



PROJECT MANUAL

2024 ROOFTOP UNIT REPLACEMENT

at

RAYMOND ELLIS ELEMENTARY SCHOOL

720 Central Park Drive
Round Lake, IL 60073

in

ROUND LAKE CUSD 116

442 N. Cedar Lake Road
Round Lake, IL 60073

January 30, 2025

Project Number: 886-F-1

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**DIVISION 02
DEMOLITION & RELOCATION**

**SECTION 024126
SELECTIVE ELECTRICAL DEMOLITION**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Removal of existing electrical equipment, wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
2. Disposal of materials.
3. Storage of removed materials.
4. Identification of utilities.
5. Salvaged items.
6. Protection of items to remain as indicated on Drawings.
7. Relocate existing equipment to accommodate construction.

1.02 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.**

1.03 SCHEDULING

- A. Schedule work to coincide with renovation schedule.**
- B. Cease operations immediately when structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.**

1.04 COORDINATION

- A. Conduct demolition to minimize interference with adjacent building areas.**
- B. Coordinate demolition work with general contractor and other trades.**
- C. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.**
- D. Shut-down Periods:**
1. Arrange timing of shut-down periods of in service panels with Owner. Do not shut down any utility without prior written approval.
 2. Keep shut-down period to minimum or use intermittent period as directed by Owner.
 3. Maintain life-safety systems in full operation in occupied facilities, or provide notice minimum one week in advance.
- E. Identify salvage items in cooperation with Owner.**

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.
- C. Verify termination points for demolished services.

3.02 PREPARATION

- A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.
- B. Temporary egress signage and emergency lighting

3.03 DEMOLITION

- A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.
- B. Remove exposed abandoned conduit including abandoned conduit above accessible ceiling finishes. Cut embedded conduit flush with walls, floors, and patch surfaces.
- C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.
- D. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- E. Reconnect equipment being disturbed by renovation work and required for continue service to previous source if remaining or nearest available panel.
- F. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
- G. Install temporary wiring and connections to maintain existing systems in service during construction.
- H. Perform work on energized equipment or circuits with experienced and trained personnel.
- I. Remove, relocate, and extend existing installations to accommodate new construction.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.

- K. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finish. Cut embedded support elements flush with walls and floors.
- L. Clean and repair existing equipment to remain or to be reinstalled.
- M. Protect and retain power to existing active equipment remaining.

3.04 EXISTING PANELBOARDS

- A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.
- B. Tag unused circuits as spare.
- C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.
- D. Remove existing wire no longer in use from panel to equipment.
- E. Provide new updated directories where more than three circuits have been modified or rewired.

3.05 SALVAGE ITEMS

- A. Remove and protect items indicated on Drawings to be salvaged and turn over to Owner.
- B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed to location as directed by Owner.

3.06 REUSABLE ELECTRICAL EQUIPMENT

- A. Carefully remove equipment, materials, or fixtures which are to be reused.
- B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.
- C. Relocate existing lighting fixtures as indicated on Drawings. Clean fixtures and re-lamp. Test fixture to see if it is in good working condition before installation at new location.

3.07 CLEANING

- A. Remove demolished materials as work progresses. Legally dispose.
- B. Keep workplace neat.

3.08 PROTECTION OF FINISHED WORK

- A. Do not permit traffic over unprotected floor surface.
- B. Coordinate floor protection with General Contractor or Construction Manager.

END OF SECTION

DIVISION 23
HVAC

**SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.04 QUALIFICATIONS

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

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

1.06 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT:

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.15.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 9. Sound Power Levels: Conform to NEMA MG 1.
- D. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 2. Voltage: 115/230 volts, single phase, 60 Hz.
- E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.02 THREE PHASE MOTORS FURNISHED LOOSE

- A. Product Description: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.
- B. Voltage: 230/460 volts, three phase, 60 Hz.
- C. Service Factor: 1.15.
- D. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.
- E. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- F. Insulation System: NEMA Class F.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: Conform to NEMA MG 1.
- K. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.03 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.
- B. Contractors' tests and startups shall be scheduled and documented in accordance with the project.

PART 3 - EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned motors
- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing motors to remain or are to be reinstalled.

3.02 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install engraved plastic nameplates.
- C. Ground and bond motors.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Non-penetrating roof supports/platforms.
7. Pipe portals.
8. Sleeves.
9. Mechanical sleeve seals.
10. Formed steel channel.
11. Firestopping relating to HVAC work.
12. Firestopping accessories.
13. Equipment bases and supports.

B. Related Sections:

1. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
2. Section 23 11 23 - Facility Natural-Gas Piping: Execution requirements for placement of hangers and supports specified by this section.
3. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

- D. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.
- G. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

1.03 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263 or UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
- B. Surface Burning: ASTM E84 or UL 723 with maximum flame spread / smoke developed rating of 25/450.
- C. Firestop interruptions to fire rated assemblies, materials, and components.

1.05 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.06 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.07 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 01 74 00 - Execution and Closeout Requirements Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for pipe hangers and supports.

1.13 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Unistrut.
 - 2. Grinnell.
 - 3. B-Line.
 - 4. Superior Valve Co.
- B. Hydronic Piping:
 - 1. Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch Malleable iron or Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

C. Refrigerant Piping:

1. Conform to ASME B31.5.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

2.02 HANGER RODS

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.03 INSERTS

- A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
 2. Soundproofing: 1 lb./sq. ft sheet lead.

- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 EQUIPMENT CURBS

- A. Manufacturers:
 - 1. Pate.
 - 2. Thycurb.
- B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, 1-1/2 inch thick insulation, factory installed wood nailer. Curbs shall be minimum of 18" high, above the surface of the roof. Refer to RTU schedule for curb type.
- C. Curbs shall match the pitch of the roof.

2.06 ROOFTOP SUPPORTS

- A. Gas, Conduit, Chilled Water Piping:
 - 1. Shall be prefabricated system with drainage grooved base and custom fitted EPDM support pads to accommodate stainless steel threaded rods and horizontal galvanized channel/strut support with clevis hanger(s):
 - a. Model 2.5 SB-H, by Miro Industries, Inc.
 - b. Model PP10 with channel and clevis hanger, by Portable Pipe Hangers, Inc.
- B. Single Gas, Chilled Water Piping (greater than 1.5-inch):
 - 1. Gas line supports shall be prefabricated system with drainage grooved base and custom fitted EPDM support pads to accommodate height adjustable stainless steel threaded rods and horizontal galvanized channel/strut support with roller hangers:
 - a. Model 5-SB-H with roller hangers, by Miro Industries, Inc.
 - b. Model PP10 with channel and roller hanger, by Portable Pipe Hangers, Inc.

2.07 NON-PENETRATING ROOFTOP SUPPORTS/PLATFORMS

- A. Manufacturers - Non-Penetrating Rooftop Assemblies:
 - 1. Miro Industries, Inc.: www.miroind.com
 - 2. PHP Systems: www.phpsd.com.
- B. Non-Penetrating Rooftop Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly.
 - 1. ACCU Pipe Line Supports:

- a. Condenser line supports shall be prefabricated system with height adjustable base to accommodate stainless steel threaded rods and galvanized channel/strut support set a minimum of 14 inches above finished roof surface as required by number and size of lines:
 - 1) Model 16-Base Strut-14 custom, by Miro Industries, Inc.
 - 2) Model PP10 custom, minimum 14 inches, with channel, by Portable Pipe Hangers, Inc.
2. Gas Line / RTU Condensate Lines Supports (less than 1.5 inch):
 - a. Shall be prefabricated system with drainage grooved base and custom fitted EPDM support pads to accommodate stainless steel threaded rods and horizontal galvanized channel/strut support with clevis hanger(s):
 - 1) Model 2.5 SB-H, by Miro Industries, Inc.
 - 2) Model PP10 with channel and clevis hanger, by Portable Pipe Hangers, Inc.
3. Single Gas Line (greater than 1.5-inch):
 - a. Gas line supports shall be prefabricated system with drainage grooved base and custom fitted EPDM support pads to accommodate height adjustable stainless steel threaded rods and horizontal galvanized channel/strut support with roller hangers:
 - 1) Model 5-SB-H with roller hangers, by Miro Industries, Inc.
 - 2) Model PP10 with channel and roller hanger, by Portable Pipe Hangers, Inc.
4. Duct Supports:
 - a. Shall be prefabricated system with bases to accommodate uni-strut tube frame as required and custom fitted EPDM support pads to support exact ductwork sizes and equipment to be installed.
 - 1) Model No.8-DS-SB(P), by Miro Industries, Inc.
 - 2) Model PPH-D, by Portable Pipe Hangers, Inc.
5. ACCU supports:
 - a. Shall be prefabricated system with bases and custom fitted EPDM support pads to accommodate uni-strut tube frame with fiberglass grating and hold own attachment clips, 14-inches above finished roof surface with extended leg for electrical disconnect placement. Support shall be 6-inches larger on all sides as required to support AC condenser equipment to be installed. Provide minimum 24-inches between adjacent units for proper airflow.
 - 1) Custom designed Mechanical Support-HD, by Miro Industries, Inc., Sandy, UT, (800) 768-6978.
 - 2) Model RTU-20 center and corner supports with galvanized tube strut support frame, 1/2-inch stainless steel threaded rod cross

- connections by Portable Pipe Hangers, Inc., Houston, TX, (713) 672-5088.
- 3) Standard for Specification: Fiberglass-reinforced plastic grating: molded fiberglass grating made with select general purpose polyester with ultraviolet (UV) inhibitors.
 - a) CC-Grate, 1.5-inch x 1.5-inch square mesh by 1.5-inch thick, by Century Composites, Inc. Tyrone, GA. (770) 632-7112. Color shall be Grey.

2.08 PIPE PORTALS

A. Curb and Portal Box:

1. All aluminum construction, zero plastic, wind rated to +225 mph and pre-insulated (R-2 for condensate) V.P./S.S. fasteners meets ICC 2015 Energy Code for air permeance levels.
2. Mini-Tower Vault, Model AWI-121022, L-12" W-10" H-22". Designed for electrical power switch/disconnects and small satellite dish mounts.

