
SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 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.

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.

1.3 SUBMITTALS

- A. Section 01 33 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 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

2.1 GLASS FIBER - TYPE A

- A. Manufacturers:
 - 1. Owens Corning Fiberglass.
 - 2. Knauf.
 - 3. Certainteed Corp.
 - 4. Mansville.
 - 5. Armstrong.
 - 6. Or approved as equal.
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' Value: ASTM C335, 0.24 at 75 degrees F.
 - 2. Minimum Service Temperature: 0 degrees F.
 - 3. Maximum Service Temperature: 250 degrees F.
 - 4. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket:
 - 1. ASTM C921, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
 - 3. Secure with self sealing longitudinal laps and butt strips.
 - 4. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch center.

- E. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation.
- F. Insulating Cement/Mastic:
 - 1. Manufacturers:
 - a. Fibrex.
 - b. Dabco.
 - c. Or approved as equal.
 - 2. ASTM C195; hydraulic setting on mineral wool.

2.2 EPDM ELASTOMERIC CELLULAR INSULATION - TYPE B

- A. Acceptable Manufacturers:
 - 1. Aeroflex/Aerocel.
 - 2. Armaflex.
 - 3. K-Flex/Echo.
 - 4. Or approved as equal.
- B. Insulation:
 - 1. 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.
 - 2. EPDM elastomeric insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's.
 - 3. 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 300°F continuous service temperature, per ASTM C411.
 - 4. 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.
 - 5. 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.
 - 6. Product must exhibit long-term UV resistance, when unfinished in outdoor installations, per ASTM G7 and ASTM G90.
 - 7. EPDM elastomeric insulation must not contribute to external stress corrosion cracking as when tested by ASTM C692.
 - 8. Longitudinal joints shall have factory applied lap tape.
- C. Adhesives, Tapes, and Finishes:
 - 1. Adhesives shall be the insulation manufacturer's recommended contact adhesive: Aerocel Aero seal or approved equal.
 - 2. Seaming tape to be 15-mil EPDM rubber with acrylic adhesive: Aerocel Protape or approved equal.
 - 3. Elbows, "P" traps, and Tees with mitered insulation fittings using tubular EPDM flexible elastomeric insulation sections, color matched to pipe insulation. **All exposed piping shall be off-white.**
 - 4. Accessories such as adhesives, mastics and cements shall not detract from any of the system ratings as specified above.
- D. Insulated Pipe Saddles:
 - 1. Insulated pipe saddles will be high-density insulation with an inner lining of EPDM rubber insulating tape and an EPDM rubber exterior or jacket.

2. 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.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 10 mil.
3. Connections: Brush on welding adhesive.

C. ABS Plastic Pipe Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature of 180 degrees F.
4. Moisture vapor transmission: ASTM E96; 0.012 perm-inches.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive.

D. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Blanket: 1.0 lb/cu ft density.
 - c. Weave: 5 x 5.
3. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

2.5 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.

2.6 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.

2.7 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape:
 - 1. 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

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Hot Piping Systems greater than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 3. Insulate flanges and unions at equipment.
- E. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install steel shield between pipe hanger and insulation.
 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install steel shield between roller and inserts.
- F. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
 2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
 3. Condensate Piping: Insulate entire piping system and components to prevent condensation.
- G. EPDM Cellular Elastomeric Insulation:
1. Piping, Valves, Fittings:
 - a. All piping, valves, fittings, duct, and equipment 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.
 - b. Piping up to 10" inside diameter is to be insulated using preformed pipe insulation. Piping over 10" 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.

- c. Insulated pipe saddles are to be at all pipe hanger and clamp locations. 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.
- d. 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.
- e. 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.
- f. All exposed pipe insulation shall be off-white.
- g. All longitudinal and butt joints shall have lap tape applied.

3.3 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: Required where insulating existing ductwork.
 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: Required for all new supply and return rectangular ductwork.
 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.
- F. Closed Cell Elastomeric Insulation:
 1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

3.4 PIPE SYSTEMS INSULATION SCHEDULE

<u>Piping Systems</u>	<u>Insulation Type</u>	<u>Pipe Size Inch</u>	<u>Thickness Inch</u>
A. Heating Systems:			
Heating Supply and Return	A	Up to 1-1/2" 2" and Up	1-1/2" 2"
Metallic Condensate Piping	B	Up to 4"	3/4"

3.5 DUCT SYSTEMS INSULATION SCHEDULE

<u>Ductwork</u>	<u>Type</u>	<u>Thickness Finish Inch</u>
1. Supply Ducts	D-3	1-1/2"
2. Return Duct	D-3	1-1/2"
3. HVAC Plenums	D-2	2"
4. Transfer Duct	D-3	1"
5. Concealed Round Branch Ductwork	D-1	1-1/2"
6. Exposed Round Ductwork	- -	Refer to Section 233100 Double wall duct

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carbon dioxide sensors.
2. Control panel enclosures.
3. Humidistats.
4. Thermostats/sensors.
5. Control air dampers.
6. Electric damper actuators.
7. Control valves.
8. Electric valve actuators.
9. Outside air measuring and modulation device.
10. Direct digital control system components.
11. Differential pressure monitor.

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.

1.2 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.

1.3 SUBMITTALS

- A. Section 01 33 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.

1.4 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.

1.5 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.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept controls on site in original factory packaging Inspect for damage.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of control components in piping systems with work of Section 23 21 16.
- C. Coordinate installation of control components in duct systems with work of Section 23 33 00.

1.9 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of control system for one year from Date of Substantial Completion.
- C. Furnish complete service of controls systems, including callbacks.
- D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing units from service during building normal occupied hours.
- F. Provide emergency call back service during working hours for this maintenance period.
- G. Maintain an adequate stock of parts locally for replacement or emergency purposes. Ensure personnel availability to ensure fulfillment of this maintenance service without unreasonable loss of time.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two of each type of thermostat, humidistat or exposed sensor.

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

2.1 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.

2.2 CONTROL VALVES

- A. Globe Pattern:
 - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 2. 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.
- B. Electronic Operators:
 - 1. Manufacturer: Belimo or owner approved equal.
 - 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.
- C. 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.

D. 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.

2.3 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.

2.4 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 or owner approved equal.
- C. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide one damper operator for maximum 25 sq ft damper section.

2.5 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.

2.6 THERMOSTATS/SENSORS

A. Room Temperature Thermostat/Sensors.

1. Room sensors shall be constructed for either surface or wallbox mounting.
2. Room sensors shall be flush mounted stainless steel plate with a 10k Type II thermistor sensor only, setpoint to be adjusted via BAS, no occupancy override.

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. 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.

D. Immersion Thermostat:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

E. 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.

F. 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.

- G. 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.
- H. 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.
- I. Averaging Sensors.
 - 1. For ductwork greater in any dimension the 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.

2.7 TRANSMITTERS

- A. Differential Pressure Transmitters.
 - 1. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - 2. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - 3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - 4. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible. Low Differential Water Pressure Applications (0" - 20" w.c.).
 - 5. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - 6. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - a. .01-20" w.c. input differential pressure range.
 - b. 4-20 mA output.
 - c. Maintain accuracy up to 20 to 1 ratio turndown.
 - d. Reference Accuracy: +0.2% of full span.
- B. Low Differential Air Pressure Applications (0" to 5" w.c.).
 - 1. The differential pressure transmitter shall be of industry quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - 2. The differential pressure transmitter shall have non-interactive zero and span adjustment that are adjustable from the outside cover and meet the following performance specifications:
 - a. (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)

- b. 4-20 mA output.
- c. Maintain accuracy up to 20 to 1 ratio turndown.
- d. Reference Accuracy: +.02% of full span.

C. 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.

2.8 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.

2.9 CABLE

A. Manufacturers:

1. Southwest Wire, 5950 Office Boulevard NE, Albuquerque, New Mexico 87109. Contact: Betty McMurrugh. Phone: (800) 334-2150, Fax: (505) 345-3862.
2. Windy City Wire, 832 South Central Avenue, Chicago, Illinois 60644. Contact: Damn Marci. Phone: (800) 379-119, Fax: (773) 379-1243.

B. School District 205 Wiring Standard:

1. Cable shall be 18 AWG wire, plenum rated, shield.
2. Color Coding (verify final color coding with school district and school district's controls maintenance contractor prior to purchase):

- a. N2 Bus Blue
- b. Analog Input Cable Yellow
- c. Analog Output Cable Tan
- d. Binary Input Cable Orange
- e. Binary Output Cable Violet
- f. N1 Bus Purple
- g. 24 VAC Cable Gray
- h. Spare White
- i. Ethernet -CAT 5 Purple
- j. N2 E Pink
- k. All cable will be purchased from the school district's preferred vendors listed above.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. 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.
- C. Verify air handling units and ductwork installation is complete and air filters are in place before installing sensors in air streams.
- D. Verify location of thermostats and humidistats and other exposed control sensors with Drawings before installation.
- E. Verify building systems to be controlled are ready to operate.

