
   4. PANDUIT CORP.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables according to TIA/EIA-568-C.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA-569-B.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits to above accessible ceiling or to backboards.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards as required. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

## 3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

## 3.3 WIRING METHOD

A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install wiring in raceways except in accessible indoor ceiling spaces. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems. All cabling subject to damage (i.e., Gymnasiums, Locker Rooms, Mechanical Rooms, etc.) shall be installed in raceway and shall be painted out to match area.

C. Install cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

## 3.4 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:
   1. Comply with TIA/EIA-568-C.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 48 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
   4. **Do not support cables from ceiling grid support wires.**
   5. **Do not install cabling above top chord of bar joists or within 6 inches of roof deck to avoid roofing nail damage.**

E. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

## 3.5 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. **Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.**

C. Wiring Method:
   1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
   2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in cabinets, or equipment enclosures where circuit connections are made.

F. Device wiring: Wire from device to device, no intermediate splices are allowed.

G. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

## 3.6 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits, No. 14 AWG.
   2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.7 CONNECTIONS

A. Comply with requirements in Division 28 Section "Fire-Alarm and Voice-Notification System" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in mechanical contractors' specification for Refrigerant Detection and Alarm for connecting, terminating, and identifying wires and cables.

3.8 FIRESTOPPING

A. Comply with requirements.

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.9 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Visually inspect cable jacket materials for U.L. certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-C.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex,

complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

**END OF SECTION**

# SECTION 28 31 11

# FIRE-ALARM AND VOICE-NOTIFICATION SYSTEM

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to drawings for manufacturer, model numbers and additional requirements.

1.2 SUMMARY

A. Section includes extension of **Existing <u>Siemens XLS-R</u>** Fire Alarm System.

B. Section Includes:
1. Existing fire-alarm control unit, including voice evacuation system.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Non-system detectors.
5. Carbon monoxide detectors.
6. Heat detectors.
7. Notification appliances, including audio speakers.
8. Magnetic door holders and/or holder closers.
9. Existing Remote annunciator with voice control kit and control switches.
10. Addressable interface monitor and control devices.
11. Existing radio alarm transmitter
12. Sprinkler system monitoring.
13. Zone Maps.
14. Passcodes.
15. **Inspection of Existing System.**

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

C. LCD: Liquid Crystal Display.

D. AHJ: Authorities Having Jurisdiction.

E. MNS: Mass Notification System.

1.4 BUILDING CODES AND STANDARDS

A. The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.

1. FM Global (Factory Mutual (FM)): FM Approval Guide
2. National Fire Protection Association (NFPA)

B. National Fire Protection Association (NFPA):
1. NFPA-70 - National Electrical Code (NEC) 2014
2. NFPA-72 - National Fire Alarm and Signaling Code - 2013 Edition with Mass Notification
3. NFPA 720 - Standard for inspection of carbon monoxide detection and wiring.
4. NFPA 101 - Life Safety Code 2015
5. IBC - International Building Code 2015
6. IFC - International Fire Code 2015
7. IMC - International Mechanical Code 2015

C. National Electrical Manufacture's Association (NEMA)

D. Underwriters Laboratories, Inc. (UL)
1. UL-864 - Control Units for Fire Protective Signaling Systems (9th Edition)
2. UL-268 - Smoke Detector for Fire Protective Signaling Systems
3. UL-217 - Smoke Detectors for Single and Multiple Station
4. UL-521 - Heat Detectors for Fire Protective Signaling Systems
5. UL-464 - Audible Signaling Appliances
6. UL-1971 - Visual Signaling Appliances
7. UL-38 - Manually Actuated Signaling Boxes
8. UL-1480 Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
9. UL-1481 - Power Supplies for Fire Protective Signaling Systems
10. UL 2017 - Mass Notification Systems
11. UL 2572 - Control and Communication Units for Mass Notification Systems
12. UL 228 - Door Holding Devices
13. UL 268A - Smoke Detectors for Duct Application
14. UL 1283 - Electromagnetic Interference Filters
15. UL 1449 - Transient Voltage Surge Suppressors

## 1.5 REGULATORY REQUIREMENTS

A. All equipment specified shall be UL/FM listed and cross listed for use with the main fire alarm control panel and shall bear the same manufacturer's name on the main control panel as well as all the remote devices. Systems having equipment with various manufacturers' names will not be acceptable. All control equipment shall be listed under UL category UOJZ as a single control unit and also UL/FM listed for power limited applications per NEC 760.

## 1.6 SYSTEM DESCRIPTION

A. Non-coded, UL Listed intelligent analog addressable system, one-way digital voice communications with multiplexed signal transmission and survivable network nodes. The entire system shall be UL2572 Listed Mass Notification System.

B. The System supplied under this specification shall utilize node-to-node, direct wired, multi priority peer-to-peer network operations where network control or remote voice command centers are located on the drawings. The system shall utilize independently addressed, input/output modules, audio amplifiers, and voice communications as described in this specification. The peer-to-peer network shall

contain multiple nodes consisting of the command center, main controller, remote control panels, and LCD panels. Each panel shall be an equal, active functional member of the network, which is capable of making all local decisions and generating network tasks to other panels in the event of panel failure or communications failure between panels. Master/slave system configurations shall not be considered as equals.

C. The fire alarm equipment and installation shall comply with the current provisions of the following latest edition UL and NFPA standards and shall be listed for its intended purpose and be compatibility listed to insure integrity of the complete system.

D. The entire system shall be a UL464 Listed Audio Evacuation System. This includes all Control Panels, Remote Command Centers, Remote Microphones, Data Gathering Panels, Network Nodes, all amplifiers and all high fidelity speakers. All of these components shall be UL cross-listed together.

E. The system performance specified herein is based upon a minimum design performance requirements utilizing high fidelity speakers with the following minimum selectable sound performance levels from 81.5; 84.1; 87.3; and 90.5 dBA (.25, .50, 1.0, 2.0 watts, respectively).

F. At a minimum, provide at least one (1), One-Way Voice Command Center as noted on the drawings. Each Command Center shall be fully redundant on the network with redundant audio network, audio messages (32 minutes of message storage capacity, minimum), paging microphone and the following:
   1. Command Center or Local Operator Console (LOC) with redundant audio messages, paging microphone and request for control switches & status indicators. Each Command Center shall have switches with LED annunciating control and requesting control as follows:
      a. Request Take Control
      b. Request Accepted
      c. Request Deny
      d. Restore command center to normal operation
      e. Priority request override Take Control

G. The Emergency Voice Paging System will provide 8-Channel audio paging up to ten (10) audio paging areas via a system microphone and telephone paging access. The paging system shall be used for routine and emergency paging.
   1. Area 1 – Interior Areas/By Floor
   2. Area 2 – Exterior Areas
   3. Area 3 – To Be Determined By Owner

H. Provide telephone access paging interface selectable with ten paging areas, plus all call.

I. All remote local operating console (remote annunciator/LOC) shall have LCD display, paging microphone, audio zone selection switches and by-pass switches. Provide visual indication which microphone is active during paging operations. During local microphone paging the speakers located near by the microphone shall be muted through software programmable audio control relays. The LOC shall not override the Command Center operations.

J. The fire alarm equipment and installation shall comply with the current provisions of the following latest edition standards (unless otherwise noted below) applicable

to the jurisdictional authorities, including their local adoptions and amendments and it shall be listed for its intended purpose of a Mass Notification and Emergency Communication Signaling System and be compatibility listed to insure integrity of the complete system. It shall be listed to all of the UL Standards listed herein, without exception.

1.7 SUBMITTALS

A. The Contractor shall not purchase any equipment for the system specified herein until the Owner and/or designated representative has approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The Contractor shall submit three (3) complete sets of documentation within 30 calendar days after award of purchase order.

B. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the Contract Documents. In addition the Contractor shall provide specific notation on each Shop Drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Architect.
   2. Provide shop drawings and battery calculations to local fire department.
   3. Technical Submittals including Engineered Fire Alarm Installation layout Shop Drawings shall be prepared by persons with the following qualifications:
      a. Registered Professional Fire Protection Engineer which is a Licensed Professional Engineer who has passed the NCEES Principles and Practices of Fire Protection Engineering Examination licensed in the state which has jurisdiction.
      b. NICET Level IV technician who has been certified at Level IV in the sub-field of Fire Alarm Systems Layout.
      c. Submittals shall also include the Quality Assurance certifications of the Fire Alarm Technician (see Paragraph Section 1.8).
      d. Distributor Qualifications: Provide documentation of the independently owned, Fire Alarm Distributor’s qualifications, including all licenses, certificates and proof of authorization as a Manufacturer’s Representative in Good Standing.

C. Product Data: Product Data sheets with the printed logo or trademark of the manufacturer of all equipment. Indicated in the documentation shall be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Owner.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Comply with all recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA72.