B. PVC Exit Seals:

1. Low profile strain relief cord grip with seating ring and locknut by Arlington Industries, Inc., Scranton PA:
 - a. 1/4" - 7/16" diameter range: LPCG754 with 3/4 inch thread.
 - b. 3/8" - 3/4" diameter range: LPCG757 with 3/4 inch thread.
 - c. 3/4" - 7/8" diameter range: NMGG100875 with 3/4 inch thread.

2.09 SLEEVES

- A. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

2.10 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.
2. NMP Corporation.

- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.11 FORMED STEEL CHANNEL

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel minimum with holes 1-1/2 inches on center.

2.12 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products.
6. Specified Technology, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Single or Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single or Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: As selected from manufacturer's full range of colors.

2.13 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:

1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.

- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 - 1. Furnish UL listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 - 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

2.14 EQUIPMENT BASES AND SUPPORTS

- A. Refer to Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of inserts and sleeves in concrete forms specified by this section.
- B. Refer to Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
- C. Refer to section 3.5 Installation – Equipment Bases and Supports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing or damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Architect and Structural Engineer before drilling or cutting structural members.

3.03 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.

- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 23 07 00.

3.05 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 23 05 48.

3.06 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- C. Provide curbs for roof installations 18 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
- D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.07 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.08 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating to uniform density and texture.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Place intumescent coating in sufficient coats to achieve rating required.
- F. Remove dam material after firestopping material has cured.
- G. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, and ceiling as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.

- b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
- c. Pack void with backing material.
- d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

H. Non-Rated Surfaces:

- 1. Seal opening through non-fire rated wall, partition floor, and ceiling roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
- 2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
- 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
- 4. Interior partitions: Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.09 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

Pipe Size <u>Inches</u>	Copper Tubing Maximum Hanger Spacing <u>Feet</u>	Steel Pipe Max. Hanger Spacing <u>Feet</u>	Copper Tubing Hanger Rod Diameter <u>Inches</u>	Steel Pipe Hanger Rod Diameter <u>Inches</u>
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8

B. Plastic Pipe Hanger Spacing:

<u>Pipe Material</u>	Maximum <u>Spacing Feet</u>	Hanger	Hanger Rod <u>Diameter Inches</u>
PVC (All Sizes)	4		3/8

END OF SECTION

SECTION 230548
VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vibration isolators.

B. Related Sections:

1. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product requirements for anchors and piping expansion compensation.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
3. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
4. Section 23 33 00 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct silencers specified for placement by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. American National Standards Institute:

1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

C. Air-Conditioning and Refrigeration Institute:

1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

D. American Society of Heating, Refrigerating and:

1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
2. ASHRAE Handbook - HVAC Applications.

E. ASTM International:

1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors':

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.
- E. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
- F. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- G. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- H. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of hangers including attachment points.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with AMCA 300, ANSI S1.13 standards and recommendations of ASHRAE 68.
- B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for inertia bases.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Mason Industries.
 - 2. Amber Booth.
 - 3. Vibration Eliminator.
- B. Open Spring Isolators:
 - 1. Spring Isolators:

- a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- C. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 - 5. Restraint: Furnish mounting frame and limit stops.
- D. Closed Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
- E. Restrained Closed Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

F. Spring Hanger:

1. Spring Isolators:

- a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
- b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:

1. Rubber or neoprene-waffle pads.

- a. 30 durometer.
- b. Minimum 1/2 inch thick.
- c. Maximum loading 40 psi.
- d. Height of ribs: not to exceed 0.7 times width.

2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify equipment, ductwork and piping is installed before work in this section is started.

3.02 EXISTING WORK

- A. Provide access to existing piping and ductwork and other installations remaining active and requiring access.
- B. Extend existing piping and ductwork installations using materials and methods compatible with existing electrical installations.

3.03 INSTALLATION

- A. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.

- B. Install isolation for motor driven equipment. Isolators shall be calculated and selected by equipment manufacturer and spring isolator provider.
- C. Adjust equipment level.
- D. Install spring hangers without binding.
- E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- G. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4 inch Diameter: First three points of support.
 - 2. 5 to 8 inch Diameter: First four points of support.
 - 3. 10 inch Diameter and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.
- H. Support duct silencers rigidly to ductwork.

3.04 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.
- B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Nameplates.
 2. Tags.
 3. Pipe markers.
 4. Labels.

1.02 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Product Description: Laminated three-layer plastic with engraved (see drawings for color) letters on light contrasting background color.

2.02 TAGS

- A. Plastic Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.

- b. Safety Sign Co.
 - c. Seton Identification Products.
 - 2. Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter. See drawings for color.
- B. Metal Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

2.03 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

2.04 LABELS

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
- B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Identify multi-zone rooftop unit, furnaces, air cooled condensing units, etc. with plastic nameplates.
- F. Identify control panels and major control components outside panels with plastic nameplates.
- G. Identify valves in main and branch piping with tags.
- H. Identify roof mounted gas piping, concealed or exposed, with plastic pipe markers. Identify service, flow and direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

3.03 SCHEDULES

- A. Identification:
 - 1. See drawings for details.
- B. Contractor shall provide an 8-1/2 x 11 valve chart and schedule in aluminum frame with clear plastic shield. Install at location directed by owner.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural Gas Piping.
2. Refrigerant Piping.

B. Related Sections:

1. Section 23 21 13 - HVAC Piping.
2. Section 23 23 00 - Refrigerant Piping.

1.02 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.
- N. ARI
- O. ASME
- P. NFPA

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

- A. Before final acceptance of all piping system, all systems must be tested in accordance with the schedule and prove to be free of leaks.
 - 1. Perform tests under observation of Architect/Engineer.
 - 2. Underground systems shall be tested prior to backfilling.
 - 3. Remove, replace or satisfactorily repair defective work revealed by tests.
 - 4. Make piping repairs with new materials; caulking of screwed joints or pin holes is not permitted.
 - 5. Furnish all test equipment and materials for testing.
 - 6. Owner to furnish water for testing and flushing.

3.02 TESTING MATERIAL

- A. Testing Medium:
 - 1. Hydrostatic Testing Medium: Clean Water.
 - 2. Pneumatic Testing Medium: Clean compressed air.
- B. Pressure Testing Gauges: ANSI B40.1, Grade AA; minimum 6 inch diameter dial with scale divisions equal or less than maximum allowable pressure drop.

3.03 TESTING SYSTEMS

- A. Air Test:
 - 1. When tests are made with air, apply minimum 5 psi with force pump and maintain 1 hour with no leakage apparent.
- B. Hydrostatic and Pneumatic Testing Requirements:
 - 1. Pressure to be raised gradually to given value; then block off tight at source.
 - 2. Allowable Pressure Drop: Maximum amount scheduled during corresponding minimum time interval.
 - a. Visually examine all joints during test.
 - 3. Upon successful completion and test approval, relieve piping of pressure, drain, put into normal operation except for potable water to be sterilized before placing in service.
- C. Hydrostatic and Pneumatic Testing Schedule:

<u>Service</u>	<u>Normal Work Pressure</u> <u>psig</u>	<u>Hydrostatic Test Pressure</u> <u>psig</u>	<u>Pneumatic Test Pressure</u> <u>psig</u>	<u>Maximum Allowable Pressure Drop</u> <u>psig</u>	<u>Minimum Test Time</u> <u>Hours</u>
Fuel:					
Natural Gas	To 25	---	100	0	8
Cooling:					
Refrigerant	To 290	---	300	0	4

<u>Service</u>	Normal Work Pressure <u>psig</u>	Hydrostatic Test Pressure <u>psig</u>	Pneumatic Test Pressure <u>psig</u>	Maximum Allowable Pressure Drop <u>psig</u>	Minimum Test Time <u>Hours</u>
Chilled Water	To 100	150	- - -	2	2

3.04 CLEANING AND ADJUSTING

- A. Cleaning: Thoroughly clean all parts of the piping installation at completion of work.
1. Remove grease, metal cutting and sludge form all equipment, pipes, valves all fittings.
 2. Repair all stoppages, discoloration or other damage to finish, furnishings or parts of building that are due to Contractor's failure to properly clean piping system.
- B. Adjusting:
1. Adjust control devices for proper operation.
 2. Demonstrate to Architect/Engineer satisfactory operation following adjustment.
 3. Readjust or replace all items not functioning properly.

END OF SECTION

SECTION 230593
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic and refrigerating systems.
3. Measurement of final operating condition of HVAC systems.

B. Related Sections:

1. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.03 SUBMITTALS

A. Section 01 30 00 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms containing information indicated in Schedules.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty.

F. Submit draft copies of report for review prior to final acceptance of Project.

- G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 ACCEPTABLE BALANCING CONTRACTORS

- A. Aero Test and Balance.
- B. Mechanical Test and Balance.
- C. Superior Test and Balance.
- D. Professional System Analysis.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations, balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.07 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.08 SCHEDULING

- A. Schedule and provide assistance in final adjustment and test of life safety and smoke evacuation system with Fire Authority.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)

- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Service and balancing valves are open.

3.02 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

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

3.04 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

3.06 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

- 1. Fans.
- 2. Air Inlets and Outlets.
- 3. Air Cooled Condensing Unit.
- 4. Duct Leak Test.
- 5. Rooftop Units.