3.2 INSTALLATION

- A. Install thermostats, humidistats, and space temperature sensors after locations are coordinated with other Work.
- B. Install thermostats, humidistats, and space temperature sensors 48 inches above floor. Align with light switches.
- C. Install freeze protection thermostats using flanges and element holders.
- D. Install outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements. Refer to Section 23 21 16.
- F. Install guards on thermostats in public areas, entrances, gymnasiums, etc. and as indicated on Drawings.
- G. 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.
- H. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- I. Install conduit and electrical wiring in accordance with Section 26 05 03.

3.3 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.

3.4 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 77 00 for general contractor closeout requirements. Refer to individual sections for specific contractor training requirements.

END OF SECTION 230900

SECTION 230923 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes control equipment and software.
- B. Related Sections:
 - 1. Section 23 09 00 - Instrumentation and Control for HVAC: Control system components.
 - 2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
 - 3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

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

1.3 SYSTEM DESCRIPTION

- A. Building automation system shall be an extension of the existing Johnson Controls Tridium JACE based LON control system.
- B. Automatic temperature controls field monitoring and control system using field programmable microprocessor based units with communications to Building Automation and Control System.
- C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment, with central and remote hardware, software, and interconnecting wire and conduit.
- D. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- E. Provide controls for boilers, rooftop units, exhaust fans, radiation, pumps, etc. when directly connected to control units. Individual terminal unit control is specified in Section 23 09 00.
- F. 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.
- G. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS

- A. Section 01 33 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.

1.5 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.

1.6 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.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 WARRANTY

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

1.9 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of control systems for two years from Date of Substantial Completion.
- C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- D. Perform work without removing units from service during building normal occupied hours.

- E. Provide emergency call back service during working hours for this maintenance period.
- F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

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

2.1 OPERATOR INTERFACE

- A. Work Station Hardware: The workstation is existing to be reused.

2.2 DDC CONTROLS

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

2.3 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. 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.
- C. Input/Output Capability: Discrete/digital input (contact status), discrete/digital output, analog input, analog output, pulse input (5 pulses/second).
- D. 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.

2.4 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.

2.5 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. Control unit shall automatically check work station data base files upon connection and verify data base match.
- 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. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- K. Provide data collection.
- L. Graphic Display: Support graphic development on work station with software features.
- M. Provide maintenance management.
- N. Provide advisories.

2.6 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and S.I. metric units of measurement.
- B. Provide automatic time scheduling.
- C. Provide start/stop time optimization.
- D. Provide night setback/setup program.
- E. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
- F. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
- G. 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.
- H. Provide fine tuning direct digital control PID or floating loops.
- I. Provide trend logging.

2.7 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.

2.8 PROGRAMMING APPLICATIONS FEATURES

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

- D. Provide event interlocking.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify conditioned power supply is available to control units and to operator workstation.
- C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 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.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- C. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for 2 day period.
- D. Contractors' tests and startups shall be scheduled and documented in accordance with the project requirements.

3.4 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 16 hours instructor time. Furnish training on site.
- 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 77 00 for general contractor closeout requirements. Refer to individual sections for specific contractor training requirements.

END OF SECTION 230923

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sequence of Operation:
 - a. Central heating system.
 - b. Boilers.
 - c. Pumps.
 - d. Variable frequency drives.
 - e. Phase monitoring.

B. Related Sections:

1. Section 23 09 00 - Instrumentation and Control for HVAC: For equipment, devices, and system components to implement sequences of operation.
2. Section 23 09 23 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.
3. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative. Refer to Section 01 70 00, Closeout Procedures, for substantial completion details.

1.2 SUBMITTALS

A. Section 01 33 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.
4. Submit valve and damper schedules.

1.3 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.

1.4 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

3.1 GENERAL

- A. Temperature control system shall be DDC as specified in Section 23 09 23 "Direct Digital Control System for HVAC" and Section 23 09 00 "Instrumentation and Control for HVAC".
- B. Temperature control system shall be web-based and communicate seamlessly, via LON 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.
- C. 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 wiring, conduit where required, transformers, relays, sensors, etc. necessary for a complete operating system. The entire control system specified herein shall be DDC.
- D. All programming and point mapping shall be performed by the installing BAS contractor. All graphics associated with the controls work will be created and implemented under a separate contract by the school districts existing service provider.

3.2 CENTRAL HEATING SYSTEM (Boilers HWB-1 and HWB-2, Boiler Circulation Pumps BCP-1 and BCP-2, Secondary Hot Water Pumps HWP-1 and HWP-2, Variable Frequency Drives VFD-1 and VFD-2)

- A. Main heating plant shall be in operation below 68 degrees F (adj.) outside air temperature.
- B. Main heating plant equipment shall be enabled when primary and secondary system water flow is established as indicated by flow switch.
- C. Starting of system shall start lead hot water boiler circulation pump. Upon proof of flow based on flow switch, associated boiler shall start on low fire. Hot water boiler and associated boiler circulation pump shall be enabled.
- D. 3-way hot water mixing valve shall remain in full system bypass until the temperature differential between the boiler primary supply temperature and boiler primary return temperature has been reduced.

- E. Mixing valve shall then modulate open to system, slowly bleeding warmer water into secondary water circuit as required until the secondary loop is up to temperature.
- F. When system secondary water supply temperature has reached setpoint, control of 3-way valve shall revert to secondary water supply temperature controller, for indoor/outdoor control.
- G. System secondary supply water temperature setpoint shall be reset from 120 degrees F. at 65 degrees F. outside air temperature to 180 degrees F. at 0 degrees F. outside air temperature (adjustable).
- H. BAS system shall start/stop boilers to maintain supply water setpoint. Lead boiler shall be started on low fire and then modulate to high fire before starting the lag boiler on low fire. Lead boiler shall alternate weekly so as to equalize run time on all boilers.
- I. If flow has not been established after 30 seconds of signal to start boiler, next boiler shall be started.
- J. When either boiler stops, its associated circulation pump shall continue operation for 5 minutes (adj.) before stopping.
- K. Heating system lead secondary circulation pump shall operate continuously whenever main heating plant is in operation.
- L. Pump speed shall be constant, the VFD shall be utilized for system balancing. Future variable speed pumping shall be utilized with future terminal heating system upgrades.
- M. Lead/standby status of heating system secondary circulation pumps shall be alternated weekly so as to equalize run time on pumps.
- N. Manual emergency fuel burner switch located at each boiler room exit door shall shut off all burners, including domestic water heaters and emergency generator in Boiler Room when activated. One (1) switch is required at each boiler room exit door, see detail on plans.
- O. Interlock combustion air dampers to open on a call for heat. One (1) damper for each boiler and emergency generator.
- P. Input/Output Schedule (minimum points required):

	<u>Description</u>	<u>Signal</u>
1.	Heating system status	DI
2.	Hot water boiler HWB-1 enable/disable	DO
3.	Hot water boiler HWB-2 enable/disable	DO
4.	Hot water boiler HWB-1 status	DI
5.	Hot water boiler HWB-2 status	DI
6.	Hot water boiler HWB-1 flue temperature	AI
7.	Hot water boiler HWB-2 flue temperature	AI
8.	Boiler circ. pump BCP-1 status	DI
9.	Boiler circ. pump BCP-2 status	DI
10.	Secondary hot water pump HWP-1 VFD start/stop	DO
11.	Secondary hot water pump HWP-1 status	DI
12.	VFD-1 status	DI
13.	VFD-1 speed	AO
14.	Secondary hot water standby pump HWP-2 VFD start/stop	DO
15.	Secondary hot water standby pump HWP-2 status	DI
16.	VFD-2 status	DI
17.	VFD-2 speed	AO
18.	Primary hot water supply temperature	AI
19.	Primary hot water return temperature	AI
20.	Secondary hot water supply temperature	AI
21.	Secondary hot water supply temp. setpoint	AO
22.	Secondary hot water return temperature	AI
23.	3-way hot water mixing valve	AO

- | | | |
|-----|---|----|
| 24. | Outside air temperature | AI |
| 25. | Secondary hot water differential pressure | AI |
| 26. | Combustion air damper status (each) | DI |
| 27. | Graphic Display | -- |

3.3 POWER/PHASE MONITORING

- A. A phase monitor 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. Pumps
 2. Boilers
 3. Variable frequency drives

END OF SECTION 230993

SECTION 231123 - FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

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.

1.2 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.

1.3 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.

1.4 SUBMITTALS

- A. Section 01 33 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.

1.5 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.

