
SECTION 220503 - PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:

1. Domestic water piping within 5 feet of building.
2. Domestic water piping, above grade.
3. Sanitary sewer and vent piping within 5 feet of building.
4. Sanitary sewer and vent piping, above grade.
5. Unions and flanges.
6. Underground pipe markers.
7. Bedding and cover materials.

B. Related Sections:

1. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
2. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
3. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
4. Section 31 23 17 - Trenching: Execution requirements for trenching for underground piping systems.
5. Section 31 23 23 - Fill: Execution requirements for backfilling required by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.3 - Malleable Iron Threaded Fittings.
3. ASME B16.4 - Gray Iron Threaded Fittings.
4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
9. ASME B31.9 - Building Services Piping.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
11. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
10. ASTM B75 - Standard Specification for Seamless Copper Tube.
11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
13. ASTM B302 - Standard Specification for Threadless Copper Pipe.
14. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
15. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
16. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
17. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Water Works Association:

1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

D. Cast Iron Soil Pipe Institute:

1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

1.3 SUBMITTALS

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

B. 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. Plumbing equipment.
5. Hangers and supports, including methods for building attachment, and vibration isolation.

C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

1.5 QUALIFICATIONS

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

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 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M, Grade B, Schedule 40 galvanized.
 - 1. Steel Fittings: ASME B16.9, wrought steel, butt welded.
 - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
 - 3. Joints: AWS D1.1, welded.
- B. Copper Tubing: ASTM B88, Type K annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- C. Copper Tubing: ASTM B42, hard drawn or annealed.
 - 1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

- A. (Pipe size 3/4" - 6") - Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, solder, Grade 95TA.
- B. (Pipe size 3/4" - 4") - Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Manufacturers:
 - a. Viega/Ridgid-Propress.
 - b. Nibco.
 - c. Apollo.
 - 2. Press Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze, O-rings for copper press fittings shall be EPDM.
 - 3. Joints: Pressed by crimping tool.

2.3 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

2.4 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

- C. Copper Tube: ASTM B306, DWV, ASTM B75, ASTM B88, ASTM B251, Type K, L or M.
 - 1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, 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.
- D. Copper Pipe: ASTM B42 and ASTM B302.
 - 1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 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.

2.5 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 joints.
 - 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.
- C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.
- D. Copper Press Connections:
 - 1. Manufacturers:
 - a. Viega.
 - b. Nibco.
 - c. Apollo.
 - 2. Press Fittings: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

2.6 UNDERGROUND PIPE MARKERS

- A. Furnish materials in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.
- B. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil. thick, manufactured for direct burial service.
- C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Domestic Water Service or Sewer Service" in large letters.

2.7 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type as specified in Section 31 05 16.
- B. Cover: Fill Type as specified in Section 31 05 16.

- C. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Section 31 05 13.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

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.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system size, location, and invert as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 5 ft of cover.
- C. Excavate pipe trench in accordance with Section 31 23 17.
- D. Install pipe to elevation as indicated on Drawings.
- E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install shutoff and drain valves at locations indicated on Drawings.
- J. Install plastic ribbon tape continuous over top of pipe. Buried 6 inches below finish grade, above pipe line; coordinate with Section 31 23 23 and 31 23 17. Refer to Section 22 05 53.
- K. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 31 23 23.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

- L. Install Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- C. Group piping whenever practical at common elevations.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- F. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- G. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.
- H. Slope piping and arrange systems to drain at low points.
- I. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- J. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- K. Install piping specialties in accordance with Section 23 21 16.
- L. Install pipe identification in accordance with Section 22 05 53.
- M. Plumbing contractor is responsible for all cutting and patching of existing walls/floor required to perform any new or demolition plumbing work.
- N. Press Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fittings and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
- O. PVC piping is not allowed in mechanical return plenum ceilings. Refer to mechanical drawings for locations of return plenum ceilings.
- P. All piping, fittings and joints shall comply with the Local Amendments and the Authority having Jurisdiction. Materials listed in specification that do not comply with these amendments shall not be used in the bidding process. It shall be the contractor's responsibility to verify these adopted amendments.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with ASME B31.9.
- B. Install Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

3.6 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install sanitary waste and vent piping systems in accordance with Section 22 13 00.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.
- E. Install Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with local authority having jurisdiction.
- C. Test sanitary waste and vent piping system in accordance with local authority having jurisdiction.
- D. Test storm drainage piping system in accordance with local authority having jurisdiction.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean and disinfect domestic water distribution system in accordance with Section 22 11 00.

END OF SECTION 220503

SECTION 220590 - TESTING OF PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Waste and Vent Piping.
 - 2. Domestic Water Piping.

1.2 REGULATORY REQUIREMENTS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. Before final acceptance of all piping system, all systems must be tested in accordance with the schedule and prove to be free of leaks.

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

3.2 TESTING MATERIAL

A. Testing Medium:

1. Hydrostatic Testing Medium: Clean Water.
2. Pneumatic Testing Medium: Clean compressed air.

B. Pressure Testing Gauges: ANSI B40.1, Grade AA; minimum 6 inch diameter dial with scale divisions equal or less than maximum allowable pressure drop.