B. Report Forms

- 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
- 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions

3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date

4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore

5. Air Cooled Condensing Unit:
 - a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors

6. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual

7. Heating Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air temperature, design and actual

- g. Leaving air temperature, design and actual
 - h. Air pressure drop, design and actual
8. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
9. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
10. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus:
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
11. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number

- d. Serial number
- e. Arrangement/Class/Discharge
- f. Air flow, specified and actual
- g. Return air flow, specified and actual
- h. Outside air flow, specified and actual
- i. Total static pressure (total external), specified and actual
- j. Inlet pressure
- k. Discharge pressure
- l. Sheave Make/Size/Bore
- m. Number of Belts/Make/Size
- n. Fan RPM

Return Air/Outside Air Data:

- o. Identification/location
- p. Design air flow
- q. Actual air flow
- r. Design return air flow
- s. Actual return air flow
- t. Design outside air flow
- u. Actual outside air flow
- v. Return air temperature
- w. Outside air temperature
- x. Required mixed air temperature
- y. Actual mixed air temperature
- z. Design outside/return air ratio
- aa. Actual outside/return air ratio

12. Duct Traverse:

- a. System zone/branch
- b. Duct size
- c. Area
- d. Design velocity
- e. Design air flow
- f. Test velocity
- g. Test air flow
- h. Duct static pressure
- i. Air temperature
- j. Air correction factor

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC ductwork insulation, jackets, and accessories.

1.02 REFERENCES

A. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
4. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
5. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
6. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
7. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
8. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
9. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
10. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
11. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
12. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
13. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
14. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
15. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
16. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
17. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
18. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
19. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

20. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

B. Sheet Metal and Air Conditioning Contractors':

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. National Fire Protection Association:

1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

D. Underwriters Laboratories Inc.:

1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

2. UL 1978 - Standard for Safety for Grease Ducts.

1.03 SUBMITTALS

A. Section 01 30 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Field Applied Grease Duct Fire Rated Enclosure: Provide ICC-ES ESR report.

1.04 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

A. TYPE P1: Glass Fiber.

1. Manufacturers:

- a. Owens Corning Fiberglass.
- b. Knauf.
- c. Certainteed Corp.
- d. Mansville.
- e. Armstrong.

2. Insulation: ASTM C547; rigid molded, noncombustible.

- a. 'K' Value: ASTM C335, 0.24 at 75 degrees F.
- b. Minimum Service Temperature: 0 degrees F.
- c. Maximum Service Temperature: 250 degrees F.
- d. Maximum Moisture Absorption: 0.2 percent by volume.

3. Vapor Barrier Jacket:

- a. ASTM C921, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
- b. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
- c. Secure with self-sealing longitudinal laps and butt strips.
- d. Secure with outward clinch expanding staples and vapor barrier mastic.

4. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch center.

5. Vapor Barrier Lap Adhesive:

- a. Compatible with insulation.

6. Insulating Cement/Mastic:

a. Manufacturers:

- 1) Fibrex.
- 2) Dabco.

- b. ASTM C195; hydraulic setting on mineral wool.

B. TYPE P-2: EPDM Elastomeric Cellular Insulation.

1. Acceptable Manufacturers:

- a. Aeroflex/Aerocel.
- b. Armacell.
- c. K-Flex/Echo.

2. Insulation:

- a. Insulation material shall be an EPDM rubber, flexible, closed-cell elastomeric insulation in tubular form. The product will be tested for and meet or exceed the requirements defined in ASTM C534.
- b. EPDM elastomeric insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's.
- c. EPDM elastomeric insulation shall have a flame-spread index of 25 or less and a smoke-developed index of 50 or less when tested in accordance with ASTM E84, for all products through 2" thickness. Product to be suitable for use from -297°F to 257°F continuous service temperature, per ASTM C411.
- d. EPDM elastomeric insulation shall have a maximum thermal conductivity of 0.245 Btu-in./h/ft²-°F at a 75°F mean temperature when tested in accordance with ASTM C177 or ASTM C518.
- e. EPDM elastomeric insulation shall have a maximum water vapor transmission of 0.03 perm-inches when tested in accordance with ASTM E96, Procedure A, latest revision.
- f. Product must exhibit long-term UV resistance, when unfinished in outdoor installations, per ASTM G7 and ASTM G90.
- g. EPDM elastomeric insulation must not contribute to external stress corrosion cracking as when tested by ASTM C692.
- h. Longitudinal joints shall have factory applied lap tape.
- i. OFF-WHITE COLOR WHEN USED FOR HOT-CHILLED WATER.
- j. STANDARD BLACK COLOR WHEN USED FOR REFRIGERANT PIPING.

3. Adhesives, Tapes, and Finishes:

- a. Adhesives shall be the insulation manufacturer's recommended contact adhesive: Aerocel Aero seal or approved equal.
- b. Seaming tape to be 15-mil EPDM rubber with acrylic adhesive: Aerocel Protape or approved equal. Longitudinal seam closure is to be Stay-Seal with Protape and butting sections are to be glued with Aero seal adhesive (or approved equal adhesives). Closures must provide water and water vapor tight seal when tested in accordance with ASTM D 3816. VOC content must be no more than 1.3% when tested in accordance with ASTM D 3960. Closures must be capable of being sealed at a low temperature of 0°F. Closures must be kept free of dust, dirt, moisture, lubricants and other contaminants.
- c. Elbows, "P" traps, and Tees with mitered insulation fittings using tubular EPDM flexible elastomeric insulation sections, color matched to pipe insulation.
- d. Accessories such as adhesives, mastics and cements shall not detract from any of the system ratings as specified above.

4. Insulated Pipe Saddles:

- a. Insulated pipe saddles will be high-density insulation with an inner lining of EPDM rubber insulating tape and an EPDM rubber exterior or jacket.
- b. Density of insulation is to be a minimum of 10 lbs./cu ft., with a compressive strength of 284 P.S.I. or greater, and a k-value of .312 or lower, usage temperature range of -297°F to 257°F, water absorption of 5% or less. Exterior jacket is to be 15-mil thick EPDM rubber.

5. Factory Fabricated Insulating Fitting Covers:

- a. Insulating fitting covers for 90 degree elbows, tee's, and 45 degree elbows, and mechanical grooved fittings will be factory-fabricated insulating fitting covers. The insulating fitting covers are to be made of EPDM rubber, with insulation thickness to match material on straight run piping. Color shall match the straight pipe insulation. Aeroflex USA Aerofit insulating fitting covers (or equal).

2.02 JACKETS

A. Jacket: Ventureclad insulation jacketing tape-1579CW.

1. Minimum Service Temperature: -40 degrees F.
2. Maximum Service Temperature: 248 degrees F.
3. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
4. Maximum Flame Spread: ASTM E84; 25.
5. Maximum Smoke Developed: ASTM E84; 50.
6. Tape joints with 1577CW-E tape.
7. Stucco embossed.

2.03 DUCTWORK INSULATION

A. TYPE D-1: ASTM C553, flexible, noncombustible blanket.

1. 'K' Value: ASTM C518, 0.29 at 75 degrees.
2. Maximum moisture absorption: 0.20 percent by volume.

B. TYPE D-2: ASTM C612, rigid, noncombustible fiberglass duct board.

1. 'K' Value: ASTM C518, 0.29 at 75 degrees.
2. Maximum moisture absorption: 0.20 percent by volume.
3. Density: 3 lb/cu ft.
4. Thickness: 2".

C. TYPE D-3: ASTM C553, flexible, noncombustible fiberglass duct liner.

1. 'K' Value: ASTM C518, 0.29 at 75 degrees.
2. Density: 1.5 lb/cu ft.
3. Maximum velocity on coated air side: 4,000 ft/min.

D. TYPE D-4: ASTM C534, Type I, flexible, closed cell elastomeric insulation sheet.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Minus 70 to 180 degrees F.

2.04 DUCTWORK INSULATION JACKETS

A. Vapor Retarder Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

- B. Canvas Duct Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.
- C. Outdoor Duct Jacket: Ventureclad.
- D. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.045 inch thick, 48 inch wide roll; white color.

2.05 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Adhesive: Waterproof, ASTM E162 fire-retardant type.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad or welded with press-on head.
- E. Lagging Adhesive: Fire resistive to ASTM E84.
- F. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- G. Adhesives: Compatible with insulation.
- H. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- B. Verify surfaces are clean and dry, with foreign material removed and dry.

3.02 INSTALLATION - PIPING SYSTEMS

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. For insulated pipes conveying fluids below ambient temperature:
 1. Provide vapor barrier jackets, factory applied or field applied.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 3. PVC fitting covers may be used.
 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump body and expansion joints.
- D. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with vapor barrier, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
3. Finish with glass cloth and adhesive.
4. PVC fitting covers may be used.
5. For hot piping water do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

E. Insulated cold pipes conveying fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
3. PVC fitting covers may be used.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

F. Inserts and Shields:

1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Provide heavy density insulating material suitable for the planned temperature range.

G. EPDM Cellular Elastomeric Insulation:

1. Insulating pipe saddles are to be installed at all pipe hanger and clamp locations. In new construction, saddles are to be installed at the time that piping is being installed, so that insulation system can be installed in a continuous manner through the pipe support system.
2. Piping up to 16" inside diameter is to be insulated using preformed pipe insulation. Piping over 16" inside diameter may be insulated with preformed pipe insulation or sheet insulation, applied according to manufacturer's installation instruction and practices described in the National Commercial and Industrial Insulation Standards Manual.
3. No additional coating or finish is required for weathering resistance. Coatings or jacket may be required for aesthetic, damage resistance, or vapor barrier enhancement purposes.
4. At a minimum, thickness used will be in accordance with the thickness tables for piping insulation used in the latest version of ASHRAE 90.1. These thicknesses may or may not sufficient to control condensation. Thickness required to control condensation may be greater than the recommendations of ASHRAE E90.1.
5. All longitudinal and butt joints shall have lap tape applied.
6. Piping, Valves, Fittings:

- a. All piping, valves, and fittings scheduled to be insulated shall have all insulation applied in strict accordance with manufacturer's installation instructions, and practices described in the National Commercial and Industrial Insulation Standards Manual. Manufacturer's installation guidelines and instruction will be used if conflicts exist.
- H. Finish insulation at supports, protrusions, and interruptions.
- I. All fittings in fiberglass covered systems: Elbows, tees, valve bodies etc. shall be insulated with blanket insulation with equivalent thickness as the surrounding pipe and finished with PVC jackets.
- J. Provide insulated valve and thermometer extensions as required for the specified pipe insulation thickness.
- K. Exterior hot and chilled water pipes shall be covered with polyisocyanurate rigid foam. At a minimum, installation shall follow manufacturer's guidelines. Longitudinal seams and an additional strip of venturclad tape must be applied.
- L. High density foam must be below each hanger and shall be able to support the weight of the piping system.
- M. Interior chilled water piping and fittings shall be covered with phenolic foam insulation.
- N. At all fittings, provide a removable vinyl jacketed cover with Velcro seams and elastic ends around all valves in pipe mains shown on drawings in chilled temperature piping.