1.6 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.

1.7 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.

1.8 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.

1.9 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. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate trenching, excavating, bedding, and backfilling of buried piping systems.

1.12 WARRANTY

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

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each type and size valve.

1.14 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

2.1 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.

2.2 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.

2.3 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.

2.4 EXTERIOR REGULATOR COVERS

- A. Provide Maxitrol “Maxi-Cap” rubber covers on all exterior regulators.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 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.

3.3 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.

3.4 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.

3.5 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. Refer to Section 09 90 00.
- 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 gas piping within walls shall be welded, not screwed.

- W. All exterior gas piping shall be scraped, primed, and painted with two (2) coats of oil based yellow paint specifically made for exterior metal applications.

3.6 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 231123

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heating water piping, above ground.
2. Equipment drains and over flows.
3. Unions and flanges.
4. Pipe hangers and supports.
5. Valves.

B. Related Sections:

1. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
3. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
4. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
5. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
6. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
7. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. 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 A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
12. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
13. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
15. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
17. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
18. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
19. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
20. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
21. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
22. ASTM D3309 - Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems.
23. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
25. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
26. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
27. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
28. ASTM F845 - Standard Specification for Plastic Insert Fittings for Polybutylene (PB) Tubing.
29. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
30. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems.
31. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Provide pipe hangers and supports in accordance with ASME B31.1.

- D. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.
- F. Use spring loaded check valves on discharge of hot water, chilled water, or pumps.
- G. Use plug valves for throttling service. Use non-lubricated plug valves only when shut-off or isolating valves are also provided.
- H. Use butterfly valves in heating water systems, in chilled and condenser water systems in heating, chilled and condenser water systems interchangeably with gate and globe valves.
- I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.
- J. Use only lug end butterfly valves.
- K. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- L. Flexible Connectors: Use at or near pumps motor driven equipment where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Shop Drawings: Submit pipe 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. Piping layout.
 - 3. Penetrations through fire rated and other walls.
 - 4. Terminal unit and coil installations.
 - 5. Hangers and supports, including methods for building attachment, and vibration isolation.
- C. 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.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and accessories.
- C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

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

1.8 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. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 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. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate trenching, excavating, bedding, and backfilling of buried piping systems.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each size and valve type.

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

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, 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; welded for pipe 2-1/2 inches and larger.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black, rolled grooved ends.
 - 1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, grooved ends.
 - 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, compatible with steel piping sizes, rigid or flexible type.
 - b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
 - c. Accessories: Steel bolts, nuts, and washers.
- C. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
- D. Copper Tubing: ASTM B88, Type L, hard drawn, rolled grooved ends.
 - 1. Fittings: ASME B16.18 cast copper alloy, grooved ends.
 - 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
 - b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
 - c. Accessories: Steel bolts, nuts, and washers.
- E. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Acceptable Manufacturers: Viega and Ridged-Progress.
 - 2. Press Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought.
 - 3. Joints: Pressed by crimping tool.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
 - 1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
 - 2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.

- B. Copper Tubing: ASTM B88, Type K, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- C. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2466, Schedule 40, PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.3 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 soldered.
 - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 - 4. PVC Piping: PVC.
- 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. PVC Piping: PVC flanges.
 - 4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.4 GATE VALVES

- A. Manufacturers:
 - 1. Milwaukee Valve Company.
 - 2. NIBCO, Inc.
 - 3. Stockham Valves & Fittings.
 - 4. Apollo.
 - 5. Or approved as equal.

2.5 GLOBE VALVES

- A. Manufacturers:
 - 1. Milwaukee Valve Company.
 - 2. NIBCO, Inc.
 - 3. Stockham Valves & Fittings.
 - 4. Apollo.
 - 5. Or approved as equal.

2.6 BALL VALVES

- A. Manufacturers: (use only full port ball valves)
 - 1. Milwaukee Valve Company.
 - 2. NIBCO, Inc.
 - 3. Stockham Valves & Fittings.
 - 4. Apollo.
 - 5. Or approved as equal.

2.7 BUTTERFLY VALVES

- A. Manufacturers: (use only full lug butterfly valves)
 - 1. Milwaukee Valve Company.
 - 2. NIBCO, Inc.
 - 3. Stockham Valves & Fittings.
 - 4. Apollo.
 - 5. Or approved as equal.

2.8 CHECK VALVES

- A. Horizontal Swing Check Valves:
 - 1. Manufacturers:
 - a. Crane Valve.
 - b. Milwaukee Valve Company.
 - c. NIBCO, Inc.
 - d. Stockham Valves & Fittings.
 - e. Apollo.
 - f. Or approved as equal.
- B. Spring Loaded Check Valves:
 - 1. Manufacturers:
 - a. Milwaukee Valve.
 - b. NIBCO, Inc.
 - c. Stockham Valves & Fittings.
 - d. Apollo.
 - e. Or approved as equal.

2.9 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.1.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2-1/2 inches and Larger: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
- F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
- H. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
- I. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
- J. 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.
- K. Vertical Support: Steel riser clamp.
- L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

- M. Floor Support for Hot Pipe 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- N. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- O. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- P. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- Q. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.3 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.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9.
- B. Support horizontal piping 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. Use hangers with 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 or sheet lead packing between hangers or support and piping.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- J. Install pipe hangers and supports in accordance with Section 23 05 29.

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install heating water piping in accordance with ASME B31.1.
- B. Route piping parallel to building structure and maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 23 05 29.
- G. Install pipe identification in accordance with Section 23 05 53.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
- J. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- L. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Insulate piping and equipment.
- O. Provide chain operated valves for those that are higher than 7'-0" above the finished floor.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Thermometer supports.
5. Test plugs.
6. Flexible connectors.
7. Air vents.
8. Strainers.
9. Pump suction fittings.
10. Combination pump discharge valves.
11. Flow controls.
12. Relief valves.
13. Air separator.
14. Expansion tank.

B. Related Sections:

1. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
2. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 PERFORMANCE REQUIREMENTS

- A. Flexible Connectors: Provide at or near pumps and other motorized equipment where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit for manufactured products and assemblies used in this Project.

1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.

2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
 4. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of actual locations of components and instrumentation.
- C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements before fabrication.

1.10 WARRANTY

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

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

2.1 HYDRONIC INDICATORS

- A. Manufacturers:
 - 1. Miljoco Corporation.
 - 2. Weiss Instruments.
 - 3. Moeller Instruments
 - 4. Palmer Instrument.
 - 5. Or approved as equal.
- B. Gage: ASME B40.1 Grade A, accurate to 1%. Case to be 4.5" diameter, stem mounted, cast aluminum with stainless steel ring and unbreakable crystal. Indicator shall have recalibrator, compound scale calibrated both in PSI and feet from full vacuum to selected pressure. Maximum indicator pressure shall at minimum equal pump shut-off head (when system pressure is at relief valve setting) and shall exceed his minimum by no more than 50 psi.
- C. Manifold valve shall be spring return push-button manifold of rugged brass construction with ports for connection to system at indicated points and with test port connection for gauge calibration.
- D. Hydronic indicator system shall be attached to system piping with heavy bracket at convenient height to permit easy push-button operation and dial observation.

2.2 PRESSURE GAGES

- A. Manufacturers:
 - 1. Miljoco Corporation.
 - 2. Weiss Instruments.
 - 3. Moeller Instruments.

4. Palmer Instrument.
5. Or approved as equal.

B. Pressure Gage:

1. Type: General use, ASME B40.1 Grade B, phosphor bronze bourdon tube, bottom connection.
2. Case: Black finished drawn steel.
3. Size: 2-1/2 inch diameter.
4. Mid-Scale Accuracy: Plus or minus two percent of range span.
5. Scale: White with black markings.
6. Range: Psi with equivalent kPa. Span to be two times the system operating pressure.
7. Connection: Brass, 1/4 inch NPT.

C. Pressure Gage Tappings:

1. Ball Valve: Lever handle, brass 1/4 inch NPT for maximum 150 psig.
2. Needle Valve: Brass, 1/4 NPT for minimum 150 psig.
3. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.
4. Snubber: Brass bushing, 1/4 inch NPT with corrosion resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Miljoco Corporation.
2. Weiss Instruments.
3. Moeller Instruments.
4. Palmer Instrument.
5. Or approved as equal.

B. Thermometer

1. Case: Nine inch die cast aluminum with hard power coated finish.
2. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
3. Tube: Non-toxic organic spirit-filled glass tube with magnifying lens.
4. Scale: Aluminum with white finish and black markings.
5. Stem: Aluminum or brass.

2.4 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and cable when required.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with aluminum perforated stem.

2.5 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F. Viton core for temperatures up to 400 degrees F. Extend as required to be accessible with insulated pipe.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapter with 1/8 inch probe, two 1-1/2 inch dial thermometers.