2. Include voltage drop calculations for notification appliance circuits based on manufacturer-provided panel start voltage and point-to-point notification appliance circuit calculations. System Layout drawings prepared using the Lump Sum Method for visual strobe circuits are not acceptable.
3. Include battery-size calculations. Batteries shall be include a 30% safety factor above the minimum requirements derived from calculations, as required by NFPA 72.
4. Power supplies shall be sized to furnish the total connected load in a worse-case condition, plus 30 percent spare capacity for future growth.
5. Include fire alarm plans (drawings to scale in AutoCAD format), riser diagrams, point-to-points showing all devices and locations of all end of line resistors.
6. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
7. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors in accordance with NFPA 72.
8. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
9. Indicate speaker wattage tap settings for all speakers on the floor plans, calculate and show dB Line Loss calculations for all speaker circuits using the Lump sum method. dB Losses shall be no greater than 3.0 dB from amplifier start terminals to last device.
10. Indicate all Acoustically Distinguishable Areas on the installation shop drawings.
11. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits from end-to-end. “Home Run” indicators or other non-end-to-end wire path designations are not acceptable.
12. Include programming matrix for all devices showing input and output functions. Air handler shut down of each unit as required based on local alarm.

E. Operation and Maintenance Data: For fire-alarm systems and components to be included in emergency, operation, and maintenance manuals. In addition to items specified, include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72.
2. Provide "Record of Completion Documents" according to NFPA72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software database file, hardcopy printout and CD, with password for delivery to the owner. Proprietary system/service companies will not be acceptable.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA72 article of the same name and include the following:
   a. Frequency of testing of installed components.

b. Frequency of inspection of installed components.
c. Requirements and recommendations related to results of maintenance.
d. Manufacturer's user training manuals (hardcopy) and electronic on CD.
e. Include every device in the system and associated print out showing each device as Passing or Failing tests.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25 results.

F. Software and Firmware Operational Documentation:
1. CD of site-specific software database file with password and all product data sheets. Provide hard copy printout of the software program. Single Source Providers or Proprietary System/service companies will not be acceptable.
2. Provide a list of global system settings.
3. Provide a list of the contents of each system cabinet and their settings.
4. Provide a list of all addressable devices with their addresses and settings.

1.8 QUALITY ASSURANCE

A. Fire Alarm vendor's employed personnel shall be trained and certified by the manufacturer (an authorized Siemens Dealer with direct ties to the manufacturer) on the make and model of the fire alarm control panel specified for this Project. *All installers without this certification will have their bids rejected unless they receive prior approval from the Owner, Architect and Engineer in writing.*

B. The following is a list of pre-approved vendors capable of bidding and working on this project. All other bidders will need to be pre-approved by the Owner, Architect and Engineer prior to bidding:
1. **For system upgrades, parts and installation contact Brian Schmid at First Security, 1811 High Grove, Suite 191, Naperville, IL 60540, 630.961.5900. b.schmid@first-sec.com**
2. **For system programming, contact Stephen Hupp at Fire Safety & Security Life Cycle Sales Executive Siemens Smart Infrastructure, 585 Slawin Ct., Mount Prospect, IL 60056, 847.217.7509.**

C. Installer Qualifications: Fire Alarm distributor's employed personnel shall be trained and certified by manufacturer (an authorized Siemens Dealer with direct ties to the manufacturer) on the make and model of the fire alarm control panel specified for this Project.

D. Additional Installer Qualifications: Installation shall be by personnel certified by NICET as a technician who has been certified at Level II in the sub-field of Fire Alarm Systems Layout.

E. Project Manager Qualifications: Installation shall be supervised by personnel certified by NICET as Fire Alarm System Layout Level IV Technician (SET), an NFPA Certified Fire Protection Specialist (CFPS) or an NCEES accredited Licensed Fire Protection Engineer (FPE).

F. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single distributor and manufacturer. Components shall be compatible with, and operate as a fully U.L. listed extension of a U.L. 864 listed fire alarm control system.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA70, by a qualified testing agency, and marked for intended location and application.

H. Fire Alarm Distributor Qualifications:
   1. Contractor shall utilize an Illinois Licensed Private Alarm Contractor Agency that is an authorized, independently owned Manufacturers representative of the specified fire alarm equipment manufacturer.
   2. Fire Alarm Distributor shall be a full service entity qualified to provide the engineering for the technical submittal, furnishing of the equipment, commissioning, testing and inspection services outlined herein including intelligibility testing and capable of providing full repair service to any fire alarm system and/or provide fire alarm system installation and design including, but not limited to, the following minimum requirements:
      a. Qualified Fire Alarm Service Company with employees who meet the criteria defined by NFPA 72 for the qualifications of both System Designers and System Installers to include the requirements of the Authorities Having Jurisdiction (AHJ).
      b. Certified Fire Alarm Service Inspectors with employees of the entity who are certified in Fire Protection Engineering Technology by the National Institute for Certification in Engineering Technologies (N.I.C.E.T.) in FIRE ALARM SYSTEMS – LEVEL II, minimum.
      c. Five (5) Years of experience with intelligibility measurement technology and testing (minimum) is required for this project and the Fire Alarm Distributor shall provide intelligibility measurement equipment capable of registering and recording Intelligibility readings in accordance with IEC 60268-16, Sound System Equipment - Part 16: Objective Rating of Speech Intelligibility by Speech Transmission Index. Equipment shall have been calibrated within one (1) year of the commencement of the intelligibility testing for this project.
   3. Distributor shall be a registered Illinois legal entity (Corporation, Partnership, Professional Corporation or Limited Liability Company) in Good Standing with the Secretary of State of Illinois.
   4. Distributor entity shall hold a valid Illinois Private Alarm Contractor Agency License. Sub-contractors or licensed individual Private Alarm Contractors DO NOT meet this requirement.
   5. Distributor entity shall be qualified by the AHJ, including the Illinois Department of Professional Regulation to provide engineering design services for a fire alarm and mass notification system as evidenced by holding an Illinois Registered Professional Design Firm license. Sub-contractors or individually licensed individual Registered Architects, Professional or Structural Engineers DO NOT meet this requirement.
   6. All service employees of the entity shall have a valid Illinois Permanent Employee Registration Card (P.E.R.C.).

I. Contractor must inspect the buildings and become familiarized with building construction prior to submitting their bid.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following

conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than seven (7) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Architect's, Construction Manager's and Owner's written permission.

1.10 INSPECTION OF EXISTING SYSTEMS

A. The contractor will be responsible for inspecting all existing systems that will be worked on (during the course of the construction project) before touching them. This shall cover, but not limited to the following systems: fire alarm system). This inspection will need to document any issues with the existing systems that are affecting their proper operation. If this report is not provided, the contractor is attesting that all systems were functional and properly operating before the start of the construction and will be responsible for all repairs. The onus is on the contractor to identify problems with any of the systems to the Owner prior to construction.

1.11 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. The contractor will maintain an operational fire alarm system throughout the course of construction. Systems can be taken out of service on non-school days or after business hours when working in the building, but must be put back into service when building is left unoccupied. If for whatever reason this process cannot be done, **the contractor will be required to hire a fire watch person that has been approved by the Fire Department to monitor the building when it is left unprotected**. Refer to drawings for additional information.

C. The contractor will be required to acknowledge when they take system out of service and when they restore system service each day. Provide fire alarm clip board next to fire panel and identify date, time and person performing this work for record. All actions must be coordinated with the Owner, no exceptions.

1.12 DELIVERY, STORAGE AND HANDLING

A. Store all devices in a clean, dry, heated space.

B. After installation, protect equipment from damage by work of other trades.

1.13 PROTECTION/CLEANING

A. Provide dumpster for all removed equipment at contractor’s expense.

B. Protect all areas working in. Provide tarps to cover all floors and equipment to avoid damage. Provide hard boards to cover specialized flooring areas such as Gymnasiums, Multi-Purpose Rooms, Cafeterias, etc., to prevent damage/scratches

to special surfaces. Thoroughly clean and vacuum all areas that work has been completed in.

1.14 ACCESSIBILITY

A. Provide appropriate lifts and ladders to reach specified work. Do not use the Owner's equipment and supply.

1.15 WARRANTY and SOFTWARE SERVICE AGREEMENT

A. The contractor shall warranty all materials, installation and workmanship for one (1) year from date of acceptance, and all Fire Alarm Equipment Component materials. Manufacturer material warranties for more than one year shall remain in force. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. The System Supplier shall maintain a service organization with adequate spare parts stocked within 75 miles of the installation. Any defects that render the system inoperative shall be repaired within 4 hours of the Owner notifying the contractor.

C. Technical Support: Beginning with Substantial Completion, provide software support for one (1) year, shall be included in this project.

D. Detector Sensitivity Testing: During the warranty period, each year the contractor is to perform detector sensitivity testing and provide report to the Owner. Unless, the system is UL Listed to perform automatic sensitivity testing without any manual intervention and should detector fall outside of sensitivity window, the system will automatically indicate a devices trouble. A copy of UL letter is to be provided as proof of system operation.

E. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within one (1) year from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.16 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide quantity equal to 2% percent of amount of each type installed, but no less than one (1) unit of each type.
      a. Smoke Detectors, heat detectors, carbon monoxide detectors, manual pull stations, duct smoke detector, monitor modules and control modules:
      b. Notification appliances; speakers, speaker-strobes and strobes.
   2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet and shall turn all of them over to the Owner at completion.
   3. Owner's Stock shall not be used for warranty service.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS (SYSTEM IS BASED ON AN EXISTING SIEMENS XLS-R)

A. Manufacturers: The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling fire alarm system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. The Contractor shall provide, from the manufacturer's current product lines, equipment and components, which comply, with the requirements of these Specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.

C. Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed, and will accommodate the future requirements and operations of the building Owner. All specified operational features must be met without exception.

D. All control panel assemblies and connected (new) field appliances shall be provided by the same System Supplier**,** and shall be designed and tested to ensure that the system operates as specified. All equipment and components shall be installed in strict compliance with the manufacturer's recommendations.

E. Approved Products: All panels and peripheral devices shall be of the standard product of single manufacturer and shall display the manufacturer’s name of each component. The catalog numbers specified under this section are those of Siemens Systems, and shall constitute the type, product quality, material and desired operating features necessary for the completion of this projects intended design and function.

2.2 MANUFACTURER’S SERVICES

A. The following supervision of installation shall be provided by a trained service technician who is employed by the manufacturer of the fire alarm equipment. The technician shall be UL and NICET Level III certified and have had a minimum of two (2) years of service experience in the fire alarm industry. The technician’s name shall appear on equipment submittals and a letter of certification from the fire alarm manufacturer shall be sent to the project engineer. The manufacturer’s service technician shall be responsible for the following items:
   1. Pre-installation visit to the job site to review equipment submittals and verify method by which the system should be wired.
   2. During job progress, make periodic job site visits to verify installation and wiring of system.
   3. Upon completion of wiring, final connections shall be made under the supervision of this technician and final checkout and certification of the system.
   4. At the time of final checkout, technician shall give operational instructions to the Owner and/or his representative on the system.

B. All job site visits shall be dated and documented in writing and signed by the electrical contractor. Any discrepancies will be noted on this document and a copy kept in the system job folder which will be turned over to the project engineer any time during the project.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Mass Notification initiated event shall override any event and take the highest system priority.

B. Fire-alarm signal initiation shall be by one or more of the following devices:
1. Manual stations.
2. Heat detectors.
3. Beam detectors.
4. Smoke detectors.
5. Carbon monoxide detectors.
6. Duct smoke detectors.
7. Verified automatic alarm operation of smoke detectors.
8. Automatic sprinkler system water flow.
9. Heat detectors in elevator shaft and pit.
10. Fire-extinguishing system operation.

C. Fire-alarm signal shall initiate the following actions where applicable to this facility and jurisdiction:
1. Activate multiple channel pre-recorded voice messages preceded and followed by temporal tone.
2. Continuously operate the visual notification appliances.
3. Display Fire Alarm Message Type on Intercom Systems' Digital Display Message Boards.
4. Identify alarm at fire-alarm control unit and remote annunciators.
5. Transmit an alarm signal to the remote alarm receiving station.
6. Unlock electric door locks in designated egress paths.
7. Release fire and smoke doors held open by magnetic door holders.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
10. Recall elevators to primary or alternate recall floors.
11. Activate emergency shutoffs for gas and fuel supplies.
12. Record events in the system memory.
13. Record events by the system printer (if shown or called for in the contract documents).

D. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.
4. Duct smoke detector activation.
5. Carbon monoxide detection, special dedicated CO Supervisory Indication.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging circuitry
8. High or low battery charge.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Fire-pump power failure, including a dead-phase or phase-reversal condition.
11. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer if specified.

2.4 FIRE-ALARM CONTROL UNIT (EXISTING TO REMAIN)

A. The existing main control panel or remote control panel(s) shall be a multi-processor based networked system designed specifically for detection, and one-way emergency audio communications applications. The control panel(s) shall be listed and approved for the application under the standard(s) as listed. The existing control panel is model **Siemens XLS-R**

B. The control panel(s) shall include all required hardware, software and site-specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

C. The network of control panels shall include the following features.
1. Ability to download all network applications and firmware from the configuration computer on the network or at any control panel (network node) location.
2. Each control panel (network node) shall have an LCD display with common controls. The display shall be configurable to display the status of any and all combinations of alarm, supervisory, trouble, monitor, or group event messages.
3. From each LCD display on the system shall be capable of being programmed for control functions of any node or the entire network. The LCD display shall reside on the network as a node and continue to operate with fault on the network. An LCD can be programmed to be only operation when a node is operational in stand-alone mode, with a network fault.
4. The system program shall have a minimum of 100 system definable Service Groups to facilitate the testing of installed system based on the physical layout of the system. Service groups that disable entire circuits serving multiple floors or fire zones shall not be considered as equal.
5. Advanced Windows based programming with Program Version Reporting to document any and all changes made during system start-up or system

commissioning. Time and date stamps of all modifications made to the program must be included to allow full retention of all previous program version data. The operator display shall clearly identify unacknowledged and acknowledged alarm, supervisory, trouble, and monitor status messages. The system shall provide the ability to download data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

6. Provide system reports that list a detailed description of the status of system parameters for corrective action or for preventive maintenance. Reports shall be displayed on the operator interface or be capable of being sent to a printer.
7. Provide an authorized operator with the ability to operate or modify system functions such as system time, date, passwords, holiday dates, restart the system and clear the control panel event history file.
8. Provide an authorized operator the ability to perform test functions within the installed system.
9. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure. The system shall provide fail-safe operation, with multiple-levels of system operation.

D. Each network control panel shall be capable of:
1. Supporting up to 1500 intelligent analog/addressable points.
2. Supporting up to six (6) intelligent addressable loops, each loop supporting detectors and modules, total of 250 points.
3. Supporting network connections up to 64 other control panels and 30 annunciators.
4. Support up ten network digital dialers with Contact ID or SIA format and TAP Pager protocol.
5. Supporting multiple RS-232 communication ports and protocol.
6. Supporting up to 1100 chronological history events.
7. Total network response shall not exceed 3 seconds.

E. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, monitor, trouble and component status messages and control menu.
1. The common control switches and with corresponding LEDs provided as minimum will be; Reset Alarm Silence, Panel Silence, and Drill. It shall be able to add additional switches/LEDs as required.
2. The main control panel shall have display that is 24 lines by 40 character graphic LCD and backlit when active, 960 characters.
3. Provide 8 simultaneous events to be displayed. The first seven (7) highest priority events in addition to the most recent event. The events shall be automatically placed in event types (Alarm, Supervisory, Monitor & Trouble) for easy access and shall be possible to view the specific event type separately. Having to scroll through a mixed list of event types is not acceptable.

4. Provide an internal audible signal with different programmable patterns to distinguish between alarm, supervisory, trouble and monitor conditions.

F. Audio One-Way Voice Communication & Amplifier Performance Requirement
1. The voice communication system shall be an eight (8) channel capable audio evacuation system, to allow the ability to have eights simultaneous announcements/paging. The audio channels shall be design as such (coordinate with Owner):
   a. Mass Notification Message (HIGHEST PRIORITY)
   b. Fire Message
   c. Alert Message
   d. Stand-by Message
   e. Elevator Message
   f. Stairwell Message
   g. Security/Weather Threat
   h. Manual Paging
2. The system custom digital voice message shall be created as a .wav file format. All messages shall be able to be created on-site without any special tools or burning of chips. Provide as minimum one twenty (20) watt supervised audio amplifier per paging zone. The system software shall be capable of selecting the required audio source signal for amplification. To enhance system survivability, each audio amplifier shall automatically provide an internally generated local 3-3-3, 1000 Hz temporal pattern output upon loss of the audio signal from the one-way emergency audio control unit, during an alarm condition.
   a. List of Potential Recorded Messages to Use (Utilize existing voice messages already recorded on the system) The following are examples only:
      1) Fire Alarm (Automatic and Pre-Recorded)
         a) Tone Type: Three Pulse Temporal (NFPA 72, A.18.4.2.1)
         b) Tone Cycles: 2 times before and after message (NFPA 72, 24.4.2.17.1)
         c) Tone Duration: Per NFPA 72, 18.4.2.1
         d) Message Content: "May I have your attention please. A fire emergency has been reported in the building. Please walk to the nearest exit and leave the building."
      2) Building Emergency (Evacuate)
         a) Tone Type: Chime (NFPA 72, A.18.4.2.1(b))
         b) Tone Cycles: 2 times before and after message (NFPA 72, 24.4.2.17.1)
         c) Tone Duration: Per NFPA 72, A.18.4.2.1(b)
         d) Message Content: "May I have your attention please. An emergency has been reported in the building. Please walk to the nearest exit and leave the building."
      3) Area Emergency (Shelter-in-Place)
         a) Tone Type: Chime or 1000 Hz tone
         b) Tone Cycles: 2 times before the message only
         c) Tone Duration: 3 seconds
         d) Message Content: "May I have your attention please. An emergency has been reported in the area. Please remain in the building and await further instructions."