3.03 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Glass Fiber Duct Insulation:
 - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 - 2. Secure insulation without vapor retarder with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

E. Duct and Plenum Liner:

1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

3.04 INSTALLATION - EQUIPMENT

- A. Install materials in accordance with manufacturer's instructions.
- B. Do not insulate factory insulated equipment.
- C. On exposed equipment, locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.
- F. For insulated equipment containing fluids above ambient temperature:
 1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
 2. Finish with glass cloth and adhesive.
- G. Finish insulation at supports, protrusions, and interruptions.
- H. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- I. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.
- J. Exterior chilled water pipes shall be covered with polyisocyanurate rigid foam. At a minimum, installation shall follow manufacturer's guidelines. Longitudinal seams and an additional strip of ventuereclad tape must be applied. Entire piping system shall be continually wrapped with ventuereclad jacketing.

3.05 PIPE SYSTEMS INSULATION SCHEDULE

A. Heating Systems:

<u>Piping Systems</u>	<u>Insulation Type</u>	<u>Pipe Size Inch</u>	<u>Thickness Inch</u>
Interior Metallic Cooling Coil Condensate Piping	P-2	Up to 4"	3/4"

B. Cooling Systems:

<u>Piping Systems</u>	<u>Insulation Type</u>	<u>Pipe Size Inch</u>	<u>Thickness Inch</u>
Refrigerant Suction	P-2	Up to 1 1/2" 2" and Above	1 1/2" 2"
Metallic Condensate Piping	P-2	Up to 4"	3/4"

3.06 DUCT SYSTEMS INSULATION SCHEDULE

<u>Ductwork</u>	<u>Insulation Type</u>	<u>Thickness Inch</u>
Supply and Return Ducts	D-3	1-1/2"

END OF SECTION

**SECTION 230900
INSTRUMENTATION AND CONTROL FOR HVAC**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Control panel enclosures.
2. Thermostats.
3. Control air dampers.
4. Electric damper actuators.
5. Control valves.
6. Electric valve actuators.
7. Direct digital control system components.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors.
2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
3. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for thermometer sockets and gage taps for placement by this section. Installation requirements for piping products furnished in this section.
4. Section 23 33 00 - Air Duct Accessories: Product requirements for duct mounted thermometers. Installation requirements for dampers and other duct mounted products furnished in this section.
5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

C. American Society of Mechanical Engineers:

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B32 - Standard Specification for Solder Metal.
4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 6. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. National Electrical Manufacturers Association:
1. NEMA DC 3 - Residential Controls - Electrical Wall Mounted Room Thermostats.
 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.
 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- H. Underwriters Laboratories, Inc.:
1. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

1.03 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Coordinate submittals with information requested in Section 23 09 93.
- C. Product Data: Submit description and engineering data for each control system component. Include sizing as required.
- D. Manufacturer's Installation Instructions: Submit installation requirements for each control component.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors.
- C. Operation and Maintenance Data: Submit inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.05 QUALITY ASSURANCE

- A. Provide pneumatic tubing located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet when tested in accordance with UL 1820.

B. Control Air Damper Performance: Test in accordance with AMCA 500.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 COORDINATION

A. Coordinate installation of control components in piping systems with work of Section 23 21 16.

B. Coordinate installation of control components in duct systems with work of Section 23 33 00.

1.09 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.

B. Conform to (IMC) International Mechanical Code. (2015)

C. Conform to (IBC) International Building Code. (2015)

D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)

E. Conform to State of Illinois Plumbing Code. (2014)

F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)

G. Conform to (IECC) International Energy Conservation Code. (2015)

H. Conform to (IFGC) International Fuel Gas Code. (2015)

I. Conform to (IPMC) International Property Maintenance Code. (2015)

J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)

K. Conform to (ICC) International Code Council Reference Standards. (2015)

L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)

M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.02 CONTROL VALVES

A. Ball Valves

- 1. Up to 2 inches: Brass body, plated bronze trim, blowout proof stem, mounting flange
- 2. Hydronic Systems:
 - a. Rate for service pressure of 200 psig at 250 degrees F.
 - b. Size for 3 psig maximum pressure drop at design flow rate.
 - c. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.

B. Globe Pattern:

- 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
- 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
- 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel or brass.
 - c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.

C. Electronic Operators:

- 1. Manufacturer: Reliable Controls.
- 2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
- 3. Select operator for full shut off at maximum pump differential pressure.

D. Reheat Valves:

- 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
- 2. Rate for service pressure of 125 psig at 250 degrees F.
- 3. Size for 3 psig maximum pressure drop at design flow rate.

4. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
5. Operators (Modulating): Self-contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel: 24 v DC, 6 watt maximum input.

E. Radiation Valves:

1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
2. Rate for service pressure of 125 psig at 250 degrees F.
3. Size for 3 psig maximum pressure drop at design flow rate.
4. Two way valves shall have equal percentage characteristics, three way valves linear characteristics. Size two way valve operators to close valves against pump shut off head.
5. Spring Return: Self-contained linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel: 24 v DC, 6 watt maximum input.

2.03 DAMPERS

- A. Performance: Test in accordance with AMCA 500.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement.
- C. Blades: Galvanized steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric or Neoprene mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Graphite impregnated nylon sleeve, with thrust washers at bearings or lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
- G. Linkage Bearings: Graphite impregnated nylon.
- H. Leakage: Less than 2 percent based on approach velocity of 2000 ft/min and 4 inches w.g.
- I. Maximum Pressure Differential: 6 inches w.g.
- J. Temperature Limits: -40 to 200 degrees F.

2.04 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

- B. Electric Operators:
 - 1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch minimum position potentiometer and 24 V dc, 24 va transformer.
 - 2. Manufacturer: Belimo, Siemens, Johnson Control.
- C. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide one damper operator for maximum 25 sq ft damper section.

2.05 INPUT/OUTPUT SENSORS

- A. Temperature:
 - 1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
 - 2. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 8 feet or 16 feet as required.
 - 3. Insertion elements for liquids shall be with stainless steel socket with minimum insertion length of 2-1/2 inches.
 - 4. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.
- B. Static Pressure Sensors:
 - 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - 2. Temperature compensates with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 4. Output: 0 - 5 vdc with power at 12 to 28 vdc.
- C. Equipment Operation Sensors:
 - 1. Status Inputs for Fans/Pumps: Differential pressure switch with adjustable range of 0 to 5 inches w.g. (0 to 1250 Pa).
 - 2. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- D. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

2.06 THERMOSTATS

- A. Room Temperature Thermostat/Sensors.
 - 1. Room sensors shall be constructed for either surface or wallbox mounting.
 - 2. Room sensors shall have the following options when specified:
 - a. Setpoint reset slide switch providing a 3 degree (adjustable) range.
 - b. Analog thermometer.
 - 3. All room sensors shall have a cover as described below in accessories.

- B. Line Voltage Thermostats:
 - 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 - 2. Dead band: Maximum 2 degrees F.
 - 3. Cover: Locking with concealed setpoint, without thermometer.
 - 4. Rating: Motor load.

- C. Room Thermostat Accessories:
 - 1. Thermostat Covers: Brushed aluminum or clear cover (owner to make final selection).
 - 2. Insulating Bases: For thermostats located on exterior walls.
 - 3. Thermostat Guards: Metal mounted on separate base.
 - 4. Adjusting Key: As required for device.

- D. Outdoor Reset Thermostat:
 - 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 - 2. Scale range: -10 to 70 degrees F.

- E. Immersion Thermostat:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

- F. Airstream Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - 2. Averaging service remote bulb element: 20 feet.

- G. Electric Low Limit Duct Thermostat:
 - 1. Snap acting, double pole, single throw snap action contacts rated for 16 amps at 120 vac, manual reset switch which trips if temperature sensed across any 18 inches of bulb length is equal to or below setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.

- H. Outside Air Sensors.
 - 1. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - 2. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - 3. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

- I. Duct Mount Sensors.
 - 1. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

J. Averaging Sensors.

1. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
3. Capillary supports at the sides of the duct shall be provided to support the sensing strip.

2.07 TRANSMITTERS

A. Temperature Transmitters:

1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50 degree span, with suitable temperature range, compensated bulb, averaging capillary, or rod.

2.08 STATUS AND SAFETY SWITCHES

A. General Requirements.

1. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal conditions occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

B. Current Sensing Switches

1. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
2. Current sensing switches shall be used for run status for fans, over-current up to twice its trip point range.
3. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

C. Air Filter Status Switches

1. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120 VAC.

2. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
3. Provide appropriate scale range and differential adjustment for intended service.

D. Air Pressure Safety Switches

1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify pneumatic tubing is clear of water, oil or other contaminants and compressed air supply has filter and dryer operating before installing control devices or actuators.
- B. Verify air handling units and ductwork installation is complete and air filters are in place before installing sensors in air streams.
- C. Verify location of thermostats and humidistats and other exposed control sensors with Drawings before installation.
- D. Verify building systems to be controlled are ready to operate.