3.3 TESTING SYSTEMS

A. Waste and Vent System Piping:

1. Test with water or air before fixtures are set.
2. After plumbing fixtures have been set and traps filled with water, subject entire waste and vent systems to final test with smoke or peppermint.
3. Water Test:
 - a. Apply to drainage and vent system in sections or in entirety dependent on size of system.
 - b. When entire system is tested, tightly close all openings in pipes except highest opening and fill system with water to overflow point.
 - c. When system is tested in sections, tightly plug each opening except highest opening, fill each section with water and test each section with minimum 10 foot head of water; test each preceding section until entire system has been tested with minimum 10 foot head of water, except uppermost 10 feet of system.
 - d. Keep water in system or in portion under test, for minimum 30 minutes before inspection.
 - e. System must be tight at all joints.
4. Air Test:
 - a. When tests are made with air, apply minimum 5 psi with force pump and maintain 1 hour with no leakage apparent.
 - b. Use mercury-column in making test.

B. Domestic Water System:

1. When rough-in is complete and before fixtures are set, test entire hot and cold water piping systems as scheduled and prove tight.
2. Where portion of water piping system is concealed before completion, test that portion separately as specified for entire system.

C. Hydrostatic and Pneumatic Testing Requirements:

1. Hydrostatic and pneumatic tests apply to piping indicate as scheduled is Paragraph D.
2. Pressure to be raised gradually to given value; then block off tight at source.
3. Allowable Pressure Drop: Maximum amount scheduled during corresponding minimum time interval.
 - a. Visually examine all joints during test.

4. Upon successful completion and test approval, relieve piping of pressure, drain, put into normal operation except for potable water to be sterilized before placing in service.

D. Hydrostatic and Pneumatic Testing Schedule:

	Normal Work Pressure <u>psig</u>	Hydrostatic Test Pressure <u>psig</u>	Pneumatic Test Pressure <u>psig</u>	Maximum Allowable Pressure Drop <u>psig</u>	Minimum Test Time <u>Hours</u>
1. <u>Service</u> Domestic Water:					
Potable Water	To 125	175	---	2	2

3.4 CLEANING AND ADJUSTING

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

END OF SECTION 220590

SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.

B. Related Sections:

1. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.

1.2 REFERENCES

A. American National Standards Institute:

1. NSF/ANSI Standard 61 – Low Lead & Lead Free Brass.
2. NSF/ANSI Standard 61, Annex F – Low Lead & Lead Free Brass.
3. NSF/ANSI Standard 61, Annex G – Low Lead & Lead Free Brass.
4. NSF/ANSI Standard 372 – Low Lead & Lead Free Brass.

B. American Society of Mechanical Engineers:

1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. American Society of Sanitary Engineering:

1. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
2. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.

1.3 SUBMITTALS

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

B. 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. Plumbing equipment.
5. Hangers and supports, including methods for building attachment, and vibration isolation.

C. Product Data:

1. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
2. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

- 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 valves and equipment.
- C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

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

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

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

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two loose keys for outside hose bibs.

1.12 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 HOSE-CONNECTION ANTI-SIPHON VACUUM BREAKERS (VB-1)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Woodford Manufacturing, model 34HD
 - 2. Watts Regulator; a Watts Water Technologies Company
 - 3. Zurn Industries, LLC
- B. Standard: ASSE 1011.
- C. Body: Brass, Stainless steel stop collar and stop screw.
- D. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- E. Finish: Chrome plated.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- B. Install Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.
- C. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

3.3 FIELD QUALITY CONTROL

- A. Test domestic water piping system in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Prior to starting work, verify system is complete, flushed and clean.
- C. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- D. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
- E. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
- H. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 221100

SECTION 221300 - FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleanouts.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
3. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
4. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
5. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
6. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
7. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.21.1 - Floor Drains.
2. ASME B31.9 - Building Services Piping.

1.3 SUBMITTALS

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

B. 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. Plumbing equipment.
5. Hangers and supports, including methods for building attachment, and vibration isolation.

C. Product Data:

1. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
2. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

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 equipment and clean-outs.
- C. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with Illinois Department of Public Health Plumbing Code, Current Edition and local jurisdiction amendments to Plumbing Code.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with sewage ejector service facilities within 100 miles of Project.
- 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 piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

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

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of pump seals.

1.12 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 CLEANOUTS

- A. Floor Cleanout (FCO-1):
 - 1. Manufacturers:
 - a. Mifab, Model C1220.
 - b. J.R. Smith.
 - c. Josam.
 - d. Watts.
 - e. Wade.
 - f. Zurn.
 - 2. Interior Finished Floor Areas (FCO-1): Lacquered cast iron, two piece body with double drainage flange, and heavy duty cast stainless steel scoriated combined cover/plug top assembly with stainless steel vandal proof allen key screws and primary gasket seal.
 - 3. Provide stainless steel square top in areas with quarry tile or ceramic tile.
 - 4. Provide secondary closure plug.
- B. Wall Cleanouts (WCO):
 - 1. Manufacturers:
 - a. Mifab, Model C1460-RD.
 - b. J.R. Smith.
 - c. Josam.
 - d. Watts.
 - e. Wade.
 - f. Zurn.
 - 2. Interior Finished Wall Areas: Line type with lacquered cast iron body and round brass gasketed plug and round stainless steel access cover secured with machine screw.