4) Severe Thunderstorm Warning
   a) Tone Type: Chime or 1000 Hz tone
   b) Tone Cycles: 2 times before the message only
   c) Tone Duration: 3 seconds
   d) Message Content: "May I have your attention please. The National Weather Service has issued a SEVERE THUNDERSTORM WARNING for this area; please take immediate shelter indoors."
5) Tornado Warning
   a) Tone Type: Chime or 1000 Hz tone
   b) Tone Cycles: 2 times before the message only
   c) Tone Duration: 3 seconds
   d) Message Content: "May I have your attention please. The National Weather Service has issued a TORNADO WARNING for this area; please take immediate shelter in the tornado shelter, basement, or on the lowest level at the center of the building away from exterior windows and doors."
6) Test
   a) Tone Type: Chime or 1000 Hz tone
   b) Tone Cycles: 2 times before and after the message
   c) Tone Duration: 3 seconds
   d) Message Content: "May I have your attention please. This is a test of the building mass notification system. Please continue your normal duties. This is only a test."
7) All Clear
   a) Tone Type: Chime or 1000 Hz tone
   b) Tone Cycles: 2 times before and after the message
   c) Tone Duration: 3 seconds
   d) Message Content: "May I have your attention please. An all clear has been issued; resume normal activities."
8) Microphone (LOC or ACU) Keying
   a) Tone Type: Chime or 1000 Hz tone
   b) Tone Cycles: Once

3. Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall be a supervised, dedicated, selectable 25Vrms output.
4. Provide a standby audio amplifier per node that will automatically sense the failure of any primary amplifier installed in the same panel and replace the function of the failed amplifier (One for All Backup).
5. Amplifier Minimum Sizing Specification shall be as follows:
   a. 7.5 Watts per Trumpet Type Loudspeaker
   b. 2 Watts per 8 inch cone type speaker
   c. 1 Watts per 4 inch cone type speaker
   d. 4 Watts per re-entrant horn-driver type speaker
   e. Plus 30% spare capacity for each connected amplifier or speaker signal circuit switching module.

G. Provide an Emergency Voice Communication System with the following design features:
1. An audio control unit with Microphone for Paging.

2. Provide 3-position switch for each evacuation signaling zone and “All-Call”, with "Page FIRE", "Auto" and “Page ALERT” positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow.
3. These LED's shall illuminate to indicate respectively:
   a. Evacuation signals activated (red).
   b. Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

H. Provide 2-position switch for manually activate pre-recorded voice messages, with “Message Name" positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.
1. These LED's shall illuminate to indicate respectively:
   a. Message activated (red)

I. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions

J. Circuits Requirements:
1. Signaling Line Circuits for Network Communications:
   a. Class A, Level 1, pathway survivability level
2. Ethernet IP Network
   a. Class C, Level 1, pathway survivability level
3. Signaling Line Circuits for Intelligent Analog Addressable Loop:
   a. Class A, Level 1, pathway survivability level
   b. No more than 100 detectors or 100 modules installed on a loop.
4. Initiating Device Circuit:
   a. Class A, Level 1, pathway survivability level
5. Notification Appliance Circuits:
   a. Class A, Level 1 pathway survivability level
   b. Maximum circuit loading to 2.25 amps for each 3.0 amp visual circuit, not to exceed 75% of the visual circuits terminal capacity or the power supplies total amperage rating (i.e. no more than 6.0 amps on an 8.0 amp power supply)
6. Door Holder Circuits
   a. Class D, Level 1, pathway survivability level
7. Activation of alarm notification appliances, smoke control, elevator recall and other functions shall occur within 3 seconds after the activation of an initiating device.

K. Smoke-Alarm Verification:
1. Initiate an audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate a UL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system memory.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
6. Coordinate final decision and program feature requirements with Fire Departments and Owner.

L. Elevator Recall:
   1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
      a. Elevator lobby detectors except the lobby detector on the designated floor.
      b. Smoke detector in elevator machine room.
      c. Smoke detectors in elevator hoistway.
   2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
   3. Heat detector and water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
      a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
   4. Contractor shall hire Owner's elevator company for making all necessary connections for a complete operating system. All costs to be covered by the contractor and included in bid.

M. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

N. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change to alternate settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values.

O. Radio Alarm Transmitter (EXISTING TO REMAIN)
   1. New fire alarm radio transmitter will be utilized. Connect to new fire alarm control panel as required.
   2. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by U.L./F.M.
   3. Comply with 47 CFR 90.
   4. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
      a. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
      b. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
      c. Normal Power Input: 120-V ac from emergency power panel on emergency generator.
      d. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
      e. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mphwith a gust factor of 1.3 without

failure. Remote mount antenna as required for best reception. Coordinate final location with Owner/Engineer.

f. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance. Install in conduit.
g. Antenna-Cable Connectors: Weatherproof.
h. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

5. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
   a. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
   b. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
   c. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
   d. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
   e. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
   f. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.
6. Test available signal strength and provide written report prior to ordering unit. If signal strength is unsatisfactory, another communication method will be required at contractor’s expense; i.e., digital communicator and phone lines.
7. Connect radio to fire alarm control panel so that when unit fails (power loss, communication failure), there is on-site trouble notification at control and annunciator panels. All new radios shall be provided with auxiliary contacts as required.
8. Contact Fire Department/Central Station for purchasing and setting up new Keltron/AES radio. Coordinate with Owner to complete all documentation/paperwork for setting up account. Contractor shall pay for two years of monitoring service, installation, and set up fees. Owner to fill out all documents and contractor to pay monitoring company.
9. Contractor is responsible for all work associated with Radio and Programming via the Central Station.

P. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, shall be powered by nominal 24-V dc source. Obtain 120-V power from emergency power panels on generator. Lock out circuit breakers.

Q. Test system and certify that central station is capable of receiving signals. Radio shall be supervised and monitored locally for trouble at both fire alarm control and annunciator panels. Radio must transmit for alarm, trouble, supervisory, and carbon monoxide supervisory.

2.5 EXISTING REMOTE ANNUNCIATOR WITH ONE-WAY VOICE COMMUNICATION (FAAP) and EXISTING LOCAL OPERATOR CONSOLE (LOC)

A. Existing annunciator matches those of fire-alarm control unit LCD display functions for alarm, supervisory, monitor and trouble indications and common system controls including; acknowledging, silencing, resetting, and testing. The fire alarm bypass function switches and LCD Keypad may be housed separately in a locked enclosure to prevent unauthorized use and control of fire alarm system program control and bypass, but the Paging Microphone, Audio Selector and Message Selector Switches shall be housed in a listed enclosure which is capable of being fitted with an unlocked latching knob for the enclosure, such that these emergency communication and signaling controls are readily accessible for emergency signaling. (LOC) Panel to include annunciator/control switches and microphone only. The Contractor shall verify this feature with Owner prior to ordering equipment.
   1. This display is a Siemens Annunciator with Switch Modules Series, cabinet size as needed including trimplates, and shall have the following minimum features:
      a. LCD Display
      b. Paging Microphone
      c. Audio Selector Switches
      d. Audio Message Selector Switches
      e. System Bypass Switches
   2. Utilize pre-finished cabinets when surface mounting is required.

2.6 NAC POWER SUPPLY

A. The NAC power supply shall be independent unit that will provide power to visual strobe notification appliances. It shall be possible to configure the NAC’s to follow the main panel’s NAC or activate from intelligent synchronized modules. The booster NAC’s must be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. Fault conditions on the power supply shall not impede alarm activation of host NAC circuits or other power supplies. The NAC power supply must be able to provide concurrent power for notification devices, security devices, access control equipment and auxiliary devices such as door holders. . All the NAC Power Supplies shall be supervised and synchronized. The power supply shall support up to 24 amp hour batteries.
   1. Power supply shall be minimum of 8 amps and UL 864 Listed.
   2. Four independent 3.0 amp NAC circuits. Each being configurable as auxiliary power.
   3. All circuits shall be synchronized.

4. Do not exceed 70 percent (70%) of each circuits rating so as to provide future capability. Minimum 30 percent (30%) spare capacity.
5. Obtain 120 V power from emergency power panels (on generator power if available). Lock out circuit breaker.
6. Do not mount above ceilings. Locate in equipment closets.
7. Install smoke detector at this location for protecting unit or other detection device suitable for the application.
8. Secondary power shall provide 60 hours of standby power in non-alarm state (24 hours if backed up by emergency generator) with 2 hours of emergency system operation or 15 minutes of evacuation alarm at maximum load.