2.6 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B. Float Type:
 - 1. Manufacturers:
 - a. Bell & Gossett, ITT.
 - b. Armstrong.
 - c. Taco.
 - d. Or approved as equal.
 - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 3. High Capacity: Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.7 STRAINERS

- A. Acceptable Manufacturers:
 - 1. Nibco.
 - 2. Milwaukee.
 - 3. Stockham.
 - 4. Keckley.
 - 5. Or approved as equal.
- B. Size 2 inch and Under:
 - 1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 - 1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 - 1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.8 PUMP SUCTION FITTINGS

- A. Manufacturers:
 - 1. Bell & Gossett, ITT.
 - 2. Armstrong.
 - 3. Taco.
 - 4. Or approved as equal.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.9 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 - 1. Bell & Gossett, ITT.
 - 2. Armstrong.
 - 3. Taco.
 - 4. Or approved as equal.
- B. Valves: Straight pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.10 CIRCUIT BALANCING VALVES

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Taco.
 - 3. Armstrong.
 - 4. Illinois.
 - 5. HCI.
 - 6. Oventrop.
 - 7. Or approved as equal.
- B. Orifice principle by-pass circuit with direct reading gage, soldered or flanged piping connections for 125 psig (860 kPa) working pressure, with shut off valves, and drain and vent connections.
- C. Direct reading with insert Pitot tube, threaded coupling, for 150 psig working pressure, maximum 240 degrees F, 5 percent accuracy.
- D. 2 1/2 Inch and Larger: Cast iron, wafer type, orifice insert flow meter for 250 psig (1720 kPa) working pressure, with read-out valves equipped with integral check valves with gasketed caps. Provide butterfly valve with memory stop for balancing.
- E. 2 1/2 Inch and smaller: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.
- F. Provide manufacturer furnished molded insulated valve covers.

2.11 RELIEF VALVES

- A. Manufacturers:
 - 1. Bell & Gossett, ITT.
 - 2. Armstrong.
 - 3. Watts.
 - 4. Or approved as equal.
- B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.12 AIR SEPARATORS

- A. Manufacturers:
 - 1. Bell & Gossett, ITT.
 - 2. Armstrong.
 - 3. Taco.
 - 4. Or approved as equal.

- B. Steel, tested and stamped in accordance with ASME SEC 8-D; for 125 psig operating pressure, with integral galvanized steel strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.
- C. Furnish air separators of quantities and sizes indicated on the piping diagrams with tangential nozzles and stainless steel air collector tube with five thirty-seconds inches (5/32") diameter perforations and sixty-three percent (63%) open area designed to trap free air and direct it into the compression tank. The air separator shall be fitted with a NPT vent to the air separator. A NPT tapping shall be provided on the bottom of the air separator to facilitate periodic blowdown.
- D. The air separator shall also be equipped with a galvanized steel system strainer with three-sixteenth inches (3/16") diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. Models with system strainer are also equipped with a blowdown nozzle to facilitate removal of the strainer for periodic routine cleaning.
- E. The air separator must be designed, constructed and stamped for one hundred twenty-five (125) psig at three hundred fifty degrees (350°) F. in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with The National Board of Boiler and Pressure Vessel Inspectors. The air separators shall be painted with one shop coat of light gray air dry enamel.
- F. A manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.

2.13 EXPANSION TANKS AND ACCESSORIES

- A. Manufacturers:
 - 1. Bell & Gosset, ITT.
 - 2. Wessels.
 - 3. Amtrol.
 - 4. Taco.
 - 5. Or approved as equal.
- B. Pressurized expansion tank shall be of a vertical design with a heavy-duty replaceable bladder. The unit shall be constructed of a welded steel shell ASME rated and stamped for 125 PSIG, working pressure installations (where noted 200 or 250 PSI working pressure may be required). The unit shall have a replaceable type bladder constructed of a heavy duty Butyl rubber material. The bladder shall be capable of filling the entire inside volume of the tank. The bladder shall be fixed in place by a flange assembly and shall have a flexible internal sparging tube to minimize bladder failures. The unit shall have a flanged bladder connection for ease of bladder removal and service as well as a NPT system connection. The unit shall be fitted with lifting rings, a floor mounted skirt for vertical installation, a NPT drain plug, an a .302" – 32 charging valve (standard tire valve) connection to facilitate on-site charging of the tank to meet system requirements. The tank comes precharged from the factory at 12 PSIG, but must be field charged, in accordance with the manufacturer's installation manual, to the same pressure as the system's pressure fill valve is set to maintain, on the system.

PART 3 - EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

- A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping
- C. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Extend nipples to allow clearance from insulation.

- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, and where indicated on Drawings.
- B. Where large air quantities accumulate, provide enlarged air collection standpipes.
- C. Install manual air vents at system high points.
- D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide drain and hose connection with valve on strainer blow down connection.
- G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- I. Support pump fittings with floor mounted pipe and flange supports.
- J. Provide radiator valves on water inlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.
- K. Provide radiator-balancing valves on water outlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.
- L. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- M. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- N. Pipe relief valve outlet to nearest floor drain.
- O. Each vent line shall be individually run full size from equipment to exterior.

3.3 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting installed construction.
- B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line circulators.
2. Base mounted pumps.

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 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
3. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties installed in hydronic systems adjacent to pumps.
4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories Inc.:

1. UL 778 - Motor Operated Water Pumps.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

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

1.5 CLOSEOUT SUBMITTALS

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

- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

- C. Maintain one copy of each document on site.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 WARRANTY

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

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of mechanical seals for each pump.

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

2.1 IN-LINE CIRCULATORS

- A. Manufacturers:
 - 1. Bell & Gossett/ITT or owner approved equal.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig maximum working pressure.
- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Stamped brass or cast bronze, keyed to shaft.
- E. Bearings: Two, oil lubricated bronze sleeves.
- F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- G. Seal: Carbon rotating against a stationary ceramic seat, 250 degrees F maximum continuous operating temperature.
- H. Drive: Drop out type flexible coupling.

2.2 BASE MOUNTED PUMPS

- A. Manufacturers:
 - 1. Bell & Gossett/ITT or owner approved equal.
- B. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 175 psig maximum working pressure.
- C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed to shaft.
- E. Bearings: Grease lubricated roller or ball bearings.
- F. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- G. Seal: Internally flushed, carbon rotating against a stationary ceramic seat, Buna-N fitted, 250 degrees F maximum continuous operating temperature.
- H. Drive: Drop out type flexible coupling with coupling guard.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

- B. Provide a minimum of five (5) pipe diameter of straight pipe between pump suction and an elbow or provide a suction diffuser. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Install flexible connectors at or near pumps and motorized equipment where piping configuration does not absorb vibration.
- D. Provide line sized shut-off valve, strainer, and combination pump discharge valve (triple duty valve) on pump discharge. Refer to pump detail on drawings.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals.
- G. Lubricate pumps before start-up.
- H. Provide side-stream filtration system for heating water systems. Install across pump with flow from pump discharge to pump suction from pump taps.
- I. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.
- J. Check, align, and certify alignment of base mounted pumps prior to start-up.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. System cleaner.
2. Closed system treatment equipment.
3. Chemicals.

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 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.

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

F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.4 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

C. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with State of Illinois standard for addition of non-potable chemicals to building systems and for discharge to public sewers.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience and with service facilities within 100 miles of Project with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish chemicals for treatment and testing during warranty period.

1.8 OPERATION AND MAINTENANCE DATA

- A. Refer to General Conditions, Division 1.
- B. Include data on all equipment, including spare parts lists, and products data and NSDS for all chemical treatments required.
- C. Include step by step instructions on testing procedures, including target concentrations.

1.9 MAINTENANCE SERVICE

- A. Provide service and maintenance of the water treatment systems, including chemical treatment products, for control of scale formation, corrosion, and microbiological growth in all treated systems from the date of start-up through the warranty period, or for a maximum of one (1) year, whichever comes first.
- B. Provide semi-annual technical service calls and perform field inspections including on-site water analysis of all treated systems. Detail findings in a written report, including chemical testing results and corrective actions needed.
- C. Provide laboratory and technical assistance for warranty period.
- D. Provide comprehensive operator training, including care, maintenance, testing and operation of water treatment systems.
- E. Provide on-site inspection of equipment during scheduled shutdowns to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

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

2.1 MANUFACTURES

- A. All items in this section shall be provided by a single water treatment firm and shall be Geen Industries, Inc., contact: Curt Geen or owner approved equal.