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. Remove scale and dirt, on inside and outside, before assembly.
- B. Prepare piping connections to equipment with flanges or unions.
- C. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Install floor cleanouts at elevation to accommodate finished floor or grade.
- D. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, flush valves, interior and exterior hose bibs.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION 221300

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

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

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 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 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.15.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.
- D. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 - 2. Voltage: 115/230 volts, single phase, 60 Hz.
- E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 THREE-PHASE MOTORS FURNISHED LOOSE

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

2.3 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 EXISTING WORK

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

END OF SECTION 230513

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

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

C. American Welding Society:

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

D. FM Global:

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

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

- F. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.
- G. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

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

1.5 PERFORMANCE REQUIREMENTS

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

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.

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

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.8 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 damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

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

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

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

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 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Unistrut.
 - 2. Grinnell.
 - 3. B-Line.
 - 4. Superior Valve Co.
 - 5. Or approved as equal.

B. Hydronic Piping:

1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

C. Refrigerant Piping:

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

2.2 HANGER RODS

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

2.3 INSERTS

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

2.4 FLASHING

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

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

2.5 EQUIPMENT CURBS

- A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, 1-1/2 inch thick insulation, factory installed wood nailer. **Curbs shall be minimum of 18" above high point of roof.**
- B. Curbs shall match the pitch of the roof.

2.6 SLEEVES

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

2.7 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
 - 3. 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.

2.8 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 minimum with holes 1-1/2 inches on center.

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

2.10 FIRESTOPPING ACCESSORIES

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

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 or damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Architect and Structural Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

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

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- B. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- C. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 21 05 48.

3.6 INSTALLATION - FLASHING

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

3.7 INSTALLATION - SLEEVES

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

3.8 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating to uniform density and texture.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Place intumescent coating in sufficient coats to achieve rating required.
- F. Remove dam material after firestopping material has cured.

G. Fire Rated Surface:

1. Seal opening at floor, wall, partition, and ceiling as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

H. Non-Rated Surfaces:

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

3.9 FIELD QUALITY CONTROL

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

3.10 CLEANING

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

3.11 PROTECTION OF FINISHED WORK

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

3.12 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

<u>Pipe Size Inches</u>	<u>Copper Tubing Maximum Hanger Spacing Feet</u>	<u>Steel Pipe Maximum Hanger Spacing Feet</u>	<u>Copper Tubing Hanger Rod Diameter Inches</u>	<u>Steel Pipe Hanger Rod Diameter Inches</u>
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8

B. Plastic Pipe Hanger Spacing:

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

END OF SECTION 230529

SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vibration isolators.
2. Duct silencers.

B. Related Sections:

1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
2. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.

1.2 REFERENCES

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

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

B. American National Standards Institute:

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

C. Air-Conditioning and Refrigeration Institute:

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

D. American Society of Heating, Refrigerating and:

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

E. ASTM International:

1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors':

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

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.
- E. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
- F. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- G. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- H. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 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 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.
- B. Furnish five year manufacturer warranty for inertia bases.

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 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Mason Industries.
 - 2. Amber Booth.
 - 3. Vibration Eliminator.
 - 4. Or approved as equal.
- B. Open Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

- C. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 - 5. Restraint: Furnish mounting frame and limit stops.
- D. Closed Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
- E. Restrained Closed Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
- F. Spring Hanger:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, rubber hanger with threaded insert.
 - 4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:

1. Rubber or neoprene-waffle pads.
 - a. 30 durometer.
 - b. Minimum 1/2 inch thick.
 - c. Maximum loading 40 psi.
 - d. Height of ribs: not to exceed 0.7 times width.
2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

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

2.2 MANUFACTURED DUCT SILENCERS

A. Manufacturers:

1. Industrial Acoustic Company.
2. Dynasonic.
3. Vibro-Acoustics.
4. Vibro-Acoustics West (VAW).
5. Price.
6. Or approved as equal.

B. Materials:

1. Type RD type silencers shall be constructed with a 22 gauge galvanized steel outer casing and 26 gauge galvanized perforated steel.
2. Type RED type silencers shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel.
3. HTL Casings: Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls equivalent to the duct wall thickness, externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

C. Constructions:

1. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed.
2. All casing seams and joints shall be lock-formed and sealed or stitch welded and sealed. All perforated steel shall have clean cut circular perforations and be adequately stiffened to assure flatness and form. All welds shall be painted.