2.7 INTELLIGENT ANALOG SYSTEM SMOKE, HEAT AND CARBON MONOXIDE DETECTORS (*MUST CONFORM TO UL 268, 7TH EDITION*)

A. General Requirements for Intelligent Analog Detectors
1. Integral Microprocessor: All decision are made at the detector determining if the device is in the alarm or trouble condition.
2. Automatically updates historic information including hours of operation, last maintenance date, number of alarms and troubles, time of last alarm1 and analog signal patterns for each sensing element just before last alarm.
3. Field Replaceable Smoke Sensing Chamber: Analog detectors must have a modular, removable smoke sensing chamber which can be removed for easy cleaning and/or convenient, cost effective service replacement without removing the detector base or resetting the device address, without removal of detector electronics and without requiring any system or device programming adjustments which necessitate a system re-test.
4. It shall be possible to address each intelligent module using rotary switches.
5. Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location and the device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.
6. Sensitivity Range: Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. It shall be possible to program control panel activity to each level.
7. Pre-Alarm: Detector stores 20 pre-alarm sensitivity values to alert local personnel prior to the sensor reaching a full evacuation sensitivity. Sensitivity values can be set in 5% increments.
8. Environmental Compensation: The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal when the detector reaches 75% (Dirty) to 99% (More Dirty) compensation has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

9. Twin Status LEDs: Flashing Green LED shows normal; flashing RED shows alarm state; steady RED and steady GREEN show alarm state in stand-alone mode, visible from any direction.
10. UL Sensitivity Testing: The detector shall utilize a supervised microprocessor that is capable of monitoring the sensitivity of the detector. If the detector sensitivity shifts outside of the UL limits, a trouble signal is sent to the panel.
11. Device Replacement: The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

B. Intelligent Photoelectric Detector
1. Provide intelligent analog addressable photoelectric smoke detectors at the locations shown on the drawings.

C. Intelligent CO (Carbon Monoxide) Detector.
1. Where called for on the contract drawings, provide intelligent CO sensor at locations shown on the drawings. The CO sensor (or combination type sensor) shall reside on the Intelligent Addressable loop with its unique system identifier and be able to be programmed as Alarm, Supervisory or Monitor.
2. CO sensor shall be capable of detecting carbon monoxide from any source of combustion and analyzes the sensor data to determine when to initiate a life safety CO alarm. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
3. The CO element shall have minimum of six year life span and be field replaceable element without. The CO element shall be factory calibrated.
4. The CO end of life shall be supervised / monitored by the Control Panel to annunciate end of life. Also, the control panel shall provide a system report of all CO detectors end of life status.
5. The CO Detector shall activate upon the following conditions:
   a. 70 PPM for 60 – 240 minutes
   b. 150 PPM 10- 50 minutes
   c. 400 PPM 4 – 15 minutes
6. The CO activation shall be programmable type as follows: Alarm, Supervisory Latching, Supervisory Non-Latching, Monitor Latching, or Monitory Non-Latching.
7. Device shall have a sounder base with remote colored alarm light/strobe.

D. Intelligent 135 Degree Fixed Temperature / Rate of Rise Heat Detector
1. Where called for on the contract drawings, provide intelligent combination fixed temperature/rate-of-rise heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135 deg F and a rate-of-rise alarm point of 15 deg F per minute. The heat detector shall be rated

for ceiling installation at a minimum of 70 ft centers and be suitable for wall mount applications.

E. Fixed Temperature Heat Detector (135 deg F and 190 deg F)
   1. Where called for on the contract drawings, provide addressable intelligent fixed temperature heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The heat detector shall have a nominal alarm point rating of 135 deg F and 190 deg F where indicated. The heat detector shall be rated for ceiling installation at a minimum of 70 ft centers and be suitable for wall mount applications.
   2. Provide:
      a. 135 deg F fix.
      b. 190 deg F fix.

F. Fixed Temperature Heat Detector (200°F) Conventional Device
   1. For all Boiler Rooms, Kiln Rooms and other areas of high ambient heat sources (unconditioned spaces), furnish and install a 200 deg F fixed temperature heat detector with base.
   2. Include addressable monitor module for each and mount in adjacent area with standard ambient room conditions.

G. Detector Base Types
   1. Provide standard detector mounting bases suitable for mounting on 1-gang, or 4 inch octagon box and 4 inch square box. The base shall, contain no electronics and support all series detector types.
   2. Provide relay detector mounting bases (where shown) suitable for mounting on 1-gang, or 4” octagon box and 4” square box. The relay base shall support all Signature Series detector types and have the following minimum requirements:
      a. The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
      b. The position of the contact shall be supervised.
      c. The relay shall automatically de-energize when a detector is removed.
      d. The operation of the relay base shall be controlled by its respective detector processor or under program control as required by the application. Detector relays not capable of operational programming independent of the detector shall not be considered equal. Form “C” Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for “pilot duty”.
      e. Removal of the respective detector shall not affect communications with other detectors.
   3. Provide audible detector mounting bases (where shown) suitable for mounting on 4” x 4” octagonal concrete ring (mud box) and 4” square x 2-1/8” deep box.
      a. The base shall support all Signature Series detector types and be capable of single or group operation. The audible base shall emit a temporal alarm tone and be selectable for low or high output. For carbon monoxide detector bases, program for special T4 temporal code

output to alert when carbon monoxide has been detected. Carbon monoxide warning strobe for space and at Main Office shall be activated.

b. The operation of the audible base shall be controlled by its respective detector processor or under program control as required by the application. Detector audible base not capable of operational programming independent of the detector shall not be considered equal.

c. The audible bases shall be UL268 and UL464 Listed, and provide a reverberant room sound output per UL464 of 81 dBA at 10ft and an average anechoic sound output of 90 dBA at 10 ft.

H. Intelligent Duct Smoke Detector – Photoelectric

1. Provide intelligent photoelectric duct smoke detector at the locations shown on the drawings.
   a. One form C auxiliary alarm relay rated at 2amps @ 30Vdc. (Not to be used for local fan shut down; use control module.)
   b. The operating range shall be 100ft/min to 4,000ft/min air velocity and temperature range of –20 to 158F.
   c. Sample tube can be installed with or without the cover place and be rotated in 45- degree increments to ensure proper alignment with duct airflow.
   d. Provide Siemens units with Head and Tubes.
2. Provide remote test station with Alarm LED and Key Switch.
3. Relay Fan Shutdown: Rated to interrupt fan motor control circuit. Furnish and install "separate" device for each motor starter. Connect to motor starter as required for local fan shutdown during alarm condition. **Coordinate with Owner prior to programming.**

2.8 INTELLIGENT MODULES

A. It shall be possible to address each intelligent module using rotary switches. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller.

1. Integral Microprocessor: All decisions are made at the module determining if the device is alarm or trouble condition.
2. Automatically updates historic information including hours of operation, number of alarms and troubles, time of last alarm.
3. Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location. The device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.
4. Twin Status LEDs: The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status.
5. Input and output circuit wiring shall be supervised for open and ground faults.

6. Two styles of modules shall be available, those designed for gang box mounting, and where multiple modules are required in a single location, plug in modules shall be provided with a Universal Input/Output motherboard.

B. Intelligent Input Module. The Input Module shall provide one or two supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2-1/2" deep 1-gang boxes and 1-1/2" deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:
1. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
2. Normally-Open Alarm Delayed Latching (Waterflow Switches)
3. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
4. Normally-Open Active Latching (Supervisory, Tamper Switches)

C. Intelligent Relay Module. Provide addressable control relay circuit modules shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on North American 2-1/2" deep 1-gang boxes and 1-1/2" deep 4" square boxes with 1-gang covers.

D. NAC Control Module: Provide intelligent NAC control module shall provide one (1) supervised Class A output circuit capable of a minimum of 2 personalities, each with a distinct operation. The gang box -mounted version shall be suitable for mounting in North American 2-1/2" deep 2-gang boxes and 1-1/2" deep 4" square boxes with 2-gang covers. The plug-In version shall plug into a universal multi-module motherboard. The NAC control module shall support the following operations:
1. 24volt NAC circuit
2. Audio notification circuit 25v.
3. Telephone Power Selector with Ring Tone (Firefighter's Telephone)
4. Visual Synchronized Output to Genesis appliances or to NAC Power Supply.

E. FA Elevator Interface Cabinet (Coordinate with Elevator Contractor)
1. Provide red metal cabinet enclosure with word FIRE in white letters on the cover. Inside will be four intelligent relays (Primary Recall, Alternate Recall, Fire Hat and Shunt Trip), one monitor input (Shunt Trip AC Power Supervision) and 120vac relay (Shunt Trip AC Power Supv).
2. Label all the relays and input modules for the function.
3. Provide Siemens Series unit with addressable monitor and control relays as required.

## 2.9 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. The manual pull station will have an intelligent module integral of the unit.

3. Station Reset: key operated switch shall match the control panel key.
4. Manual pull stations that initiate an alarm condition by opening the unit are not acceptable.
5. *For pull stations that are installed behind tamper guards, utilize single action type pull stations.*

B. Indoor Protective Shield "Stopper Covers": Factory-fabricated clear plastic enclosure. Hinged at the top to permit lifting for access to initiate alarm. Lifting the cover actuates an integral battery powered audible horn intended to discourage false-alarm operation.

2.10 NOTIFICATION APPLIANCES

A. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.