2.2 WATER TREATMENT EQUIPMENT

- A. Closed Recirculating Water Systems (Less than 20,000 gallons).
 - 1. Provide and install equipment for manual addition of chemical treatment and removal of suspended solids for each closed recirculating water system. Equipment shall consist of the following components:
 - a. Make-up Water Meter shall be cold water oscillating type rated for industrial use. Meter shall be of bronze construction with NPT union connections, standard register totalizing in gallons, maximum pressure rating of 150 psi, and maximum temperature rating of 110°F. Water Meter shall be installed in the make-up water piping to the system fitted with a three (3) valve by-pass.
 - b. By-Pass Feeder shall be five (5) gallon capacity, steel construction with maximum operating pressure of 300 psi at 200°F. By-pass feeder shall have 4" wide opening with cast iron, course thread, quick opening top closure, demountable leg extensions, and 3/4" NPT inlet, outlet and drain fittings. By-pass feeder shall be installed across the common discharge and suction piping of the recirculating pumps.
 - c. Cartridge Filter Vessel shall be 304 stainless steel construction with maximum operating pressure of 150 psi at 250°F. Filter vessel shall be split shell construction with 1-1/4" NPT inlet, outlet, bottom drain, and top vent fittings. Filter vessel shall be installed across the common discharge and suction piping of the recirculating pumps and shall be sized to filter the equivalent of the system water volume once every four (4) hours.
 - d. Filter cartridges shall be wound polypropylene media with a tin core, ten (10) micron rating, and a maximum temperature of 200° F sized to properly fit the filter vessel. Filter cartridges shall be furnished in a quantity sufficient for six (6) complete changes of the filter vessel. Filter cartridges shall be changed when the pressure drop across the filter vessel exceeds 20 psi, or as recommended by the water treatment contractor.
 - e. Corrosion coupon rack shall be preassembled, constructed of 1" NPT carbon steel pipe. Rack shall have four (4) 1" FPT openings for the mounting of corrosion test coupons and shall include a Flow Control for continuous flow regulation. Racks shall be installed between system supply and return piping.

2.3 CHEMICALS

- A. Refill all existing systems to the chemical concentration prior to construction.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type of water treatment and quantities of chemical treatment needed to maintain acceptable water quality

3.2 INSTALLATION

- A. Install water treatment equipment level and plumb. Maintain manufacturers recommended clearances. Arrange units so that controls and devices requiring servicing are accessible.
- B. All cleaning, flushing and chemical treatment shall be observed by the chemical treatment representative.
- C. Refill all existing systems to the chemical concentration prior to construction.
- D. Contractor shall drain, flush, fill, and vent piping systems.

3.3 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Confirm applicable electrical requirements for connecting electrical equipment. Power and control and interlock wiring materials and labor.

3.4 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components and equipment installation, including piping. Report results in writing.
- C. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before initiating water-treatment system.
- D. Prior to acceptance by the owner, all grease, dirt, oil and metallic oxides shall be removed from each closed recirculating water system. Mechanical contractor shall inform the water treatment contractor of all the system materials of construction to insure chemical cleaner compatibility. Supervision and cleaner shall be provided by Chemical Treatment Company. The following cleaning procedure shall apply:
- E. Closed Recirculating Water Systems Cleaning:
 - 1. The system shall be filled through a suitable water meter to determine total water volume, taking care to bleed all air.
 - 2. With the system circulating, flow will be verified throughout the system. All debris shall be flushed from the system and all strainers cleaned.
 - 3. H-O-H Water Technology C-312 Multi-Purpose Cleaner shall be added to the system at a dosage rate of twenty (20) gallons per one thousand (1,000) gallons of system volume. The chemical treatment contractor shall verify cleaner strength.
 - 4. Hot water systems shall be heated to 160-180°F and circulated for twenty-four (24) hours.

5. During the cleaning period, system water shall be circulated through the entire system. Mechanical contractor shall insure that all small orifices (control valves, strainers, etc.) remain free of debris. A side stream filter shall be used for removal of suspended solids during the cleaning period. Filter Media shall be changed as required.
 6. When cleaning period is complete, the system shall be drained and flushed with fresh water to remove the cleaning solution. Flushing shall continue until the total (M) alkalinity of the system water is within fifty (50) ppm of the total alkalinity of the make-up water.
 7. All strainers, dead legs, and areas of low flow shall be thoroughly flushed to remove accumulated debris.
 8. Immediately following completion and verification of flushing, certification records covering the cleaning shall be submitted to the mechanical contractor and the owner. Records shall include system volume, cleaner concentration, circulation time, and final alkalinity reading. Each system shall be chemically treated as provided elsewhere in this specification.
- F. Place water-treatment system into operation during the preliminary phase of systems' startup procedures.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-treatment systems and equipment.
- B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
- C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 Section "Operation and Maintenance Data."
- D. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 232500

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Double wall metal stacks.
2. Listed Special Gas Vent.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
2. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Device.
3. ANSI Z21.68 - Thematically Actuated Automatic Vent Damper Devices.

B. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. 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.
5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.
6. ASTM A 959 – Type AL29-4C Vent

C. National Fire Protection Association:

1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.
3. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - Guide for Steel Stack Construction.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.
2. UL 127 - Factory-Built Fireplaces.
3. UL 378 - Draft Equipment.
4. UL 441 - Gas Vents.
5. UL 641 - Type L Low-Temperature Venting Systems.
6. UL 959 - Medium Heat Appliance Factory Built Chimneys.

1.3 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Smoke Pipe: Round, single wall vent connector.
- D. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- E. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittals procedures.
- B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations.
- C. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- D. Natural draft appliances complying with NFPA 211 and UL listed and labeled.

1.5 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.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain water integrity of roof during and after installation of chimney or vent.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 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

2.1 DOUBLE WALL METAL STACK

- A. Manufacturers:
 - 1. Selkirk - Metalbestos.
 - 2. Ampco.
 - 3. Metalfab.
 - 4. Van Packer.
 - 5. Schebler.
 - 6. Or approved as equal.
- B. Provide double wall positive pressure type metal stacks, tested to UL 103, and UL 641, for use with building heating equipment, in compliance with NFPA 211.
- C. Fabricate with 1 inch minimum air space between walls. Construct inner jacket of 20 gage ASTM A167 Type 304 stainless steel. Construct outer jacket within the building of aluminum coated steel and outside the building of Type 304 stainless steel outer jacket to be 24 gage for sizes 10 inches to 24 inches and 20 gage for sizes 28 inches to 48 inches.
- D. Accessories, UL labeled:
 - 1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
 - 2. Stack Cap: Consists of conical rain shield with inverted cone for partial rain protection with low flow resistance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install concrete inserts for support of breeching, chimneys, and stacks in coordination with formwork.

3.2 INSTALLATION

- A. Install in accordance with NFPA 54, NFPA 31, and SMACNA Guide for Steel Stack Construction.
- B. Install breeching with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- C. Support breeching from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breeching, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

- D. Pitch breeching with positive slope up from fuel-fired equipment to chimney or stack.
- E. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement.
- F. Level and plumb chimney and stacks.
- G. Clean breeching, chimneys, and stacks during installation, removing dust and debris.
- H. Install slip joints allowing removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.

END OF SECTION 235100

SECTION 235236 - FLEXIBLE WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Boilers.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 22 11 00 - Facility Water Distribution: Execution requirements for cold water piping connections to boilers specified in this section.
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 11 23 - Facility Natural-Gas Piping: Execution requirements for natural gas piping connections to boilers specified in this section.
5. Section 23 21 13 - Hydronic Piping: Execution requirements for hot water piping for piping connections to boilers specified in this section.
6. Section 23 51 00 - Breechings, Chimneys, and Stacks: Execution requirements for breeching, chimney, and stack connections to boilers specified in this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to boilers specified in this section.

1.2 REFERENCES

A. American Gas Association:

1. AGA - Directory of Certified Appliances and Accessories.
2. AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.

B. American Society of Mechanical Engineers:

1. ASME SEC 1 - Boiler and Pressure Vessel Codes - Rules for Construction of Power Boilers.
2. ASME SEC 4 - Boiler and Pressure Vessel Codes - Rules for Construction of Heating Boilers.
3. ASME SEC 8D - Boiler and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.

C. Hydronics Institute:

1. HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.

1.3 SUBMITTALS FOR REVIEW

- A. Section 01 30 00 - Submittals: Procedures for submittals.
- B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
- C. Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.
- D. Manufacturer's Field Reports: Indicate specified performance and efficiency has been met or exceeded. Provide combustion test which shall include boiler firing rate, over fire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALIFICATIONS

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

1.6 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 code for internal wiring of factory wired equipment.
- B. Conform to ASME for construction of boilers.
- C. Units: AGA certified.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- E. Conform to Health/Life Safety Code for Public Schools.
- F. Conform to (IMC) International Mechanical Code. (2015)
- G. Conform to (IBC) International Building Code. (2015)
- H. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- I. Conform to State of Illinois Plumbing Code. (2014)
- J. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- K. Conform to (IECC) International Energy Conservation Code. (2015)
- L. Conform to (IFGC) International Fuel Gas Code. (2015)
- M. Conform to (IPMC) International Property Maintenance Code. (2015)

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

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Section 01 60 00 - Material and Equipment: Transport, handle, store, and protect products.
- B. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.8 WARRANTY

- A. Section 01 70 00 - Contract Closeout.
- B. Provide a two year full parts and labor warranty from date of startup.
- C. Provide a five year warranty to include coverage for heat exchanger.
- D. Provide a 25 year warranty against thermal shock damage. Warranty shall be non-prorated.