D. Acoustic Media:

1. Media for type RD and RED dissipative silencers shall be of acoustic quality, shot free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient against media fracture and conforming to irregular surfaces. Media will not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

- E. Combustion Ratings:
1. Silencer materials shall have the following combustion ratings when tested in accordance with ASTM E84-03:
 2. Dissipative silencer materials, including glass fiber shall have maximum Flame spread Classification: 15; Smoke Development Rating: 5.
- F. Submittal package:
1. Shop drawings detailing all silencer data specified in the schedule. The data shall match the project's system requirements for volume and direction of airflow.
 2. Submittals shall include certified test data on dynamic insertion loss, self-noise power levels, and pressure drop for reverse or forward flow. Silencer manufacturer shall operate its own duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM E477-06a. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-06a test standard. A copy of the NVLAP accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted. Shop drawings submitted without proper certifications will be rejected.
 3. To provide, for approval, acoustical calculations for all systems with silencers to demonstrate that the resultant ductborne fan sound level, including airborne and breakout noise, in the occupied spaces meet NC-25
- G. Performance Guarantee
1. The noise control manufacturer shall guarantee the resultant noise level due to fan generated noise in the indoor occupied spaces not to exceed the specified noise criteria level (NC Level) according to the ASHRAE guidelines (Table 42 2007 ASHRAE Handbook –HVAC Applications):

Classroom:	NC30 to NC35
Office:	NC30 to NC35
Learning Center:	NC25 to NC30
 2. The noise control manufacturer shall guarantee the resultant noise level in the occupied spaces served by HVAC systems with silencers. If the noise level in the occupied spaces exceeds the specified noise criteria level, it will be the financial responsibility of the silencer manufacture to provide product and labor to achieve the specified criteria. The guarantee shall be based on the sound power levels of the “basis of design” air handling units. Additional noise control required as a result of the purchase of noisier air handling units will be the financial responsibility of the purchasing Contractor.
 3. The contribution of other noise sources, including but not limited to dampers, duct regenerated noise, diffusers and vibration is excluded from this guarantee. The total noise contribution from other sources other than the AHU's must be at least 5 dB below the specified noise criteria. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations.
 4. If products other than those of the basis of design manufacturer are supplied on the project, the purchasing Contractor assumes full performance, project schedule and monetary responsibility for meeting the project noise criteria, including any retrofit work that may be required.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 EXISTING WORK

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

3.3 INSTALLATION

- A. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.
- B. Install isolation for motor driven equipment.
- C. Adjust equipment level.
- D. Install spring hangers without binding.
- E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- G. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4 inch Diameter: First three points of support.
 - 2. 5 to 8 inch Diameter: First four points of support.
 - 3. 10 inch Diameter and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.
- H. Install silencers in accordance with manufacturer's instructions.
- I. Support duct silencers rigidly to ductwork.

3.4 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.
- B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.
- C. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

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

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- 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 three years documented experience.
- 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 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. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
 - 4. Or approved as equal.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags:
 - 1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags:
 - 1. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame or plastic laminated.

2.3 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Tape Pipe Markers:
 - 1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.4 LABELS

- A. Description: Aluminum Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Identify rooftop units, duct silencers exhaust fans, intake hoods, relief hoods. etc. with plastic nameplates. Small devices may be identified with tags.
- F. Identify control panels and major control components outside panels with plastic nameplates.
- G. Identify valves in main and branch piping with tags.
- H. Tag automatic controls, instruments, and relays. Key to control schematic.
- I. Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

3.3 VALVE CHART AND SCHEDULE

- A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location directed by owner.

END OF SECTION 230553

SECTION 230590 - TESTING OF PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Heating Hot Water Piping.
 - 2. Natural Gas Piping.
- B. Related Sections:
 - 1. Section 23 21 13 - Hydronic Piping.

1.2 REGULATORY REQUIREMENTS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

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

3.2 TESTING MATERIAL

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

3.3 TESTING SYSTEMS

- A. Hydrostatic and Pneumatic Testing Requirements:
 - 1. Hydrostatic and pneumatic tests apply to piping indicated as scheduled in Paragraph B.
 - 2. Pressure to be raised gradually to given value; then block off tight at source.
 - 3. Allowable Pressure Drop: Maximum amount scheduled during corresponding minimum time interval.
 - a. Visually examine all joints during test.
 - 4. Upon successful completion and test approval, relieve piping of pressure, drain, put into normal operation except for potable water to be sterilized before placing in service.
- B. Hydrostatic and Pneumatic Testing Schedule:

	Normal Work Pressure <u>psig</u>	Hydrostatic Test Pressure <u>psig</u>	Pneumatic Test Pressure <u>psig</u>	Maximum Allowable Pressure Drop <u>psig</u>	Minimum Test Time <u>Hours</u>
1. <u>Service</u> Heating Systems:					
Heating Water	To 100	150	---	2	2
2. Fuel:					
Natural Gas	To 25	---	100	0	8

3.4 CLEANING AND ADJUSTING

- A. Cleaning: Thoroughly clean all parts of the piping installation at completion of work.
 - 1. Remove grease, metal cutting and sludge form all equipment, pipes, valves all fittings.
 - 2. Repair all stoppages, discoloration or other damage to finish, furnishings or parts of building that are due to Contractor’s failure to properly clean piping system.

B. Adjusting:

1. Adjust flush valves and other parts of work for quiet operation.
2. Adjust control devices for proper operation.
3. Demonstrate to Architect/Engineer satisfactory operation following adjustment.
4. Readjust or replace all items not functioning properly.