B. Any appliances, which do not meet the above requirements, and are submitted, for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers which clearly states that their equipment (as submitted) are 100% compatible with each other for the purposes intended. All appliances shall be UL 1971, UL 1638 and UL 464 listed for Fire Protective Service. Speakers shall also be UL 1480F listed. Combination Speaker-Visual appliances may be used where shown on the contract drawings and standalone Visual Strobes and Speaker-Only devices may be used where shown on the contract drawings provided they meet the performance requirements specified herein for both audible and visual notification.

C. Notification Appliances – Visual (Fire – Evacuation)
1. Provide RED wall or ceiling mounted clear lens strobes with red body and "FIRE" markings. Strobes shall provide a smooth light distribution pattern field selectable candela 15 cd, 30 cd, 75 cd, and 110 cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to one-gang electrical box.
2. The device shall have plastic protective cover for during installation. All ceiling mounted devices shall be provided with junction box and T-grid support bar or other means of adequate support that is U.L. listed.
3. The actual candela setting on the visual shall be marked on the appliance.

D. Notification Appliances – Visual/Audible (Carbon Monoxide Warning)
1. WHITE wall mounted notification device with AMBER colored lens to indicate presence of carbon monoxide in space. Adjustable visual/audio output settings.
2. With custom warning plaque that reads: "CARBON MONOXIDE HAS BEEN DETECTED. EVACUATE THE SPACE AND CALL FIRE DEPARTMENT." Final verbiage to be coordinate with the Fire Department and Owner. Final plaque size and color scheme as selected by the Architect.
3. Include control module for activating notification device.

4. Device shall have T-4 temporal coding or other as required by the Fire Department.
5. WHITE alarm device with "ALERT" wording with Amber Lens Series Unit.

E. Notification Appliance – High Fidelity Speaker
1. RED High Fidelity Speakers shall have a 4" Mylar/paper cone. The rear of the speakers shall be completely sealed protecting the cone during and after installation. In and out screw terminals shall be provided for wiring. Speakers shall provide 1/4w, 1/2w, 1w, and 2w power taps for use with 25V systems. The actual speaker wattage & strobe candela setting shall be view from the device window to verify the wattage setting, without removing the device. To make any changes to the speaker wattage will only require the removal of the cover plate.
2. High Fidelity Speaker listed frequency response of 400 to 4,000 Hz and listed sound output of 90.5 dBA at 10 feet, as measured in reverberation room per UL-1480.
3. Furnish devices with the following selectable minimum sound level output:
   a. 1/4 watt – 81.5 dBA
   b. 1/2 watt – 84.1 dBA
   c. 1 watt – 87.3 dBA
   d. 2 watt – 90.5 dBA
   e. All ceiling mounted devices shall be provided with speaker back box and speaker truss support for T-grid ceilings or utilize other U.L. listed support means for other types of ceiling materials.

F. Notification Appliance - Re-entrant Speakers (Mechanical, Storage, Unfinished Ceiling Locations and Exterior Use)
1. Provide 4 inch diameter red re-entrant speakers at loud ambient locations or for outdoor weatherproof installation. Weatherproof boxes shall be provided for outdoor mounting. Speakers shall provide 2w, 4w, 8w, and 15w power taps. The re-entrant speakers shall utilize a high-efficiency compression driver. Cone type drivers are not acceptable. At the 15 watt setting, the speaker shall provide a 102 dBA sound output over a frequency range of 400-4000 Hz. when measured in reverberation room per UL-1480.
2. Combination speaker strobes shall meet both sections of above.

G. Trumpet Type Loudspeaker (High-Ceiling Locations)
1. Provide a trumpet speaker at the locations shown on the drawings. The trumpet speaker shall be able to operate within any ambient temperature environment ranging from 150°F to -30°F, with weather-resistant unit shall be constructed of heavy-gauge treat aluminum. Model shall be a double re-entrant type with 15 watts RMS audio power rating compression driver producing a UL-rated sound pressure level of 102dB measured at 15 watts, 10 ft. (3dB increment rating) within a frequency range of 400 Hz to 4 kHz. Impedance shall be 8 ohms and sound dispersion 70°. Unit shall have impedance selection via 7-position switch of 5000, 2500, 1300, 666, 333, 89 and 45 ohms. Power taps shall be available at 1, 2, 3.8, 7.5, 15watts for 70V line. Trumpet loudspeaker assembly shall be furnished with mounting bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding, or strapping. Wiring terminals for amplifier output shall be fully enclosed and a vandal-resistant adapter cover shall provide connection facilities for cable or conduit.

Dimensions: 77/8" W x 83/4" H x 95/16" D. Unit shall be finished in either gray baked epoxy or red baked epoxy. Color shall be verified with Owner prior to ordering and installation. Include wire guards for protection in Gymnasiums.

2. Cooper Wheelock STH-15S-R or equivalent

2.11 SURGE PROTECTION

A. Install U.L. listed surge protection on normal ac power for the FACP and its accessories.

B. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

C. Install surge protection on all lines entering the building and other out-buildings.

D. Ground to building ground/water piping system as required.

E. Manufacturer: Ditek.

2.12 SPRINKLER SYSTEM (*EXISTING*)

A. Sprinkler Waterflow Switch: Switch shall have two (2) sets of N.O. contacts and adjustable retard chamber to compensate for water surge. Verify quantity in field.

B. Sprinkler System Gate Valve Supervisory Switch: Verify quantity in field.

C. Sprinkler System Dry System Pressure Switch and Alarm Switch: Existing.

D. Provide addressable monitor module for each device listed above.

2.13 BELLS (Existing to remain)

A. Electric-vibrating, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet from the bell. Size 6 inch inside, 10 inch outside, unless otherwise indicated. Bells are weatherproof where indicated.

2.14 VISIBLE C.O. WARNING STROBE

A. AMBER colored strobe with WHITE base with "ALERT" or "CO DETECTED" warning verbiage to be activated when any C.O. device goes into alarm. Provide warning plaque next to strobe with instructions. See drawings for additional information.

2.15 VISIBLE WEATHERPROOF FIRE ALARM INDICATOR (Existing to remain)

A. Strobe (color selected by Fire Department) mounted above each sprinkler bell outside or as directed by Fire Department. Coordinate final location in field.

2.16 GUARDS FOR PHYSICAL PROTECTION

A. Provide welded mesh of size and shape for the manual pull stations, smoke detectors, notification appliances at location noted on the drawings.

2.17 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall mounting as indicated and are complete with matching doorplate.
   1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
   2. Wall-Mounted Units: Flush or surface mounted as required. **Owner does not want to use floor mounted units.**
   3. Rating: 24-V dc.
   4. Contractor will field verify exact type to be used prior to bidding. Installation of devices must allow for at least 90 degree door swing if adjacent to wall.
   5. Include structural framework and mounting plates as required to accommodate wall mounted type magnetic holders. Include extension rods and extended catch plates as required. Paint structural systems out to match surrounding areas.
   6. If location does not have an adjacent wall to use wall mount magnetic holder, utilize LCN/Sentronic type magnetic door holder/closer.
   7. Where existing door closers have a locking feature to hold door open, remove locking feature from closer. Coordinate work with Owner.

2.18 FIRE ALARM DOCUMENT BOX (existing to remain)

A. The Fire Alarm Document/System Record Document box shall comply with NFPA 72 document storage requirements. Standard features include 16 ga steel construction with red powder coat, piano hinge, and key lock. A removable document holder and space for a can of detector test gas are standard as are key ring hooks, a business card holder, and an important notes sticker for the door. Also include a minimum 4GB flash drive for digitally storing fire alarm system software, programming, etc. Minimum dimensions shall be 13"H X 12"W x 2-1/4"D.

2.19 INSPECTION BAR CODES (Match existing system and labeling scheme in use)

A. Company shall provide a web-based reporting system for creating, updating and maintaining all service work, inspections, and maintenance performed as part of this specification to Inspection bar codes shall be installed on all initiating devices, annunciators, control panels and power supplies.

B. Inspection bar codes used by the system must utilize Code 3 of 9 or other approved format, and contain a minimum of eight (8) digits that comprise a unique serial identifier within the Web-based Reporting System. There shall be no duplication of serial numbers. Serial number shall be printed below the bar code for identification purposes.

C. Inspection bar codes shall be limited in size to no more than 2 inches in width, and 3/8 inches in height and shall include a Mylar or other protective coating to protect the bar code from fading due to sunlight or exposure.

D. Inspection bar codes shall be installed on each device in such a manner as to require that scanning of the bar code take place no further than 12 inches from the device during inspection.

E. Include software to Owner including all associated licenses and Excel Spreadsheet form with this information on all fire alarm devices, their device type, location,

address, bar code, date of inspection, pass/fail status, etc. Include electronic file of this including hard copy to owner as part of close out documents. Continue numbering sequence in order of last device listed.

2.20 WIRE AND CABLE (*PLENUM RATED*)

A. Signaling Line Circuits – Network Data: Plenum rated cable (FPLP), twisted pair, not less than No. 16 AWG or as recommended by the manufacturer. Systems which use Shielded Wire requiring continuous foil shields and continuous drain wires are not acceptable, as they may lead to multiple ground faults and communication integrity faults.