PART 2 - PRODUCTS

2.1 BOILERS

- A. Manufacturers:
 - 1. Bryan.
 - 2. Unilux.
 - 3. Parker.
 - 4. Or approved as equal.
- B. Manufactured Units:
 - 1. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
 - 2. Unit: Steel membrane wall water tube boiler on integral structural steel frame base with integral forced draft burner, burner controls, boiler trim, insulation, and jacket.
- C. Boiler Shell:
 - 1. Construct applicable ASME Boiler and Pressure Vessels Code for a maximum allowable working pressure of 160 psi water. Boiler shall be constructed with adequately sized upper drums, water legs and tube headers provide proper thermal internal water circulation.
 - 2. Provide two lifting eyes on top of boiler.
 - 3. Provide adequate tappings, observation ports, removable panels and access doors for entry, cleaning, and inspection.
 - 4. Insulate casing with readily removable 1 1/2 inch glass fiber blanket insulation covered by sectional performed rust resistant coating metal jacket.
 - 5. Factory paint boiler, base, and other components with hard finish silicone enamel.
 - 6. Water tubes are to be 1 inch O.D., 12 gauge steel, 6 pass flexible serpentine bends, not subject to thermal shock.
 - 7. Individual water tubes shall be easily removable and replaceable without either welding or rolling.
 - 8. Boiler shall have not less than 7 sq. ft. of fireside heating surface per boiler horse power.

9. Provide boiler with adequate service access to fit into room as shown on the drawings.
10. Downcomers shall be insulated and jacketed at factory prior to shipment.

D. Hot Water Boiler Trim:

1. Low Water Cut-off: Probe type with manual reset to automatically prevent burner operation whenever boiler water falls below safe level. Switch shall include test switch and lights to indicate function status.
2. Temperature Controls:
 - a. Honeywell operating and high limit (manual reset) aquastats.
 - b. Siemens immersion type water temperature sensor (RTD) to send signal back to Siemens RWF-40 single loop PID controller that is flush mounted in burner control panel.
3. Pressure Control: Fixed setting type shall control burner to ensure minimum operating pressure does not to exceed relief valve setting.
4. Two (2) full sized ASME rated 60# pressure relief valves.
5. Combination pressure and thermometer gage.

E. Fuel Burning System:

1. Acceptable Manufacturer:
 - a. Power Flame.
 - b. Riello.
 - c. Or approved as equal.
2. General: Forced draft automatic burner integral with front head of boiler designed to burn natural gas and maintain fuel-air ratios automatically.
 - a. Blower: Statically and dynamically balanced to supply combustion air; direct connected to motor.
 - b. The burner air louvers and gas butterfly valve shall be operated independently by individual servo motors controlling both fuel and air supply. The fuel/air control system shall assure burner starts in the low fire position. Burner shall have an auto/manual switch to allow for manual control (override) of the burner firing rate
3. Gas Burner: Forced draft, high radiant multi-port power burner with electric ignition modulating with low fire ignition position.
 - a. Natural Gas Burner Piping: Include on unit complete gas train including high and low gas pressure switches, plug valve, and gas pressure regulator. Gas pressure gauge dual motorized safety gas valves, two manually operated lubricated gas cocks. 1/4" leak test cock.
 - b. Pilot Gas Train: Include on unit pilot gas train including gas pilot regulator solenoid safety gas valve and 3/8" lubricated plug shut off cock.
4. Burner and Controls shall meet UL, FM and CSD-1 code requirements.
5. Available gas pressure shall be verified by the boiler/burner representative prior to ordering the equipment. Gas train and regulators shall be provided to meet the job requirements.
6. Boiler/burner unit shall be supplied for single point electrical connection.
7. Fuel/air ratio control of boilers shall be full modulation with proven low fire start.

F. Burner Controls:

1. Manufacturer:
 - a. Honeywell Flame Safeguard & Fuel Air Controller: RM7800 with S7800 Display Module, S7830 Annunciator, R7999A Controller, and S7999B set up display or combination flame safeguard / fuel-air control system equal to Siemens Model LMV complete with Siemens AZL Display and Siemens RWF40 load controller.

- b. Or approved as equal.
2. System shall be microprocessor based burner management control system with self-diagnostics, non-volatile memory center to provide the operator with status and failure mode information.
3. It shall be designed to provide the proper burner sequencing, ignition and flame monitoring protection on automatically ignited gas burners. In conjunction with limit and operating controls, it shall program the burner/blower motor, ignition and fuel valves to provide for proper and safe burner operation. On a safety shutdown, it shall advise the operator that the control is in “lockout”. All diagnostic functions shall be available to BAS via a Modbus interface (verify with BAS contractor). It shall be designed to provide the proper burner sequencing, ignition and flame monitoring protection on automatically ignited gas burners. In conjunction with limit and operating controls, it shall program the burner/blower motor, ignition and fuel valves to provide for proper and safe burner operation. On a safety shutdown, the message center shall advise the operator that the control is in “lockout” and scroll a message indicating the cause as well as the position in the sequence it occurred.
4. Control shall have complete versatility in selection of control function, timing and flame scanning means. Functions such as pre-purge timing, recycling interlocks, high fire proving interlock and trial for ignition timing of the pilot and main flame determined by the programmer module. The system shall be able to be used with ultraviolet flame scanner.
5. The wiring base shall allow for many functional circuits including motors, valves and ignition transformers as well as multiple interlocks such as hi-purge, low purge, fuel valve and running circuits.

G. Burner Control Panel:

1. A factory pre-wired control panel shall be supplied on each boiler-burner unit. The burner panel will have a handle and dust gasket seal. The panel shall house the fuel/air flame safeguard control, main start switch, burner motor starter, step down transformer, fuses, terminal strip, relays and lamps.
2. Provide five indicating lights on each panel: Power on, Call for heat, ignition on, fuel valve open, and alarm. Provide a 4 inch alarm bell with silencing acknowledgment switch to ring on flame failure, limit failure or low water condition.
3. Dry contacts shall be provided for remote enable/disable. Dry contacts will be provided to send boiler alarm condition to boiler sequencing panel or BAS.
4. Provide a remote/local switch on each burner control panel. When in remote position the burner will be controlled by a 4-20ma input signal it receives from BAS. When switch is in the “Local” position the burners will operate off their own boiler controls completely independent of BAS or independent sequencing panel.
5. Provide relay and dry contract for combustion air damper interlock.
6. Electric Supply: Primary power shall be as scheduled, manufacturer to provide step down transformer for 120v/60 controls circuit and control shall be 120/60/1 phase.
7. Provide a digital display showing current boiler water temperature and set point. This display shall be flush mounted in the burner control panel door. A 4-20ma temperature sensor shall be supplied on boiler supply to send signal to this display.

H. Manufacturer’s Field Services:

1. The boiler manufacturer’s representative, upon completion and start-up of the system shall submit to the Owner a written certified report that the installation of the complete system is in accordance with the specifications and the system is in proper operating condition. The report shall include at least the following:
 - a. Stack temperature - high, medium and low fire.
 - b. CO₂ reading of the flue gas - high, medium, and low fire with combustion efficiency being a minimum of 85%.
 - c. Draft read.
 - d. Voltage output of flame scanner.
 - e. Operationally check for safety low water cutoff and all operating and limit controls as specified on boiler.
 - f. Operationally simulate pilot and main flame failure to check electronic flame safeguard control.