END OF SECTION 230590

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic and refrigerating systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

B. Related Sections:

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

1.2 REFERENCES

A. Associated Air Balance Council:

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

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

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

C. Natural Environmental Balancing Bureau:

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

1.3 SUBMITTALS

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

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

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

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

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

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

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

1.4 ACCEPTABLE BALANCING CONTRACTORS

- A. Aero Test and Balance.
- B. Mechanical Test and Balance.
- C. Superior Test and Balance.
- D. Professional System Analysis.
- E. Airdronic.
- F. International.
- G. Or approved as equal.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

1.7 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum five years documented experience certified by AABC or Certified by NEBB.

1.8 SEQUENCING

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

1.9 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Schedule and provide assistance in final adjustment and test of life safety and smoke evacuation system with Fire Authority.

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 (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.

3.2 PREPARATION

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

3.3 INSTALLATION TOLERANCES

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

3.4 ADJUSTING

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

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main supply, return and exhaust ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- O. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Rooftop Units.
 - 2. Exhaust fans.
 - 3. Air Coils.
 - 4. Terminal Heat Transfer Units.
 - 5. Fans.
 - 6. Air Filters.
 - 7. Air Inlets and Outlets.
 - 8. Intake/Relief Hoods.
 - 9. Rooftop Units.

B. Report Forms

1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual

- g. Leaving air WB temperature, design and actual
 - h. Entering air WB temperature, design and actual
 - i. Leaving air DB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual
7. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
8. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
9. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
10. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow

- f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
11. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
12. Combustion Test:
- a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft
 - f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input
 - k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air
 - p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output

END OF SECTION 230593

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

2.7 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 **Niagara 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 rooftop units, exhaust fans, radiation, 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. Rooftop Units.
 - b. Exhaust fans.
 - c. Hot Water Finned Tube Radiation.
 - d. Occupancy Sensor.
 - 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 PACKAGED CV, ROOFTOP UNITS (MES.RTU-1, MES.RTU-2, MES.RTU-3, MES.RTU-4)

- A. Controllers shall be provided by the RTU manufacturer and interface with the new BAS.
- B. Supply Fan Control:
 - 1. The start/stop times for the supply and return fans shall be based on an operator defined occupancy schedule.
 - 2. Incorporated into the occupancy schedule will be optimum start and warm-up flags. These flags shall be used to start the system before occupancy in order to achieve temperature setpoints by defined occupancy times.
 - 3. A night setback flag shall be used to start the fans during unoccupied times when space temperature falls below heating setpoint in winter and rises above cooling setpoint in summer.
 - 4. An operator defined special events schedule shall start and stop the fans for times other than normal occupancy.
 - 5. The fans shall shut down through a hardwire interlock if the low limit stat trips.

6. Upon fan start-up/shut down, unit VFD shall provide a soft start/stop, increasing/decreasing to the required design occupied speed.
 7. CO2 sensor for demand control ventilation operation.
- C. Exhaust Fan VFD Control:
1. The exhaust fan shall modulate to maintain a positive building pressure (0.05 to 0.1” w.c. adj.).
- D. Mixed Air Damper Control:
1. The mixed air dampers shall modulate to maintain the mixed air temperature setpoint if all of the following are true.
 - a. The system is occupied.
 - b. Proof of fan status.
 - c. The low limit stat is off.
 - d. The outside air enthalpy is less than the return enthalpy.
 - e. The return air temperature is above 65°F (adj.).
 2. If the outside air enthalpy is greater than the return, the mixed air dampers shall go to a minimum outside air position.
 3. The mixed air dampers shall go to the 100% closed to outside air if the return air temperature falls below 65°F (adj.).
 4. If the fan fails to prove status or if any of the safeties trip, the mixed air dampers shall go to 100% closed to outside air.
 5. Provide demand controlled ventilation when not in economizer mode.
 6. The outside air damper shall be 100% closed and the return damper shall be 100% open during unoccupied times and morning warm-up.
- E. Economizer Dampers: Economizer dampers shall be enabled to provide free cooling when the outside air temperature is below the dry bulb economizer set point.
1. Economizer Available: Economizer dampers shall modulate subject to a mixed air low limit of 40 degrees F. (adj.).
 2. If the CO2 levels are below the recommended ASHRAE Standards while the dampers are at minimum positions, the outside air dampers shall modulate **below** the schedule minimum position to save operational costs while maintain acceptable CO2 levels.
 3. At no time shall the outside air dampers go above the minimum setting unless the outside air conditions are appropriate for economizer operation.
- F. ‘DX’ Cooling Section:
1. The section shall stage and modulate (between 10% and 100%) to maintain the discharge air temperature setpoint if the following is true:
 - a. Proof of fan status.
 - b. Discharge air temperature is above setpoint minus deadband.
 - c. Outside air temperature is greater than the discharge air temperature (indicating that economizer cooling is not available).
 - d. Provide discharge air reset based on return space temperatures.
 2. The cooling section shall be off whenever the system is in the heating mode.
- G. Gas Heating:
1. The unit shall modulate the gas heat between 6% and 100% to maintain discharge air temperature setpoint commanded from the BAS.
 2. The gas furnace shall be off whenever the system is in the cooling mode.
 3. If CO sensor senses any levels of carbon monoxide, the heating section shall shut down and BAS goes into alarm.