B. Signaling Line Circuits – Intelligent Loop: Plenum rated cable (FPLP), non-Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer. Systems which use Shielded Wire requiring continuous foil shields and continuous drain wires are not acceptable, as they may lead to multiple ground faults and communication integrity faults.

C. Notification Appliance Circuits
1. Audio: Plenum rated (FPLP), shielded, twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.
2. Visual. Plenum rated (FPLP), non-Twisted pair, not less than No. 14 AWG or as recommended by the manufacturer and required by the voltage drop calculations (it may be No. 12 AWG in some cases).

D. Cable/Wire Color Coding:
1. Signal Line Circuit- SLC: Overall red jacket with black and red conductors.
2. DC power supply circuit: Overall red jacket with violet and brown conductors.
3. Notification Appliance Circuit- NAC: Overall red jacket with blue and white conductors.
4. Door release circuit: Gray conductors.
5. Central station trip circuit: Orange conductors.
6. Central station fire alarm loop: black and white conductors.

E. Manufacturers:
1. Rockbestos-Suprenant Cable Corp.
2. Radix
3. Comtran Corp.
4. Helix
5. West Penn/CDT.

## PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. The Contractor shall schedule work so as not to interrupt areas of the building being used by the Owner. Work shall be performed in those areas once activities have ended or shall not be scheduled in those areas for that day. Contractor to work with the Owner in order to prioritize areas of the building to be completed first.

1. Contractor shall protect all rooms while working within them. Cover all furniture and equipment. Move desks and furniture as needed. Return room as originally found and clean up all debris on a daily basis.
2. Contractor to provide their own lifts and ladders.
3. Contractor to inspect all ceiling tiles for damage prior to starting their work. If any damage is found they shall bring it to the attention of the Owner in writing prior to performing any work. If this document is not provided the contractor is assuming the liability for replacing all damage tiles discovered after the completion of the project. All damaged tiles found will be replaced at the contractor's expense.

B. Comply with NFPA 72 and Article 760 for installation of fire-alarm equipment.

C. All new system devices (initiating and notification) shall be inspected and tested for operation including the operation of air handlers and roof top units under shut down sequence. All NAC panels shall be checked for supervision. See drawings for sequence of operation matrix to understand current operation of system. All devices not labeled shall be labeled per the specifications.

D. The contractor shall download the system software with all associated programmed devices onto an electronic disk for the Owner's safekeeping. Include a printout of all system devices, locations, nomenclature and their address. Have the Owner sign for the disk and print out prior to performing any work on the system.

E. Coordinate the pretest date and time with the Owner a minimum of one week in advance. The Owner will be required to be present with the technician during the pretest. All tests done without the Owner's presence will be redone at the contractor's expense.

F. Equipment Mounting: Install fire-alarm control unit on wall with tops of cabinets not more than 72 inches above the finished floor.

G. Smoke- or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix in NFPA 72.
5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
7. DO NOT INSTALL HEAT DETECTORS ABOVE MECHANICAL HEATING PIPES, ADJUST LOCATION ACCORDINGLY TO PREVENT FALSE ALARMS.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

I. Heat Detectors in Elevator Shafts and Elevator Machine Room: Coordinate temperature rating and location with sprinkler rating and location. Mount within 24 inches of sprinkler heads. Devices when activated shall operate elevator main circuit breaker via shunt trip mechanism. Furnish and install control module for operating shunt trip mechanism and monitor module for supervising control circuit.

Provide monitor modules for elevator shaft and machine room sprinkler tamper switches.

J. Smoke Detectors in Machine Rooms and Lobbies: Install smoke detectors and connect to fire alarm system. Install control modules for operation of primary and secondary elevator recall positions.

K. Elevator Fire-Fighters Hat Indicator Light: Connect to fire alarm control panel through control module. Hat light to be activated when fire alarm system encounters an alarm condition.

L. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

M. Audible Alarm-Indicating Devices (When Wall Mounting): Install at 80 inches above finished floor to bottom or 6 inches below the ceiling, whichever is less. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install ceiling mounted devices when shown.

N. Visible Alarm-Indicating Devices (When Wall Mounting): Install adjacent to each alarm bell or alarm horn and at least 80 inches above finished floor to bottom or 6 inches below the ceiling, whichever is less. Install ceiling mounted devices when shown.

O. Device Location-Indicating Lights: Locate in public space near the device they monitor.

P. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

Q. Annunciator: Install with top of panel not more than 56 inches above the finished floor to top of unit, unless unit is large in size. Coordinate with Engineer.

R. Pull Stations: Mount top of unit at 48 inches above finished floor.

S. Furnish and install additional power sub-panels as required to obtain power to new "NAC" panels. Two breakers from one existing 120/208 volt emergency power panel shall be removed to accommodate the installation of a two pole, 50 amp breaker. The sub-panel and feeder shall be rated for 50 amp single phase, three wire with ground. Conduit shall be type EMT. Install two breakers sized to match existing removed and reconnect to existing branch circuit. Extend wiring as required. Install additional single pole breakers to power new "NAC" panels. Install lock-out device on breakers serving "NAC" panels. Install card directory. Panel shall be U.L. listed, equivalent to Square-D NQOD System. All bussing shall be copper. All breakers shall be "QOB" style.

T. All "NAC" panels being remotely located shall be protected with a smoke detector. Mount detector above all panel locations and connect to system.

U. If the contractor is unable to maintain an active fire alarm system during times of construction, a certified Fire Watchman (approved by the Fire Department) shall be hired to guard the building. All costs shall be part of this contract. No additional costs will be incurred by the Owner. At no time shall the building be left unprotected/unsupervised, including on days when Staff are within the building. String up temporary detectors throughout the building for protection as required. Remove once new system is operational.

V. Furnish and install spare fire alarm key and security alarm code in Knox box. Coordinate with Fire Department for access. Tie in to FACP for monitoring.

W. Contractor shall coordinate with Owner in programming three (3) emergency messages for their use.

X. Contractor shall coordinate with Owner and Fire Department on which message or system warning tones shall be used for all alarm or initiated conditions.

3.2 WIRING INSTALLATION

A. **ALL WIRING TO BE PLENUM RATED, FIRE PROTECTION LISTED AND INSTALLED IN RACEWAY.**

B. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-C.

C. All wiring shall be color coded as follows: all junction boxes and conduit (Allied Red Raceway) above ceilings to be painted red and labeled "FIRE ALARM" in black lettering. Identify circuiting information for both initiating and notification circuits. All exposed raceways to be red in color unless otherwise directed by Architect/Owner.

D. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
2. All fire alarm junction boxes and conduits being installed above ceilings shall be "RED" in color. All exposed conduit approved by architect shall be painted out to match surrounding area. Coordinate with Owner prior to ordering.
3. All raceways shall be supported from bar joists. Do no fasten to other electrical conduits, other system piping or raceway, ceiling system supports, etc.
4. Do not install conduit above top chord of bar joists or within 6 inches of roof deck so as to prevent damage from roofing nails.
5. All surface mounted back boxes shall match device color with same shape and size with no visible knockouts. Back boxes shall be manufactured by the fire alarm device manufacturer so as to properly fit the device and match the devices required depth.

E. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

F. Cable Taps: DO NOT INSTALL TAPS OUTSIDE OF FIRE ALARM DEVICES. Wire from device to device.

G. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

H. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

I. All fire alarm terminal and junction locations shall be identified in accordance with NFPA 70, Section 760-3 and the latest edition of the National Electrical Code. All junction and terminal boxes shall be painted red and stenciled "Fire Alarm." This requirement is to prevent unintentional interference with the signaling circuits during testing, servicing and additional modifications to the system.

J. Connect fire protection sprinkler bell to 24VDC power circuit from fire alarm system.

K. Install new fire alarm zone maps (in plexi-glass frame with metallic frame boarder) showing existing and new devices and "NAC" panels at both control and annunciator panel locations. Refer to drawings for additional information. Provide copy, including electronic copy, to Fire Department.

L. Remove and replace ceiling systems as required for installation of work. Replace all damaged ceiling materials with type to match existing ceiling without any additional cost to the Owner.

M. Where ceiling devices are removed and openings are abandoned, install blank coverplate and replace ceiling tile to match surrounding area.

N. Where wall devices are removed and openings are abandoned, install blank finished coverplate. Furnish and install oversized coverplates as required to obtain a finished look. Paint out to match surrounding area.

O. When raceway and devices are removed and leave existing walls and ceilings marked by absence of materials, existing walls and ceilings shall be patched and painted to match surrounding areas.

## 3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements. Connect hardware and devices to fire-alarm system.
   1. Verify that hardware and devices are UL/FM listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated air-conditioning duct systems.
   2. Alarm-initiating connection to elevator recall system and components.

3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
4. Supervisory connections at valve supervisory switches.
5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
6. Supervisory connections at elevator shunt trip breaker.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Provide identification labels on all cabling entering all panels and junction boxes.