- g. Record set-point readings of all aquastats and controls.
 - 2. The certified report shall include, but shall not be limited to the operational checking of the following:
 - a. All remote controlled boiler booster pumps for both automatic and manual operation.
 - b. Any other controls not herein specified that directly affect the operation and performance of equipment supplied under this section.
 - 3. Owner Training: At the completion of the project, the manufacturer shall provide training of Owner’s staff. Training shall consist of two parts.
 - a. Part one will be a classroom situation which describes the equipment’s operation, maintenance and repair requirements.
 - b. Part two will be on site (hands-on) training which will show the location of all devices and the operation of all controls, devices, motors, etc. Prior to commencement of training, Contractor shall provide Engineer with a schedule of dates, times and agenda for each training session.
- I. Spare Parts:
 - 1. Boiler manufacturer shall provide one spare boiler tube for each different tube configuration used in each boiler. Boiler tubes shall be supplied to the Owner at time of tube removal and replacement demonstration.
 - 2. Provide one can of factory spray paint for contractors use to touch up boiler jacket.
- J. Source Quality Control:
 - 1. Provide testing and analysis of units.
 - 2. Provide factory tests to check construction, controls, and operation of unit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Provide connection of natural gas service in accordance with NFPA 54.
- D. Provide piping connections and accessories as indicated; refer to Section 23 11 23.
- E. Provide piping connections and accessories as indicated; refer to Section 23 21 13.
- F. Pipe relief valves to nearest floor drain.
- G. Provide for connection to electrical service. Refer to Section 26 05 03.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer field representative for boiler and burner for starting unit, training operator, and testing unit.
- B. Tube removal demonstration should be performed during Owner training scheduled above.

END OF SECTION 235236

SECTION 239900 - VARIABLE FREQUENCY MOTOR CONTROLLER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes variable frequency controllers.
- B. Related Sections:
 - 1. Section 26 28 13 - Fuses.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.
 - 4. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions complying with NEMA ICS 7.1. Include procedures for starting and operating controllers, and describe operating limits possibly resulting in hazardous or unsafe conditions. Include routine preventive maintenance schedule.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Conform to NEMA ICS 7 service conditions during and after installation of variable frequency controllers.

1.8 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish three year manufacturer warranty for variable frequency controller.

1.9 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two of each air filter.

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

2.1 VARIABLE FREQUENCY MOTOR CONTROLLER

A. Manufacturers:

1. ABB.
2. Danfoss.
3. Or approved as equal.

B. Description:

1. Provide enclosed variable frequency drives suitable for operating the indicated loads.
2. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control.
3. The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
4. Input and output power circuit switching shall be able to be done without interlocks or damage to the VFD.
5. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 220% of rated current for up to 1 second while starting.

C. Ratings:

1. Rated Input Voltage: 208 or 460 volts, three phase, 60 Hertz, see drawings.
2. Motor Nameplate Voltage: 208 or 460 volts, three phase, 60 Hertz, see drawings.
3. Operating Ambient: 0 degrees C to 40 degrees C.
4. 0 to 95% relative humidity, non-condensing.
5. Elevation to 3,300 feet without derating.
6. AC line voltage variation, -10 to +10% of nominal with full output.
7. No side clearance shall be required for cooling of wall mount units and all power and control wiring shall be done from the bottom.
8. Drive shall be capable of operating a motor up to 1,000 feet away without derating or field modification.

D. Design:

1. VFD shall have an adjustable carrier frequency of 2 to 14 kHz through 60 HP.
2. Three variable-torque V/Hz patterns shall be provided with the ability to select a constant torque start pattern for each of them.
3. Adjustable acceleration and adjustable deceleration ramps shall be provided.
4. Four current limit settings shall be provided.
5. If VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: Undervoltage, overvoltage, current limit, inverter overload and motor overload.
6. The number of restart attempts shall be selectable from 0 through 10 and the time between attempts shall be adjustable from 0 through 10 seconds.
7. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive, so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

E. Product Options and Features:

1. Local/Hand, Stop/Reset and Remote/Auto selector switches shall be provided to start and stop the drive and determine the speed reference.
2. Provide a 24 V DC, 40 mA max, output signal to indicate that the drive is in Remote/Auto mode.
3. Digital manual speed control.
4. Lockable, alphanumeric backlit display keypad.
5. A red FAULT light and a green POWER-ON light shall be provided.
6. The drive shall be fitted with an RS 485 serial communications port and be supplied with software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings as well as storage of each controller's operating and setup parameters.
7. Two set point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set points and make various control decisions. If drive is not available with 2 set point control, a separate set point controller shall be provided for supply/return fan tracking control.
8. An elapsed time meter and kWh meter shall be provided.
9. The following displays shall be accessible from the control panel in actual units: Reference Signal Percent, Output Frequency, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature (% until trip) and Motor Speed in engineering units per application in percent speed.
10. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
11. The VFD shall store in memory the last 8 faults and record all operational data.
12. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
13. Two programmable relay outputs shall be provided for remote indication of drive status.
14. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
15. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
16. Under fire mode conditions the VFD shall automatically default to a preset speed.
17. Class 20 I2 electronic motor overload protection for single motor applications and thermal mechanical overloads for multiple motor applications.
18. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
19. Protect VFD from sustained power or phase loss. The VFD shall incorporate a 5 second control power loss ride through to eliminate nuisance tripping.
20. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the starter.
21. The drive shall be fitted with output line reactors to limit the rate of output voltage rise over time (dV/dt), reduce motor operating temperature and RFI and EMI.
22. Drive shall catch a rotating motor operating forward or reverse up to full speed.
23. The VFD shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.

F. Fabrication:

1. Wiring Terminations: Match conductor materials and sizes indicated.
2. Enclosure: NEMA 250, Type 1.
3. Finish: Manufacturer's standard enamel.

G. Source Quality Control:

1. Inspect and production test each product specified in this section.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surface is suitable for controller installation.
- B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.2 INSTALLATION

- A. Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Install fuses in fusible switches.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Provide engraved plastic nameplates.
- F. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.3 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.4 ADJUSTING

- A. Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

3.5 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

3.6 WARRANTY

- A. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.

3.7 START-UP SERVICE

- A. Provide factory start-up service. Coordinate with the temperature control contractor.

END OF SECTION 239900

SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

PART 1 - GENERAL

1.1 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.

1.2 REFERENCES

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

1.3 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.

1.4 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.

1.5 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

2.1 CORD AND PLUGS

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Pass and Seymour.
 - 4. Or approved as equal.
- 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

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 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.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. 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 260503

SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 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.

1.2 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.

1.3 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Solid 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.

1.4 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Test Reports: Indicate procedures and values obtained.

1.6 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.

1.7 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.

1.8 QUALIFICATIONS

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

1.9 FIELD MEASUREMENTS

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

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- C. 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

2.1 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. Or approved as equal.
- 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.

2.2 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

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify interior of building has been protected from weather.
- C. Verify mechanical work likely to damage wire and cable has been completed.
- D. Verify raceway installation is complete and supported.

3.2 PREPARATION

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

3.3 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.

3.4 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.

3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 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.

1.3 SYSTEM DESCRIPTION

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

1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms maximum.

1.5 SUBMITTALS

- A. Section 01 33 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.

1.6 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.

1.7 QUALITY ASSURANCE

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

1.8 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.

1.9 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 mechanical damage, by storing in original packaging.
- D. 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 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

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

2.1 WIRE

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

2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Apache Grounding/Erico Inc.
 - 2. Copperweld, Inc.
 - 3. Erico, Inc.
 - 4. ILSCO Corporation.
 - 5. O-Z Gedney Co.
 - 6. Thomas & Betts, Electrical.
 - 7. Or approved as equal.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install in accordance with IEEE.
- B. Install rod electrodes at service locations. Install additional rod electrodes to achieve specified resistance to ground.
- C. Install grounding and bonding conductors concealed from view.
- D. Install grounding well pipe with cover at each rod location. Install well pipe top flush with finished grade.
- E. Install 4 AWG bare copper wire in foundation footing.
- F. Install grounding electrode conductor and connect to reinforcing steel in foundation footing. Electrically bond steel together.
- G. Bond together metal siding not attached to grounded structure; bond to ground.

- H. Bond together reinforcing steel and metal accessories in pool and fountain structures.
- I. Install isolated grounding conductor for circuits supplying network equipment and in accordance with IEEE 1100.
- J. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- K. Bond to lightning protection system.
- L. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- M. 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.
- N. 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.
- O. 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.
- P. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- Q. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground resistance testing in accordance with IEEE 142.
- E. Perform leakage current tests in accordance with NFPA 99.
- F. Perform continuity testing in accordance with IEEE 142.
- G. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.

1.2 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.

1.3 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.

1.4 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.

1.5 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.

1.6 SUBMITTALS

- A. Section 01 33 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.

1.7 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.

1.8 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.

1.9 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 mechanical 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.
- D. Provide ventilation in areas to receive solvent cured materials.

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

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. Electroline Manufacturing Company.
 - 3. O-Z Gedney Co.
 - 4. Or approved as equal.
- 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.

2.2 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. Or approved as equal.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

- A. Manufacturers:
 - 1. B-Line Systems.
 - 2. Erico, Inc.
 - 3. Thomas & Betts Corp.

4. Or approved as equal.

- B. Product Description: Mounting hole and screw closure.