3.02 INSTALLATION

- A. Install sleeves through concrete surfaces in minimum one inch sleeves, extended 6 inches above floors and one inch below bottom surface of slabs.
- B. Install thermostats and space temperature sensors after locations are coordinated with other Work.
- C. Install thermostats and space temperature sensors 48 inches above floor. Align with light switches.
- D. Install freeze protection thermostats using flanges and element holders.
- E. Install outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- F. Provide separable sockets for liquids and flanges for air bulb elements. Refer to Section 23 21 16.
- G. Install guards on thermostats in public areas, entrances and as indicated on Drawings.
- H. Install control panels adjacent to associated equipment on vibration free walls or freestanding supports. Install engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face. Label with appropriate equipment or system designation.
- I. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

J. Install conduit and electrical wiring in accordance with Section 26 05 03.

3.03 FIELD QUALITY CONTROL

- A. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.
- B. Contractors' tests and startups shall be scheduled and documented in accordance with the project requirements.

3.04 DEMONSTRATION AND TRAINING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate complete operation of systems, including sequence of operation prior to Date of Substantial Completion.
- C. Demonstrate complete and operating system to Owner.
- D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 70 00 for general contractor closeout requirements. Refer to individual sections for specific contractor training requirements.

END OF SECTION

**SECTION 230923
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes control equipment and software.
- B. Related Sections:
 - 1. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
 - 2. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.03 SYSTEM DESCRIPTION

- A. Building automation system shall be an extension of Johnson Control Metasys System. Map all points to the existing Application and Data Server.
- B. Automatic temperature controls field monitoring and control system using field programmable microprocessor based units with communications to Building Automation and Control System.
- C. Provide control panels, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Provide controls for unit ventilators, air cooled condensing units, rooftop units, VRF's, etc.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- F. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.04 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate the following:
 - 1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 - 2. Connected data points, including connected control unit and input device.

3. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration diskette containing graphics.
 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 5. Description and sequence of operation for operating, user, and application software.
 6. Use terminology in submittals conforming to ASME MC85.1.
 7. Coordinate submittals with information requested in Section 23 09 93.
- C. Product Data: Submit data for each system component and software module.
- D. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Submit data specified in "Submittals" in final "Record Documents" form.
- C. Operation and Maintenance Data:
1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
 3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.08 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Intelli-Building Control and Solutions LLC, Chicago, IL
Contact: Rick Freund (312) 735.6546, rick@intelli-building.com

2.02 WEB SERVER INTERFACE

- A. Field panel shall provide a web based graphical user interface compatible with the BACnet network. Through the web server, the facility operator shall be able to easily monitor and control the Building Automation System.
 - 1. Web server features: Memory shall reside on the field panel without the need for additional hardware:
 - 2. Unlimited number of user accounts
 - 3. User access shall be password encrypted.
 - a. Customized system graphics
 - b. Live animation of equipment
 - c. Real-time point values and status updates.
 - d. Network LayoutView network layout
 - e. View BACnet MS/TP network
 - f. Navigate to other web enabled panels

- g. Search database for individual points
4. System Status Bar
 - a. Visual detection of new alarms and acknowledged alarms
 - b. Visual detection of out of service, faults and failed devices
 - c. Ability to view, filter and acknowledge system alarms from a single page
 - d. Point Commanding Change point values
 - e. Place points "out of service"
 - f. Command BACnet MS/TP points
 5. Scheduler
 - a. View schedules in daily, weekly or monthly view
 - b. Add and delete schedules
 - c. Create exceptions for existing schedules
 6. Reporting
 - a. Generate point log report with multiple filters
 7. Graphical trend display
 - a. Ability to view one or more trends on a single display
 - b. Ability to view raw data values and export to CSV file
 - c. Print trend graph to network printers
 - d. Display points with current values
 8. Configuration and Customization
 - a. Custom welcome page
 - b. User interface translatable to any browser supported language
 - c. Ability to customize font sizes and display colors
 - d. Display points with current values
 9. Online database editing
 - a. Database configuration
 - 1) Add/ modify/ delete points
 - 2) Add/ modify/ delete trend definitions
 - 3) Add/ modify/ delete schedules
 - 4) Add/ modify/ delete event enrollment
 - 5) Add/ modify/ delete notification class objects
 - b. User Account
 - 1) Add/ modify/ delete user accounts
 - 2) Change user passwords
 - c. Custom Program editor
 - 1) Add/ modify/ delete programs
 - 2) View and clear trace bits
 - 3) View disabled, unresolved, and comment lines

10. Graphics creation and editing

- a. Graphics configuration tool allows remote creation, modification and deletion of graphics
- b. Library of predefined graphic backgrounds

2.03 DDC CONTROLS

- A. Unit Controllers: Programmable control module shall be pre-programmed prior to jobsite delivery for the applicable sequence of operation.

2.04 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger. This battery backup shall only be used to retain memory in the controller, not to keep it functioning.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both data base and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in stand-alone mode: Start/stop, duty cycling, automatic temperature control, demand control via a sliding window, predictive algorithm, event initiated control, calculated point, scanning and alarm processing, full direct digital control, trend logging, global communications, maintenance scheduling.
 - 8. Global Communications: Broadcast point data onto network, making that information available to all other system control units.
 - 9. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.
- D. Input/Output Capability: Discrete/digital input (contact status), discrete/digital output, analog input, analog output, pulse input (5 pulses/second), pulse output (0-655 seconds in duration with 0.01 second resolution).
- E. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control units with minimum 30 percent spare capacity.
- F. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

- G. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.
- H. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment.

2.05 LOCAL AREA NETWORKS (LAN)

- A. Provide communication between network control units (NCU) over local area network (LAN). System must be capable of supporting Ethernet LAN between network control units.
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 10 MB as an Ethernet.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.
- H. Secondary network N2 to operate at 9.6 KB.

2.06 OPERATING SYSTEM SOFTWARE

- A. Provide input/output capability from operator station.
- B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Changes shall utilize standard procedures.
- D. Provide capability of dynamic color graphic displays if so noted on point charts.
- E. Provide alarm processing.
- F. Provide event processing.
- G. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.
- H. Provide message display.
- I. Provide reports.

- J. Provide data collection.
- K. Graphic Display: Support graphic development on work station with software features.
- L. Provide maintenance management.
- M. Provide advisories.

2.07 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and S.I. metric units of measurement.
- B. Provide demand limiting.
- C. Provide duty cycling.
- D. Provide automatic time scheduling.
- E. Provide start/stop time optimization.
- F. Provide night setback/setup program.
- G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
- H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
- I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
- J. Provide fine tuning direct digital control PID or floating loops.
- K. Provide trend logging.

2.08 HVAC CONTROL PROGRAMS

- A. Support inch-pounds and S.I. metric units of measurement. Identify each HVAC Control system.
- B. Provide optimal run time.
- C. Provide supply air reset.
- D. Provide enthalpy switchover.

2.09 PROGRAMMING APPLICATION FEATURES

- A. Provide trend logs.
- B. Provide alarm messages.
- C. Provide weekly scheduling.

- D. Provide event interlocking.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditioned power supply is available to control units and to operator workstation.
- B. Verify field end devices and wiring is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls were not subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- C. Install with 120 volts alternating current, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Install conduit and electrical wiring in accordance with Section 26 05 03.
- E. Install electrical material and installation in accordance with appropriate requirements of Division 26.
- F. Coordinate all new DDC work with existing control system/s within the building, making sure that the existing system remains undisturbed and functional.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.

3.04 DEMONSTRATION AND TRAINING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Furnish basic operator training for 3 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 24 hours instructor time. Furnish training on site.
- C. Demonstrate complete and operating system to Owner.

END OF SECTION

SECTION 230993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. Sequence of Operation:
 - 1. MZ Rooftop unit.
 - 2. Power phase monitoring.

1.02 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.03 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.04 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)

- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

- A. Temperature control system shall be web-based and communicate seamlessly, over the district's Ethernet LAN/WAN. All DDC control points listed in this section shall be performed by the DDC system and displayed on a PC browser with Internet Explorer. For future work, new DDC system software shall have capability and sufficient capacity to control entire building plus 20 percent spare capacity.
- B. All DDC control points listed in this section shall be performed by the DDC system. Any other control work required to complete the sequence of operation herein specified shall be electric temperature controls. Contractor shall provide all transformers, relays, etc. necessary for a complete operating system. At contractor's option, entire control system specified herein may be DDC.
- C. In general, system shall automatically control changeover to heating at 68 degrees F. and to cooling at 70 degrees F. as sensed by outside air temperature sensor.

3.02 MULTI-ZONE ROOFTOP UNIT

- A. The rooftop unit will function as programmed at the unit controller by the unit manufacturer. The sequence of operations noted is responsible for proper operation of the unit per the codes and manufacturer's recommendations. The Building Automation System will interface with the RTU through the BACnet data connection. All applicable available points from manufacturer BACnet communication module shall be mapped into the BAS.
- B. BAS contractor shall mount and wire all loose shipped manufacturer supplied components and provide any required devices to achieve the sequence, including add a building static pressure sensor and tubing.
- C. During occupied mode, both supply and exhaust fans shall operate continuously.
- D. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes and programmed by the BAS contractor:
 - 1. Occupied Mode: The unit shall maintain
 - a. A 71°F (adj.) cooling setpoint
 - b. A 74°F (adj.) heating setpoint (where applicable).

2. Unoccupied Mode (night setback): The unit shall maintain unoccupied zone setpoints during unoccupied periods.
 - a. A 79°F (adj.) cooling setpoint.
 - b. A 66°F (adj.) heating setpoint (where applicable).

- E. Demand Control Ventilation: A return CO2 sensor shall be used to reset the outside air damper position to **below its minimum** % OA scheduled setting only when CO2 reading are below the ASHRAE guidelines.

- F. Activation of any return or supply air smoke detector the system shall have a wired shut down, signal BAS alarm, and signal fire alarm system.

- G. Alarms shall be provided as follows:
 1. Zone High Zone Temp by BAS: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 2. Zone Low Zone Temp by BAS: If the zone temperature is less than the heating setpoint (where applicable) by a user definable amount (adj.).
 3. All applicable BACnet alarms generated by the RTU controller.
 4. High CO: If the return air CO is sensed, unit shall shut-down and go into alarm.