B. Install framed instructions in a location visible from fire-alarm control unit.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

D. Program all addressable initiating devices with their true building location. Utilize Owner's final building room name and number plan. Do not use electrical drawing room labeling unless authorized by the Owner and verified by the Architect. Contractor shall bear all costs associated with walking each room/area for verification of actual room numbers prior to programming, no exceptions. Label all devices with their addressable identification and circuit numbering scheme. Use P-Touch label maker. Do not use markers.

E. Inspection Bar Codes:
1. Inspection bar codes shall be installed on all initiating devices, annunciators, control panels and power supplies. These bar codes shall support future testing and archiving of the test via building reports.com protocol.
2. Inspection bar codes used by the system must utilize Code 3 of 9 or other approved format, and contain a minimum of eight (8) digits that comprise a unique serial identifier within the Web-based Reporting System. There shall be no duplication of serial numbers. Serial number shall be printed below the bar code for identification purposes.
3. Inspection bar codes shall be limited in size to no more than 2" in width, and 3/8", in height and shall include a Mylar® or other protective coating to protect the bar code from fading due to sunlight or exposure.
4. Inspection bar codes shall be installed on each device in such a manner as to require that scanning of the bar code take place no further than 12" from the device during inspection.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL (*GENERAL*)

A. Field tests shall be conducted by manufacturer's service representative and witnessed by the Owner, Engineer and authorities having jurisdiction (Fire Department). Notify local authorities having jurisdiction (AHJ), Owner and Engineer one (1) week in advance of inspection and testing, in writing with copies

to Architect's/Engineer's office. Coordinate with owner in advance of scheduling with AHJ.

B. Two (2) tests shall be required to be performed by the fire alarm manufacturer's representative/technician:
   1. First Test to be performed by contractor to ensure system is operating correctly.
   2. Second test to be performed with Owner, Engineer and Fire Department/County Inspector.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Tests and Inspections:
   1. Intelligibility testing (refer to Paragraph 3.08 for scope of this work).
   2. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
      a. Devices that are outside their marked sensitivity range shall be replaced.
   3. Visual Inspection: Conduct visual inspection prior to testing.
      a. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
      b. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      c. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   4. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   5. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4. Modify and adjust audible taps to meet room needs.
   6. Test audible appliances for the private operating mode according to manufacturer's written instructions. Modify and adjust audible taps to meet room needs.
   7. Test visible appliances for the public operating mode according to manufacturer's written instructions.
   8. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

E. Testing General:
   1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags

located in an area not visible when installed, showing the initials of the installing technician and date.

2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
   a. Ladders and scaffolds as required to access all installed equipment.
   b. Multi-meter for reading voltage, current and resistance.
   c. Two-way radios and flashlights.
   d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
   e. Decibel meter, complying with Type 2 Requirements in ANSI S1.4.
   f. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

F. After tests have been completed, obtain written certification from Fire Department and include in As-Built/O&M Documentation.

G. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

H. Fire-alarm system will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.
   1. Upon completion of installation of fire alarm equipment, electrical contractor and fire alarm contractor shall provide to the engineer a signed, written statement substantially in the form as follows:

      "The undersigned having been engaged as the electrical contractor and fire alarm contractor on the **Oakton Community College** building confirms that the fire alarm equipment was installed in accordance with wiring diagrams, instruction and directions provided to us by the manufacturer and authorities having jurisdiction, and system as installed complies with local codes and NFPA codes."

   2. Turn over Inspection Report to Owner showing all devices on the system, both initiating and notification devices, and all other active devices, with PASS / FAIL report for each. Each device shall be listed with their address, device location, and their panel display label. All devices that fail shall be fixed and re-tested until they pass.

J. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

3.7 ACCEPTANCE TESTING (ADDITIONAL INFORMATION/PROCEDURES)

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.

C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

D. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.

E. Preliminary Testing: Conduct preliminary tests and intelligibility tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

F. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 14 calendar days prior to the test date. A final acceptance test will not be scheduled until meggar test results, the loop resistance test results, and the submittals required in Part 1 are provided to the owner. Test the system in accordance with the procedures outlined in NFPA 72.
   1. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
   2. Test each initiating and indicating device (public operating mode) and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
   3. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.
   4. Visually inspect all wiring.
   5. Verify that all software control and data files have been entered or programmed into the FACP.
   6. Verify that Shop Drawings reflecting as-built conditions are accurate.
   7. Measure the current in circuits to assure that there is the calculated spare capacity for the circuits.
   8. Measure voltage readings for circuits to assure that voltage drop is not excessive.
   9. Measure the voltage drop at the most remote appliance on each notification appliance circuit.

G. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      a. Open, shorted and grounded signal line circuits.
      b. Open, shorted and grounded notification, releasing circuits.
      c. Primary power or battery disconnected.
   2. System notification appliances shall be demonstrated as follows:
      a. All alarm notification appliances actuate as programmed.
      b. Audibility and visibility at required levels.
   3. System indications shall be demonstrated as follows:
      a. Correct message display for each alarm input at the control display.
      b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
      c. Correct history logging for all system activity.
   4. System off-site reporting functions shall be demonstrated as follows:
      a. Correct zone transmitted for each alarm input.
      b. Trouble signals received for disconnect.
   5. Secondary power capabilities shall be demonstrated as follows:
      a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
      c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

## 3.8 INTELLIGIBILITY TESTING AND ACOUSTIC ADJUSTMENT

A. Installing Contractor and Fire Alarm Distributor Shall include in their bid all costs to provide two (2) full Intelligibility Tests of all Acoustically Distinguishable Spaces (ADS). Such tests shall be made and witnessed in the presence of the Owner and/or their designated representative.

B. Intelligibility testing of the System shall be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, IEC 60268-16, and ASA S3.2.
   1. Following are the specific requirements for intelligibility tests:
      a. Intelligibility Requirements: Verify intelligibility by measurement after installation.
      b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is 0.65.
      c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the AHJ installation, and if

building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.

d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value shall be measured on the floor or other walking surface as follows:

1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

2) Curving around any corners or obstructions, with a 12 inches clearance there from.

3) Terminating directly below the location where the minimum required CIS value has been obtained.

2. Use commercially available test instrumentation to measure intelligibility as specified by ISO 7240-19 and ISO 7240-16 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3. Record all intelligibility readings for the ADS in the web-based bar code inspection and testing software and affix barcode to the nearest audible notification appliance closes to the entrance or exit from the ADS.

C. Upon completion of fire alarm system installation, the contractor shall perform an audibility level check in all occupied spaces. Adjust all speakers to assure sound levels meet code:

1. 15 dB above average ambient sound levels or 5 dB above maximum ambient sound level (whichever is greater).
   a. Classrooms Average Ambient Sound Level: 50 dB
   b. Offices Average Ambient Sound Level: 45 dB
   c. Corridors Average Ambient Sound Level: 60 dB
   d. Gymnasiums and Warehouses Average Ambient Sound Level: 80 dB
   e. Cafeteria Average Ambient Sound Level: 75 dB
   f. Toilet Rooms Average Ambient Sound Level: 35 dB
   g. Exterior Locations at Property Line Not to Exceed 50 dB in alarm mode.
2. Contractor to verify average ambient sound levels for each space prior to adjusting speaker tap settings.

D. Provide a preliminary report to the Owner and Owner's Representative for review. Include time for a review meeting to discuss the results and any areas for adjustments.

E. Provide one (1) full speaker tap setting adjustment to each notification appliance within the entire audible notification appliance network. Adjust speaker wattage tap settings up or down based upon the direction provided by the Owner's

Representative. Do not adjust speaker tap settings for speakers or areas which are not determined to need adjustment.

F. Provide a second full Intelligibility Test and Final Intelligibility Report to the Owner and Owner's Representative for approval.

3.9 DOCUMENTATION (*3 SETS REQUIRED*)

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
   1. System record drawings and wiring details including THREE (3) sets of drawings, and a Memory Stick with copies of the record drawings in DXF format for use in a CAD drafting program, and in "PDF" format.
   2. System operation, installation and maintenance manuals.
   3. System matrix showing interaction of all input signals with output commands.
   4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
   5. System program showing system functions, controls and labeling of equipment and devices.
   6. System print out showing all active devices, their address, and room location.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Annual Test and Inspection: Eleven months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections. Repair/replace all defective parts at no additional cost to the Owner. Contractor shall schedule this with Owner at the ten month point after substantial completion. If this procedure is not done and the warranty has expired, the contractor/manufacturer will be liable for all defective parts after the warranty expiration period for an indefinite period of time.

3.11 DEMONSTRATION (At the Owner's discretion)

A. Coordinate exact Date and Time with Owner.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Sections.

3.12 PASSCODES

A. At the end of the project, the contractor shall turn over all fire alarm control panel passcodes to the Owner. Include all necessary documentation as needed for the safeguarding and transferring of this information to the Owner. Obtain signature

from the Owner for the receipt of this information and include in the close out documents.

**END OF SECTION**