2.4 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.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 1. Thunderline Link-Seal, Inc.
 2. NMP Corporation.
 3. Wiremold.
 4. Or approved as equal.
- 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.

2.6 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. Or approved as equal.
- 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.

2.7 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

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

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

3.9 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 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. 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.

1.3 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. Underground More than 5 feet outside Foundation Wall: Provide rigid steel conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Thin-wall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal or nonmetallic boxes.
- D. Under Slab on Grade: Provide rigid steel conduit. Thin-wall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast or nonmetallic metal boxes.
- E. Outdoor Locations, Above Grade: Provide rigid steel and aluminum conduit. Provide cast metal, pull, and junction boxes.

- F. In Slab above Grade: Provide rigid steel conduit and intermediate metal conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide sheet metal boxes.
- G. Wet and Damp Locations: Provide rigid steel and aluminum conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. 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.
- I. 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.

1.4 DESIGN REQUIREMENTS

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

1.5 SUBMITTALS

- A. Section 01 33 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.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

1.9 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

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Southwire Company.
 - 3. Wheatland Tube Company.
 - 4. Or approved as equal.
- 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.

2.2 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anamet Electrical.
 - 2. Electricflex Company.
 - 3. Southwire Company - Alfex.
 - 4. Or approved as equal.
- B. Product Description: Interlocked steel construction.
- C. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Anamet Electrical.
 - 2. Electricflex Company.
 - 3. Southwire Company - Alfex.
 - 4. Or approved as equal.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Southwire Company.
 - 3. Wheatland Tube Company.
 - 4. Or approved as equal.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, compression type.

2.5 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Cantex.
 - 2. Carlon-Lamson and Sessions.
 - 3. Petroflex.
 - 4. Or approved as equal.
- B. Product Description: NEMA TC 2; Schedule 40 and 80 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 SURFACE METAL RACEWAY

- A. Manufacturers:
 - 1. Wiremold Co. Model V700 Series.
 - 2. Hubbell.
 - 3. Or approved as equal.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: 21/32" x 3/4" 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.

2.7 WIREWAY

- A. Manufacturers:
 - 1. Circle AW.
 - 2. Hoffman.
 - 3. Square D Company.
 - 4. Or approved as equal.
- 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.

2.8 OUTLET BOXES

- A. Manufacturers:
 - 1. Appleton Electric.
 - 2. OZ Gedney.
 - 3. Raco.
 - 4. Red Dot.
 - 5. Thomas & Betts.
 - 6. Or approved as equal.
- 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.

2.9 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Appleton Electric.
 - 2. OZ Gedney.
 - 3. Raco.
 - 4. Red Dot.
 - 5. Thomas & Betts.
 - 6. Or approved as equal.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 27 16.

- D. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
 - 1. Material: Galvanized cast iron or Cast aluminum.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: "ELECTRIC".

- E. Fiberglass or Concrete composite Handholes: Die-molded, glass-fiber or concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
 - 2. Cover: Glass-fiber or concrete composite, weatherproof cover with nonskid finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 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.

3.3 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. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- R. 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.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. 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.
- X. Close ends and unused openings in wireway.

3.4 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.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- 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.

3.6 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

- A. Section 01 70 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 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 SUBMITTALS

A. Section 01 33 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.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

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

1.4 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

2.1 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.

2.2 LABELS

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

2.3 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.
- D. Conduit and Raceway Markers:
 - 1. Furnish materials in accordance with industry standards.
- E. Description: Labels fastened with adhesive or stencils.
- F. Color:
 - 1. 480 Volt System: Black lettering on white background.
 - 2. 208 Volt System: Black lettering on white background.
- G. Legend:
 - 1. Medium Voltage System: HIGH VOLTAGE.
 - 2. 480 Volt System: 480 VOLTS. HIGH VOLTAGE.
 - 3. 208 Volt System: 208 VOLTS.

2.4 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 Section 09 90 00, 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 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.
- F. Stencil Installation:
1. Apply stencil painting in accordance with Section 09 90 00.
- G. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 260553

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes main and distribution switchboards components.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 26 28 13 - Fuses.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C12.1 - Code for Electricity Metering.
 - 2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.
- B. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
 - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- C. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
 - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- D. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Record actual locations of switchboard in project record documents.

- C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

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

1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.7 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence Work to avoid interferences with building finishes and installation of other products.

1.8 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Material and Equipment: Transport, handle, store, and protect products.
- B. Deliver individually wrapped for protection and mounted on shipping skids.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.10 FIELD MEASUREMENTS

- A. Verify that field measurements are as required to suit installation.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS - EXISTING

- A. Manufacturers:
 - 1. District Standard: Square D, to match existing in every particular.
- B. Add new thermal-magnetic circuit breaker or fusible switch type branch circuit devices to existing distribution panelboards as required.
- C. All new devices shall be of the same manufacturer, type and interrupting capacity as the original equipment.
- D. Provide new nameplates upon completion of all wiring.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify surface is suitable for circuit breaker installation.

3.2 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- C. Install engraved plastic nameplates in accordance with Section 26 05 53.
- D. Install breaker circuit directory.
- E. Ground and bond switchboards in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust operating mechanisms for free mechanical movement.
- C. Tighten bolted bus connections.

- D. The contractor shall furnish short circuit and protective device coordination studies as prepared by Square D engineering services or approved equal. The scope of the studies shall include all new distribution equipment supplied under this contract. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fuses.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 DESIGN REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.
- B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

1.4 FUSE PERFORMANCE REQUIREMENTS

- A. Main Service Switches Larger than 600 amperes: Class L time delay.
- B. Main Service Switches: Class RK1 time delay.
- C. Power Load Feeder Switches Larger than 600 amperes: Class L time delay.
- D. Power Load Feeder Switches: Class RK1 time delay.
- E. Motor Load Feeder Switches: Class RK1 time delay.
- F. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay.
- G. Lighting Load Feeder Switches: Class RK1 time delay.
- H. Other Feeder Switches Larger than 600 amperes: Class L time delay.
- I. Other Feeder Switches: Class RK1 time delay.
- J. General Purpose Branch Circuits: Class RK1 time delay.
- K. Motor Branch Circuits: Class RK1 time delay.
- L. Lighting Branch Circuits: Class G.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.6 CLOSEOUT SUBMITTALS

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

- B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.7 QUALIFICATIONS

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

1.8 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two fuse pullers.

1.9 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish three spare fuses of each Class, size, and rating installed.

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

2.1 FUSES

- A. Manufacturers:
 - 1. Bussman.
 - 2. Littlefuse.
 - 3. Ferraz Shawmut.
 - 4. Or approved as equal.

- B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuse with label oriented so manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262819 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fusible and nonfusible switches.
- B. Related Sections:
 - 1. Section 26 28 13 - Fuses.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

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

1.6 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

2.1 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. District Standard:
 - a. Square D Company or owner approved equal.
- B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
- D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.
- E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- F. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. District Standard:
 - a. Square D Company or owner approved equal.
- B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.
- D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
- E. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.
- D. Install engraved plastic nameplates in accordance with Section 26 05 53.
- E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262819

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes manual and magnetic motor controllers in individual enclosures.
- B. Related Sections:
 - 1. Section 26 28 13 - Fuses.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - 4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
 - 6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations and ratings of enclosed controllers.
- C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.5 QUALIFICATIONS

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

1.6 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

2.1 MANUFACTURERS

- A. District Standard:
 - 1. Square D Company or owner approved equal.

2.2 MANUAL CONTROLLERS

- A. Manual Motor Controller: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller with overload element, red pilot light, and push button toggle operator.
- B. Fractional Horsepower Manual Controller: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.
- C. Enclosure: NEMA ICS 6; Type 1.

2.3 AUTOMATIC CONTROLLERS

- A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Two Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.
- C. Coil operating voltage: 120 volts, 60 Hertz.
- D. Overload Relay: NEMA ICS; bimetal.
- E. Enclosure: NEMA ICS 6, Type 1 unless indicated otherwise or required to suit location.

2.4 PRODUCT FEATURES FOR AUTOMATIC CONTROLLERS

- A. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 2, standard heavy duty type.
- C. Pilot Device Contacts: NEMA ICS 2, Form Z, rated A150.

- D. Indicating Lights: Neon type.
- E. Selector Switches: Rotary type hand-off-auto. Provide additional high/low push-button type switch for 2-speed motors.
- F. Control Power Transformers: 120 volt secondary, in each motor starter. Verify secondary voltage with building controls. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.5 DISCONNECTS

- A. Combination Controllers: Combine motor controllers with fusible switch disconnect in common enclosure.
- B. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.
- C. Fuse clips: Designed to accommodate Class R fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible switches. Refer to Section 26 28 13 for product requirements.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.
- F. Neatly type label and place inside each motor controller door identifying motor served nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 262913