- H. BAS shall display and allow end user to control all functions and display all alarms produced by the BACnet integration.

- I. Input/Output Schedule (minimum points required):

Description	Signal
1. RTU Integration (all available points consult with owner and unit manufacturer)	via BACnet MS/TP
2. Supply Fan Status (Typical of 6 Furnaces)	DI
3. Supply Fan Start/Stop (Typical of 6 Furnaces)	DO
4. Exhaust Fan Status	DI
5. Exhaust Fan Start/Stop (modulate)	DO
6. Outside/Return/Exhaust Air Dampers	AO
7. Zone Discharge Air Temperature Set Point (Typical of 7)	AI
8. Zone Discharge Air Temperature (Typical of 7)	AI
9. Zone Space Temperature Set Point	AI
10. Zone Space Temperature (Typical of 7)	AI
11. Gas valve position (Typical of 6)	AI
12. Return Air Temperature	AI
13. Return Air Humidity	AI
14. Return Air CO2 Concentration (ppm)	AI
15. Zone Low-Limit (Typical of 7)	DI
16. Filter Differential Pressure (Typical of 6)	AI
17. Outdoor Air Temperature	AI
18. Condensing unit Status (Typical of 6)	DO
19. Condensing unit Stage (Typical of 6)	DI
20. High CO Levels and Alarm	DI
21. Fire Alarm System	DI
22. Graphic Display	--

3.03 POWER/PHASE MONITORING

A. A phase monitor (Hawk Eye or Siemens) shall monitor each main power phase of the incoming service. Upon loss or imbalance of voltage for legs A, B, or C the building automation system shall shut-down and send an alarm to the BAS system the following equipment:

1. MZ Rooftop Unit

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural gas piping above grade.
2. Unions and flanges.
3. Valves.
4. Pipe hangers and supports.

B. Related Sections:

1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
2. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

- D. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- E. American Water Works Association:
 - 1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- F. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
- G. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.04 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

- B. Project Record Documents: Record actual locations of valves, piping system, and system components.
- C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform work in accordance with applicable code and local gas company requirements.
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Perform Work in accordance with authority having jurisdiction and AWS D1.1 for welding hanger and support attachments to building structure.
- E. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 COORDINATION

- A. Coordinate trenching, excavating, bedding, and backfilling of buried piping systems.

1.12 WARRANTY

- A. Section 01 74 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.13 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inches and smaller (unless routed through the building outside of mechanical rooms); welded for pipe 2-1/2 inches and larger.

2.02 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with brazed joints.

3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.03 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 54 and ASME 31.9.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe 3 inches and Smaller: Cast iron hook.
- F. Vertical Support: Steel riser clamp.
- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- I. Sheet Lead: ASTM B749, 2.5 lb/sq ft inch thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION - INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.9.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping and sheet lead packing between hangers or support and piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.05 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access where valves and fittings are not exposed.

- K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- L. Provide support for utility meters in accordance with requirements of utility company.
- M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
- O. Install identification on piping systems including underground piping. Refer to Section 23 05 53.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- R. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- S. Install gas pressure regulator with tee fitting not less than 10 pipe diameters downstream of regulator. Cap or plug one opening of tee fitting.
- T. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- U. Provide new gas service complete with gas meter and regulators. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.
- V. **All exterior gas pipe and gas vent piping shall be brushed clean, primed and painted with two coats of weather resistant oil base paint (color selected by Architect).**

3.06 FIELD QUALITY CONTROL

- A. Pressure test natural gas piping in accordance with NFPA 54.
- B. Inspect, test and purge gas piping in accordance with applicable code.
- C. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct Materials.
2. Flexible ducts.
3. Insulated flexible ducts.
4. Single wall spiral round ducts.
5. Ductwork fabrication.

B. Related Sections:

1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
2. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
9. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
10. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - Fibrous Glass Duct Construction Standards.
2. SMACNA - HVAC Air Duct Leakage Test Manual.
3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

1.03 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.04 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit and coil installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

- C. Product Data: Submit data for duct materials and duct liner.

- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

- E. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)

- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of in conformance with ASTM A90.

2.02 MANUFACTURED DUCTWORK

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Insulated Flexible Ducts:
 - 1. Manufacturers:
 - a. Flex-Master.
 - b. Therma Flex.
 - c. Techna Flex.
 - 2. Underwriters Laboratory Standard 181; Class 1.
 - 3. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
 - 4. Pressure Rating: 10 inches w.g. positive and 1.0 inches w.g. negative.
 - 5. Maximum Velocity: 4000 fpm.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

PART 3 - EXECUTION

3.01 INSTALLATION

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

- B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Connect diffusers to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- G. Connect flexible ducts to metal ducts with draw bands.
- H. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- I. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- J. Connect terminal units to supply ducts with three foot maximum length of flexible duct. Do not use flexible duct to change direction.
- K. Cleaning and Protection:
 - 1. Clean air handling unit and ductwork prior to the installation. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
 - 2. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

3.02 SCHEDULES

A. Ductwork Material Schedule:

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
Low Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel

B. Ductwork Pressure Class Schedule:

<u>AIR SYSTEM</u>	<u>PRESSURE CLASS</u>	<u>SEAL CLASS</u>
Return Duct	3 inch wg.	B
Relief/Return	2 inch wg.	C
Supply Duct	2 inch wg min.	C
General Exhaust	2 inch wg	C
Transfer duct	1 inch wg	

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Duct access doors.
3. Volume control dampers.
4. Flexible duct connections.
5. Duct test holes.
6. Dynamic fire dampers.
7. Fire/smoke dampers.

B. Related Sections:

1. Section 23 09 00 - Instrumentation and Control for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
2. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
3. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 555 - Standard for Safety for Fire Dampers.
2. UL555S- Standard for Safety for Smoke Dampers

1.03 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.
- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
- D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
 - 1. Fire dampers including locations and ratings.
 - 2. Backdraft dampers.
 - 3. Flexible duct connections.
 - 4. Volume control dampers.
 - 5. Duct access doors.
- E. Product Data: For fire dampers submit the following:
 - 1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
 - 2. Indicate materials, construction, dimensions, and installation details.
 - 3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- F. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of access doors.
- C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.05 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.06 QUALIFICATIONS

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two of each size and type of fusible link.

1.10 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 AIR TURNING DEVICES

- A. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Cook.
 - 3. Ruskin.
 - 4. Dowco Products
 - 5. Carnes
 - 6. Vent Products.
 - 7. Pottorff.
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage thick galvanized extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Cesco Products.
 - 3. Carnes.
 - 4. Vent products.
 - 5. Pottorff.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
 - 1. Less than 12 Inches Square: Secure with sash locks.
 - 2. Up to 18 Inches Square: Provide two hinges and two sash locks.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.04 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Vent Products.
 - 3. Dowco Products.
 - 4. Air Balance Inc.

5. Pottorff.
6. Greenheck.

- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inches. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- E. Quadrants:
 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 3. Access doors shall be rated for the same pressure clad as the duct system.
- F. Remote Operator: Provide Young Regulator or equal, remote operator where damper access cannot be attained through ceiling access door. Operator to be by cable through 7/18" diameter paintable cold rolled steel cover plate concealing socket wrench operated rack and pinion gear drive. Damper shall be complete with similar gear drive smoothly to operate damper through full range of motion from tight shut-off to wide open.

2.05 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Connector: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 2. Net Fabric Width: Approximately 3 inches wide.
 3. Metal: 3 inch wide, 24 gage galvanized steel.
- C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.06 DUCT TEST HOLES

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

2.07 DYNAMIC FIRE DAMPERS

A. Manufacturers:

1. Ruskin.
2. Vent Products.
3. Dowco Products.
4. Air Balance, Inc.
5. Cesco Products.
6. Greenheck.
7. Pottorf.

B. Fabricate in accordance with NFPA 80, 90A, 101 and UL 555, and as indicated.

C. All dampers shall be mounted in a sleeve of sufficient length and gauge to meet UL installation requirements. The sleeve shall be held in place with retaining angles.

D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring.

E. Curtain Type Dampers: Galvanized steel with interlocking blades, 3.688 inches frame, blades in gauges required by UL. Provide stainless steel closure springs and latches for horizontal installations, closure under minimum 2000 fpm air flow conditions @ 4inches w.g. Configure with blades out of air stream except for pressure class ducts up to 12 inches in height.

F. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. The damper shall have a dynamic closure under minimum 2000 fpm air flow conditions @ 4inches w.g

G. Fusible Links: UL 33, separate at 165 degrees F. with adjustable link straps.

H. Security Bars (provide only in storm shelter area): 3 1/2" x 3 1/2" custom grid provided by the installing contractor.

1. Vertical Bars: 1/2" diameter zinc plated bar. 3 1/2" on center.
2. Horizontal Bars: 2" x 1/4" flat bar. 3 1/2" on center.
3. Grille Frame: 10 gauge x2" galvanized steel.
4. Vertical bars pass through the horizontal bars. Bars are welded to the frame and at each intersection of the horizontal bars

2.08 DYNAMIC FIRE/SMOKE DAMPERS

A. Manufacturers:

1. Ruskin.
2. Vent Products.
3. Greenheck.
4. Pottorf.

B. Fabricate in accordance with NFPA 80, 90A, 101 and UL 555, UL 555S and as indicated.

- C. All dampers shall be mounted in a sleeve of sufficient length and gauge to meet UL installation requirements. The sleeve shall be held in place with retaining angles.
- D. Multiple Blade Dampers: 16 gage galvanized steel frame and air foil blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage. The damper shall have a dynamic closure under minimum 2000 fpm air flow conditions @ 4 inches w.g
- E. Fire/Smoke damper shall be UL listed, similar to Ruskin FSD60.
- F. Fire Smoke dampers shall include 120 volt actuators, factory mounted, normally closed with spring return
- G. High temperature thermal link set at 165 degrees for damper closure.
- H. Security Bars (provide only in storm shelter area): 3 1/2" x 3 1/2" custom grid provided by the installing contractor.
 - 1. Vertical Bars: 1/2" diameter zinc plated bar. 3 1/2" on center.
 - 2. Horizontal Bars: 2" x 1/4" flat bar. 3 1/2" on center.
 - 3. Grille Frame: 10 gauge x2" galvanized steel.
 - 4. Vertical bars pass through the horizontal bars. Bars are welded to the frame and at each intersection of the horizontal bars

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, fire and smoke dampers, and elsewhere as indicated. Provide minimum 18 x 18 inch size for shoulder access or 2 inches smaller than duct size, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.