- H. Smoke Detectors:
 - 1. Upon sensing the products of combustion, the smoke detector shall signal the DDC to de-energize the unit (smoke detectors provided by the electrical contractor).
- I. Summer Unoccupied Operation (by BAS schedule):
 - 1. Fans shall be off and O.A. damper closed.
- J. Winter Unoccupied Operation (by BAS schedule):
 - 1. Fans shall be off.
 - 2. If room temperature sensor senses a temperature below the night setback temperature setpoint, system shall start in “warm-up” cycle the fan and furnace until such time as thermostat is satisfied with outside air damper closed.
- K. Emergency Modes: Provide a special system shut-down mode and an outside air damper closure mode per the school district standards.
- L. Input/Output Schedule. (Minimum points required. Space sensors to be flat plate stainless steel.):

	<u>Description</u>	<u>Signal</u>
1.	Map all required points selected by contractor	--
2.	Room temperature	AI
3.	Return air temperature	AI
4.	Mixed air temperature	AI
5.	Discharge air temperature	AI
6.	Return air humidity	AI
7.	Outside air humidity	AI
8.	Supply fan status	DI
9.	Exhaust fan status	DI
10.	Low temperature alarm	DI
11.	Supply duct high static pressure alarm	DI
12.	Supply duct smoke detector	DI
13.	Supply fan VFD status	DI
14.	Exhaust fan VFD status	DI
15.	Supply fan start/stop	DO
16.	Exhaust fan start/stop	DO
17.	Supply fan VFD control	AO
18.	Exhaust fan VFD control	AO
19.	Mixed air control	AO
20.	Heat enable	DO
21.	Discharge air setpoint	AO
22.	Cooling enable	DO
23.	Filter status	DI
24.	Economizer status on/off	DO (from BAS)
25.	Special system shutdown	DO (from BAS)
26.	Special system O.A. damper closure	DO (from BAS)
27.	Return air CO2 level	AI
28.	CO	AI
29.	Graphic Display	--
30.	Graphic Display	--

3.3 MISCELLANEOUS EXHAUST FAN CONTROL

- A. Exhaust fans shall be furnished with a gravity backdraft dampers by the manufacturer. If required by the energy code, the BAS Contractor shall be responsible providing a motorized backdraft damper and field wiring the damper motors to the exhaust fan motors.

- B. Some exhaust fans will have local on/off switch or timer switch with indicator light furnished and installed by this BAS Contractor.
- C. Thermostatically controlled fans will not be controlled by the BAS system but BAS Contractor will provide a line or low voltage thermostat (reverse-acting type).
- D. BAS system will show status (on/off) of all exhaust fans installed through a current sensing relay on each fan. Issue a non-critical alarm on failure.
- E. Refer to exhaust fan schedule on contract documents for control requirements.
- F. Interlock associated intake or exhaust air damper with exhaust fan. Remove/replace damper operator.
- G. Control toilet exhaust fan(s) with occupancy sensors and local light switch.

3.4 EXISTING FINNED TUBE RADIATION AND CONVECTORS

- A. All existing finned tube radiation shall be controlled by new DDC control valves (see plans) to be controlled by a BAS room sensor which shall modulate the normally open control valve to maintain room setpoint.
- B. Input/Output Schedule (minimum points required):

	<u>Description</u>	<u>Signal</u>
1.	Control valve	AO
2.	Room temperature	AI
3.	Room setpoint (65°F adj.)	AI
4.	Graphic Display	--

3.5 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. RTUs

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 vent protector.

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 1/8" NPT Outdoor Vent Protector 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 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
2. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
4. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in 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-Propress.
 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. Air vents.
2. Flow controls.

B. Related Sections:

1. Section 23 21 13 - Hydronic Piping: 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 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.

2.2 CIRCUIT BALANCING VALVES

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Taco.
 - 3. Armstrong.
 - 4. Illinois.
 - 5. HCI.
 - 6. Oventrop.
 - 7. Or approved as equal.
- B. Multi-turn, 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.

PART 3 - EXECUTION

3.1 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 radiator valves on water inlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.
- F. Provide radiator-balancing valves on water outlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.

3.2 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 233100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duct materials.
2. Insulated flexible ducts.
3. Ductwork fabrication.
4. Single wall spiral round ducts.
5. Double wall insulated acoustical spiral ductwork.

B. Related Sections:

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

1.2 REFERENCES

A. ASTM International:

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

B. National Fire Protection Association:

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

C. Sheet Metal and Air Conditioning Contractors:

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

- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications and sizes in plain view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire rated and other walls.
 - 7. Terminal unit and coil installations.
 - 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Product Data: Submit data for duct materials and duct liner.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- E. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

1.7 ENVIRONMENTAL REQUIREMENTS

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

1.8 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 MATERIALS

- A. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of in conformance with ASTM A90.
- B. Aluminum Sheets: Comply with ASTM B209 alloy 3003-414, with mill finish for concealed ducts, and standard, one-sided bright finish for duct surfaces exposed to view.
- C. Stainless Steel Ducts: Minimum 18 gauge, 316 stainless steel with welded seams. The installation shall conform to SMACNA round industrial duct construction standards for duct supports and reinforcement using stainless steel material.