- H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- I. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 238107
PACKAGED MULTI-ZONE ROOFTOP AIR CONDITIONING UNITS - MEDIUM CAPACITY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Multi-Zone packaged rooftop unit.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for identification for placement by this section.
3. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
4. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
5. Section 23 11 23 - Facility Natural-Gas Piping: Natural gas piping connections.
6. Section 23 33 00 - Air Duct Accessories: Flexible connections.
7. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 58 - Liquefied Petroleum Gas Code.
3. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

- E. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 QUALITY ASSURANCE

- A. Prior to bidding the manufacturer and its local representative shall measure existing conditions and quantify the number of zones on the existing multi-zone unit.
- B. Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
- C. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- E. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.
- F. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- G. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.04 SUBMITTALS

- A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.05 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and locations of units and valves. Include pre-purchase equipment submittals.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to installation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- B. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.08 WARRANTY

- A. Manufacturer shall provide a "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of shipment, whichever occurs first. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.
- B. Provide ten (10) year heat exchanger limited warranty.
- C. Provide five (5) year compressor warranty.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

1.10 EXTRA MATERIALS

- A. Provide one set of filters.

PART 2 - PRODUCTS

2.01 ROOFTOP UNIT

- A. Acceptable Manufacturers:
 - 1. CME Custom Mechanical Equipment (basis of design).
 - 2. No substitutes.
- B. Structure: Penthouse shall have an aluminum construction with high ribbed steel, bubble wrap R-9 insulation, and color fast steel siding and trim. Color as selected by owner. The penthouse units will be PMZ factory assembled one piece design. All components will be factory installed, wired, and plumbed inside the penthouse. Coils to be complete with factory insulated cabinets, corrosion resistant drain pan, and expansion valve kits.
- C. Heating: Heating shall be high efficiency two stage condensing type, utilizing outside air for combustion. Units shall be certified with AGA laboratories and the ratings certified by GAMA, tested according to DOE test procedures and FTC labeling regulations. Unit shall be available for use with LPG/propane as an option. The units shall be Lennox EL297UH090XV60C with A.F.U.E. of 97.0%
- D. Blowers: The blowers shall have variable speed drive motors. The variable speed motor shall maintain a specified air volume throughout the static pressure range. Change in blower speeds shall be accomplished by changing a setpoint in the control system. When in ventilation mode, furnaces run at low speed setting. When heating, cooling, or economizing, the fans run at high speed.
- E. Condensers: Condensing units will be Lennox Two Stage R-410a refrigerant, air cooled type with scroll compressors and resilient mounts. Coils shall be copper-aluminum construction, pressure tested at 450 to 500 psig. A timed off control shall prevent the compressor from short cycling. The PMZ will be provided with condensing units that need to be field installed, piped, and evacuated according to manufacturers recommended practice.
- F. Economizers: Economizers shall be provided for each furnace, consisting of gasketed low leakage return and outside air dampers in a steel housing with 2" pleated filters. Damper position shall be controlled by an air sensor and solid state outside air enthalpy sensor. Minimum position is factory set and adjustable via the controls.
- G. Electrical: Single point 208 volt, three phase connection with MOCP and branch circuit breakers shall be provided with each unit. Condensing unit fused disconnect switches shall be mounted on the exterior of the penthouse adjacent to the respective condensing units. A low voltage control center shall be factory installed to allow connections of the low voltage thermostat wires.
- H. Ductwork: Unit will have factory installed internal duct system. Individual zone heads are designed to match existing zone system. The common or ducted return air opening will have a protective grate.

- I. Condensate: Unit will be provided with a single point INTERNAL drain connection. Unit manufacture shall pipe all condensate to neutralization kit(s) prior to existing unit in to the space below.
- J. The following components will be factory installed, wired, and plumbed inside the penthouse:
 - 1. Two stage natural gas heating sections with 97.0% A.F.U.E.
 - 2. Dx cooling coils with installed expansion valves
 - 3. Modulating, dual position enthalpy economizers
 - 4. External primary disconnect
 - 5. Pre-wired ACCU service disconnect switches
 - 6. Gas line with single point 1 1/4 inch connection
 - 7. Refrigeration piping stubs to exterior (1 1/8" suction, 3/8" liquid)
 - 8. Condensate piping to single point internal connection
 - 9. Furnace combustion intake and exhaust piping to end termination
 - 10. Zonehead to match existing ductwork
 - 11. Service lighting and GFCI outlet
 - 12. High efficiency 2" pleated MERV 14 filters
 - 13. BACnet control integration
 - 14. Barometric relief section
- K. The following options will be included:
 - 1. Unit color: To be determined by owner
 - 2. 24" new curb
 - 3. Roof curb cap
 - 4. Smoke detectors by others
 - 5. Condensation neutralization kits

2.02 ROOF CURB

- A. Replacement multizone rooftop unit is designed to fit on manufacturers new insulated 24"-high roof curb to align with existing supply and return drops and existing support structure.
 - 1. Unit shall match the existing curbs and supply duct connections. The use of curb adapters is not acceptable. Roof curb gasket shall be provided and shipped loose with the unit. Units shall match existing duct connections and require minimal field time to reconnect and seal. Units shall match existing gas and electrical power connections and shall require only minimal field time to reconnect.
 - 2. Prior to fabrication of the equipment, a factory engineer shall visit the jobsite, measure the unit, and become familiar with the exact requirements of the project. A local manufacturer's representative shall not be considered as a substitute. The factory employee shall also be present at the installation to assist / supervise the unit installation and unit start up. The responsibility of these functions shall not be transferred to the local manufacturer's representative. A factory technician shall submit a check test start-up report after field installation and start-up.
 - 3. Unit curb shall be divided and provided with a cap over the return air plenum section to utilize the existing return air opening.

4. **Contractor shall fill the non-plenum return section between the bottom of the unit and the roof deck with layers of sound batt and board insulation. Refer to detail.**

PART 3 - EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

- A. RTU manufacturer and the mechanical contractor shall field verify the exact supply and return openings and zone damper sizes and arrangement prior to fabrication of the rooftop unit.
- B. The manufacturer shall provide unit start-up and 2 hours of owner field training on unit.

3.02 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Verify that proper power supply is available.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork. Install rooftop unit level on steel.
- C. Contractor to participate and coordinate manufacturer start-up and commissioning.
- D. Fill void in roof curb between roof deck and unit with sound batt insulation and gypsum board with staggered joints. Refer to drawings for additional information.

3.04 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- D. Install new filters after construction.

END OF SECTION

**DIVISION 26
ELECTRICAL**

**SECTION 260503
EQUIPMENT WIRING CONNECTIONS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
 - 1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.
- B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.04 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

1.05 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)

- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 CORD AND PLUGS

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Pass and Seymour.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Attachment Plug Construction: Conform to NEMA WD 1.
- C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
- D. Cord Construction: Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- E. Size: Suitable for Connected Load of Equipment, Length of Cord, and Rating of Branch Circuit Overcurrent Protection.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.02 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.

- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.03 ADJUSTING

- A. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION 260519
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes building wire and cable and wiring connectors and connections.
- B. Related Sections:
 - 1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.

1.02 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. Underwriters Laboratories, Inc.:
 - 1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.03 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Solid or stranded conductor for feeders and branch circuits 10 AWG and smaller.
 - 2. Stranded conductors for control circuits.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 4. Conductor not smaller than 16 AWG for control circuits.
 - 5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
 - 2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
 - 3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway.
 - 4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

5. Exterior Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.
6. Underground Locations: Use only building wire, Type THHN/THWN or XHHW insulation, in raceway.

1.04 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

1.05 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Requirements for submittals.
- B. Test Reports: Indicate procedures and values obtained.

1.06 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and circuits.

1.07 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet when tested in accordance with NFPA 262.
- B. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

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

1.09 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

1.10 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- B. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 ft of length shown.

1.11 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)

- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

- A. Manufacturers:
 - 1. American Insulated Wire Corp.
 - 2. General Cable Co.
 - 3. Pirelli Cable.
 - 4. Republic Wire.
 - 5. Rome Cable.
 - 6. Southwire.
 - 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation Temperature Rating: 90 degrees C.
- F. Insulation Material: Thermoplastic.

2.02 TERMINATIONS

- A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger: Color keyed compression type copper, with insulating sealing collars.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques - Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 4 AWG and larger with pulling equipment.
- E. Special Techniques - Cable:
 - 1. Protect exposed cable from damage.
 - 2. Support cables above accessible ceiling, using spring metal clips or plenum rated plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
 - 3. Use suitable cable fittings and connectors.
- F. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 - 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
 - 7. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

- G. Install stranded conductors for branch circuits 10 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
- H. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.
- I. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- J. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

3.04 WIRE COLOR

A. General:

- 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:

- 1. For 6 AWG and smaller: Green.
- 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.05 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Wire.
 - 2. Mechanical connectors.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 99 - Standard for Health Care Facilities.

1.03 SYSTEM DESCRIPTION

- A. Grounding systems uses the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Rod electrode.

1.04 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms maximum.

1.05 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.06 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)

- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes: 4 AWG.
- C. Grounding Electrode Conductor: Copper conductor bare.
- D. Bonding Conductor: Copper conductor bare.

2.02 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Harger Lighting and Grounding.
 - 2. Apache Grounding/Erico Inc.
 - 3. Copperweld, Inc.
 - 4. Erico, Inc.
 - 5. ILSCO Corporation.
 - 6. O-Z Gedney Co.
 - 7. Thomas & Betts, Electrical.
 - 8. Substitutions: Section 01 60 00 - Product Requirements.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.02 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.03 INSTALLATION

- A. Install in accordance with IEEE.
- B. Install grounding and bonding conductors concealed from view.
- C. Install isolated grounding conductor for circuits supplying network equipment and in accordance with IEEE 1100.

- D. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- E. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- F. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- G. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.
- H. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- I. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.04 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground resistance testing in accordance with IEEE 142.
- D. Perform leakage current tests in accordance with NFPA 99.
- E. Perform continuity testing in accordance with IEEE 142.
- F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

1.02 REFERENCES

A. ASTM International:

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

E. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.03 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, and UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
 - 1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.
- B. Surface Burning: ASTM E84 and UL 723 with maximum flame spread / smoke developed rating of 25/450.
- C. Firestop interruptions to fire rated assemblies, materials, and components.

1.05 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code and UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.06 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers, where required.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.

- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.07 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.
- D. In pool equipment rooms or rooms open to the pool, all hangers, inserts, slotted channels, rods, fasteners, etc. shall be stainless steel or epoxy coated to prevent corrosion.

1.11 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.

2. Electroline Manufacturing Company.
 3. O-Z Gedney Co.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
 - C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
 - D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
 - E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
 - F. Cable Ties: High strength nylon temperature rated to 185 degrees F. self-locking.
 - G. In pool equipment rooms or rooms open to the pool provide stainless steel or epoxy coating to prevent corrosion.

2.02 FORMED STEEL CHANNEL

- A. Manufacturers:
 1. Allied Tube & Conduit Corp.
 2. B-Line Systems.
 3. Midland Ross Corporation, Electrical Products Division.
 4. Unistrut Corp.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.
- C. In pool equipment rooms or rooms open to the pool provide stainless steel or epoxy coating to prevent corrosion.

2.03 SPRING STEEL CLIPS

- A. Manufacturers:
 1. B-Line Systems.
 2. Erico, Inc.
 3. Thomas & Betts Corp.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Mounting hole and screw closure.
- C. In pool equipment rooms or rooms open to the pool provide stainless steel or epoxy coating to prevent corrosion.

2.04 SLEEVES

- A. Sleeves for cabling Through Non-fire Rated Floors: 18 gage thick galvanized steel.

- B. Sleeves for cabling Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduits or cabling Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Stuffing Type Fire-stopping Insulation: Glass fiber type, non-combustible.
- E. In pool equipment rooms or rooms open to the pool provide stainless steel or epoxy coating to prevent corrosion.

2.05 MECHANICAL SLEEVE SEALS

A. Manufacturers:

- 1. Thunderline Link-Seal, Inc.
- 2. NMP Corporation.
- 3. Wiremold.
- 4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.06 FIRESTOPPING

A. Manufacturers:

- 1. Dow Corning Corp.
- 2. Fire Trak Corp.
- 3. Hilti Corp.
- 4. International Protective Coating Corp.
- 5. 3M fire Protection Products.
- 6. Specified Technology, Inc.
- 7. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

- 1. Silicone Firestopping Elastomeric Firestopping: Silicone elastomeric compound and compatible silicone sealant.
- 2. Foam Firestopping Compounds: Foam compound.
- 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
- 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
- 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
- 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
- 7. Firestop Pillows: Formed mineral fiber pillows.

- C. Color: Where fire proofing will be visible after construction, provide products as selected by the architect products from manufacturer's full range of colors.

2.07 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
 - 3. Sheet metal.
 - 4. Alumina silicate fire board.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 - 1. Furnish UL listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing and/or damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect or Structural Engineer before drilling or cutting structural members.

3.03 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:

1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors and preset inserts.
2. Steel Structural Elements: Provide beam clamps, steel ramset fasteners, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above recessed into and grouted flush with slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:

1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.04 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- F. Place intumescent coating in sufficient coats to achieve rating required.
- G. Remove dam material after firestopping material has cured.
- H. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, conduit, wireway, trough, and cabling penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- I. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons, floor plates, or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
 - 4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.05 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.06 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install escutcheons at finished surfaces to match surrounding surfaces.

3.07 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.08 CLEANING

- A. Section 01 71 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.09 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 260533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections.
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Section 26 05 53 - Identification for Electrical Systems.
 - 5. Section 26 27 26 - Wiring Devices.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Wet and Damp Locations: Provide rigid steel and aluminum conduit. Thickwall nonmetallic conduit may be utilized where approved. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- C. Concealed Dry Locations: Provide intermediate metal conduit and electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- D. Exposed Dry Locations: Provide electrical metallic tubing except where subject to damage then provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.04 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.05 SUBMITTALS

- A. Section 01 30 00 - Submittal Procedures: Submittal procedures.
- B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.06 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents:
 - 1. Record actual routing of conduits larger than 2 inch.
 - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.08 COORDINATION

- A. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)

- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Southwire Company.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Intermediate Metal Conduit (IMC): Rigid steel.
- E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.02 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anamet Electrical.
 - 2. Electricflex Company.
 - 3. Southwire Company - Alfex.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Interlocked steel construction.
- C. Fittings: NEMA FB 1.

2.03 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anamet Electrical.
 - 2. Electricflex Company.
 - 3. Southwire Company - Alfex.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.04 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube and Conduit.
2. Southwire Company.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, compression type.

2.05 SURFACE METAL RACEWAY

A. Manufacturers:

1. Wiremold Co. Model V3000 Series.
2. Hubbell.
3. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: 2 3/4" x 1 15/32" x length as required.

D. Finish: Scratch resistant ivory finish.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.06 WIREWAY

A. Manufacturers:

1. Circle AW.
2. Hoffman.
3. Square D Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: General purpose or as required to match environment installed

C. Knockouts: Manufacturer's standard.

D. Size: As indicated on Drawings.

E. Cover: Hinged cover.

F. Fittings: Lay-in type with removable side.

G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.07 OUTLET BOXES

A. Manufacturers:

1. Appleton Electric.
2. OZ Gedney.
3. Raco.
4. Red Dot.
5. Thomas & Betts.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.08 PULL AND JUNCTION BOXES

A. Manufacturers:

1. Appleton Electric.
2. OZ Gedney.
3. Raco.
4. Red Dot.
5. Thomas & Betts.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.02 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.03 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceway.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maximum Size Conduit in Slab above Grade: 1 inch. Do not cross conduits in slab.
- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows or hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- W. Close ends and unused openings in wireway.

3.04 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights required and as indicated on Drawings.
- B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with the construction documents.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
- C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.06 ADJUSTING

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

3.07 CLEANING

- A. Section 01 71 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Stencils.
6. Lockout Devices.

B. Related Sections:

1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.02 SUBMITTALS

A. Section 01 30 00 - Submittal Procedures: Submittal procedures.

B. Product Data:

1. Submit manufacturer's catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesives are within range recommended by manufacturer.

1.04 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.

B. Conform to (IMC) International Mechanical Code. (2015)

C. Conform to (IBC) International Building Code. (2015)

D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)

E. Conform to State of Illinois Plumbing Code. (2014)

F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)

G. Conform to (IECC) International Energy Conservation Code. (2015)

H. Conform to (IFGC) International Fuel Gas Code. (2015)

- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. Furnish materials in accordance with industry standards.
- B. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.
- C. Letter Size:
 - 1. 1/8 inch high letters for identifying individual equipment and loads.
 - 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 3/32 inch.

2.02 LABELS

- A. Furnish materials in accordance with industry standards.
- B. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

2.03 WIRE MARKERS

- A. Furnish materials in accordance with industry standards.
- B. Description: Cloth tape, split sleeve, or tubing type wire markers.
- C. Legend:
 - 1. Power and Lighting Circuits: Actual branch circuit or feeder number.
 - 2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

2.04 CONDUIT AND RACEWAY MARKERS

- A. Furnish materials in accordance with industry standards.
- B. Description: Labels fastened with adhesive or stencils.
- C. Color:
 - 1. 480 Volt System: Black lettering on white background.

2. 208 Volt System: Black lettering on white background.

D. Legend:

1. Medium Voltage System: HIGH VOLTAGE.
2. 480 Volt System: 480 VOLTS. HIGH VOLTAGE.
3. 208 Volt System: 208 VOLTS.

2.05 STENCILS

- A. Furnish materials in accordance with industry standards.
- B. Stencils: With clean cut symbols and letters of following size:
 1. Up to 2 inches Outside Diameter of Raceway: 1/2 inch high letters.
 2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.
- C. Stencil Paint: As specified in construction documents, semi-gloss enamel, colors conforming to the following:
 1. Black lettering on white background.
 2. White lettering on gray background.
 3. Red lettering on white background.
 4. Blue lettering on white background.

2.06 LOCKOUT DEVICES

- A. Lockout Hasps:
 1. Anodized aluminum or reinforced nylon hasp with erasable label surface; size minimum 7-1/4" x 3".

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with construction documents for stencil painting.

3.02 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using screws, rivets, or adhesive.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.

6. Install nameplates for the following:

- a. Switchboards.
- b. Panelboards.
- c. Transformers.
- d. Service Disconnects.
- e. Motor Starters.

C. Label Installation:

1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations.
3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:

1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
3. Install labels at data outlets identifying patch panel and port designation as indicated on Drawings.

E. Conduit Marker Installation:

1. Install conduit marker for each conduit 1 1/2" and larger longer than 20 feet.
2. Conduit Marker Spacing: 20 feet on center.
3. Raceway Painting: Identify conduit using field painting in accordance with Section 09 90 00.
 - a. Paint colored band on each conduit longer than 20 feet.
 - b. Paint bands 20 feet on center.
 - c. Color: Utilize the owners standard color coding. If no standard exists provide;
 - 1) 480 Volt System: Orange.
 - 2) 208 Volt System: Blue.

END OF SECTION