2.2 MANUFACTURED DUCTWORK

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Insulated Flexible Ducts:
 - 1. Manufacturers:
 - a. Flex-Master.
 - b. Therma Flex.
 - c. Techna Flex.
 - d. Or approved as equal.
 - 2. Underwriters Laboratory Standard 181; Class 1.

3. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
4. Pressure Rating: 10 inches w.g. positive and 1.0 inches w.g. negative.
5. Maximum Velocity: 4000 fpm.

2.3 DUCTWORK FABRICATION

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

2.4 SINGLE WALL SPIRAL DUCTWORK

- A. General:
 1. The duct system shall consist of fittings that are factory fitted with a sealing gasket. The spiral duct fitting will seal the duct joints without the use of duct sealer.
- B. Materials:
 1. Unless otherwise noted, all duct and fittings shall be G-90 galvanized steel in accordance with ASTM A-653 and A-924.
- C. Construction:
 1. Fittings:
 - a. All fitting ends shall come factory equipped with a EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
 - b. All fittings shall be furnished with gasket on the outer shell.
 - c. All fittings ends shall be calibrated to manufacturer's published dimensional tolerance standard.
 - d. All fitting ends O.D. shall have rolled over edges for added strength and rigidity during installation and shipping.
 - e. Transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.
 - f. When contract documents require divided flow fittings, only full body fittings will be accepted. Saddle taps are unacceptable.
 2. Spiral Duct:
 - a. Spiral duct shall be calibrated to manufacturer's published dimensional tolerance standard.
 - b. All spiral duct 12" Dia. and larger shall be corrugated for added strength and rigidity. The duct will be of spiral lockseam construction.
 - c. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
 - d. When gasket or flanges are not acceptable the duct shall be welded construction.

2.5 DOUBLE WALL INSULATED ACOUSTICAL SPIRAL DUCTWORK

A. General:

1. All exposed round supply ductwork shown on the plans or indicated in the project specification to be insulated shall be Double Wall. The duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct and will seal the duct joints without the use of duct sealer.

B. Materials:

1. Unless otherwise noted, all duct and fittings shall be G-90 galvanized steel in accordance with ASTM A-653 and A-924 and extension duct shall be paint grip ready.
2. Perforated liner on double wall duct only shall consist of 1/8 inch perforations on 1/4 inch staggered centers corresponding to an overall open area of 23%.
3. Fiber glass insulation shall have a maximum conductivity factor (K) of 0.26 BTU-in/hr•ft²•°F at 75°F mean ambient temperature.
4. Retaining fabric shall be 0.008 inch thick, 15.6 lb/ft³ density with an air permeability rate of 9.2 ft³/ft²•s.

C. Construction:

1. Fittings:

- a. All double wall fitting ends shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
- b. Double wall duct and fittings shall consist of a perforated or solid inner liner, a 1 inch, 1.50 lb/ft³ (unless otherwise specified) layer of fiber glass insulation and a solid outer pressure shell. When a perforated inner liner is specified, a retaining fabric shall be wrapped between the perforated inner and the fiber glass insulation. The fabrics provide fiber glass tear retention while maintaining the desired acoustical properties. For 1-inch thick insulation, the outer pressure shell diameter shall be 2 inches larger than the inner liner.
- c. All fittings shall be furnished with gasket on the outer shell. The inner shell on all double wall fittings shall extend a minimum of 1" past the outer shell.
- d. All fittings ends shall be calibrated to manufacturer's published dimensional tolerance standard.
- e. All fitting ends O.D. shall have rolled over edges for added strength and rigidity during installation and shipping.
- f. Double wall to single wall transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.
- g. When contract documents require divided flow fittings, only full body fittings will be accepted. Double wall saddle taps are unacceptable.
- h. All double wall duct and fittings shall be furnished with both an inner liner and a outer pressure shell coupling. The inner liners shall not be fastened together to allow for expansion and contraction.

2. Spiral Duct:

- a. Spiral duct shall be calibrated to manufacturer's published dimensional tolerance standard.
- b. All spiral duct 12" Dia. and larger shall be corrugated for added strength and rigidity. Inner and outer duct will be of spiral lockseam construction.
- c. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Connect diffusers to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- G. Connect flexible ducts to metal ducts with draw bands.
- H. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- I. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller with crimp in direction of air flow. Provide flanged joints for duct sizes 10” and larger.
- J. Connect terminal units to supply ducts with three foot maximum length of flexible duct. Do not use flexible duct to change direction.
- K. Cleaning and Protection:
 - 1. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
 - 2. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
 - 3. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

3.2 SCHEDULES

A. Ductwork Material Schedule

<u>Air System</u>	<u>Material</u>	<u>Pressure Class</u>	<u>Seal Class</u>
Return Ductwork	Galvanized	2”	C
Supply Ductwork	Galvanized	2”	C
Transfer Ducts	Galvanized	1”	-
Exposed Ductwork	Double Wall Spiral	-	-

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 REFERENCES

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

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

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

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

D. Sheet Metal and Air Conditioning Contractors:

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

E. Underwriters Laboratories Inc.:

1. UL 555 - Standard for Safety for Fire Dampers.

1.3 SUBMITTALS

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

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.

C. Product Data: Submit data for shop fabricated assemblies and hardware used.

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

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 QUALIFICATIONS

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

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

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

- B. Furnish two of each size and type of fusible link.

1.10 REGULATORY REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES

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

2.2 BACKDRAFT DAMPERS

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

2.3 DUCT ACCESS DOORS

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

2.4 FLEXIBLE DUCT CONNECTIONS

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

2.5 DUCT TEST HOLES

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

2.6 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Vent Products.
 - 3. Dowco Products.
 - 4. Air Balance Inc.
 - 5. Or approved as equal.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inches. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- E. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- F. Remote Operator: Provide Young Regulator or equal, remote operator where damper access cannot be attained through ceiling access door. Operator to be by cable through 7/18" diameter paintable cold rolled steel cover plate concealing socket wrench operated rack and pinion gear drive. Damper shall be complete with similar gear drive smoothly to operate damper through full range of motion from tight shut-off to wide open.

2.7 DYNAMIC FIRE DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Vent Products.
 - 3. Dowco Products.
 - 4. Air Balance, Inc.
 - 5. Cesco Products.
 - 6. Or approved as equal.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations, closure under air flow conditions. Configure with blades out of air stream except for pressure class ducts up to 12 inches in height.
- E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- F. Fusible Links: UL 33, separate at 160 degrees F. with adjustable link straps for combination fire/balancing dampers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, fire and smoke dampers, and elsewhere as indicated. Provide minimum 18 x 18 inch size for shoulder access or 2 inches smaller than duct size, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.

- E. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install fire dampers in accordance with NFPA 92A.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- I. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- J. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- K. The material of the duct accessories shall match the material of the system in which they are installed.

END OF SECTION 233300

SECTION 233700 - AIR OUTLET AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.

B. Related Sections:

1. Section 09 90 00 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
2. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

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 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

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

1.3 SUBMITTALS

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

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Test Reports: Rating of air outlet and inlet performance.

D. 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 air outlets and inlets.

1.5 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

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. Titus.
- B. Carnes.
- C. Metal-Air.
- D. Price.
- E. Nailor.
- F. Acutherm.

2.2 DIRECT SPIRAL DUCT-MOUNTED ALUMINUM SUPPLY GRILLES (TYPE A)

- A. Type: Direct spiral duct-mounted double deflection aluminum supply grilles. The front deflection blades shall be parallel to the short dimension of the grille. All supply grilles shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter. All supply grilles shall be constructed with a 1-3/8 inch wide border.
- B. Fabrication: Blades shall be constructed of heavy duty extruded aluminum and shall be spaced 3/4 inch apart. Blades shall extend completely through the side frame on each side to ensure stability throughout the complete CFM operating range of the grille. Blades shall be individually adjustable without loosening or rattling and shall be securely held in place with tension wire. The grille finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50 inch pound force applied.
- C. Accessories: Air scoop damper/extractor (option ASD) shall be constructed of heavy duty aluminum. The ASD must be operable from the face with a screwdriver.

2.3 HEAVY DUTY RETURN REGISTERS/GRILLES (TYPE B)

- A. Type: Streamlined blades, 3/8 inch maximum spacing with 38° deflection.
- B. Frame: 1 1/4 inch margin with countersunk screw and gasket mounting.
- C. Fabrication: Steel with 16 gage minimum frames and 14 gage minimum blades and corners securely fastened to be immobile.

2.4 DIRECT SPIRAL DUCT-MOUNTED ALUMINUM RETURN GRILLES (TYPE C)

- A. Type: Direct spiral duct-mounted perforated aluminum return grilles. All return grilles shall be constructed with radius end caps and foam gaskets for a tight seal to the duct diameter. All return grilles shall be constructed with a 1-3/8 inch wide border.
- B. Fabrication: Perforated screen with 3/16 inch diametric holes on 1/4 inch staggered centers constructed of heavy duty extruded aluminum. The grille finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50 inch pound force applied.
- C. Accessories: Opposed blade damper shall be constructed of heavy duty aluminum. The ASD must be operable from the face with a screwdriver.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling and wall systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Provide hard 90 degree duct elbow at ceiling diffusers per detail.
- C. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- D. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233700

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.

1.7 QUALITY ASSURANCE

- A. Unit shall be rated in accordance with AHRI Standard 340/360, latest edition.
- B. Unit shall be designed to conform to ANSI/ASHRAE 15 (latest edition), ASHRAE 62, and UL Standard 1995.
- C. Unit shall be listed by ETL and ETL, Canada as a total package.
- D. 48A3, A5 units shall be designed to conform with ANSI Standard Z21.47 (U.S.A.) / CSA Standard 2.3 (Canada), Gas-Fired Central Furnaces.
- E. Roof curb shall be designed to NRCA criteria per Bulletin B-1986.
- F. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
- G. Unit shall be manufactured in a facility registered to the ISO 9001 manufacturing quality standard.

1.8 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer's warranty for compressors.
- C. Furnish twenty-five year manufacturer's warranty for heat exchangers.

1.9 SUMMARY

- A. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

PART 2 - PRODUCTS

2.1 ROOFTOP UNIT

A. Acceptable Manufacturers:

1. Aaon.
2. Carrier.
3. Daikin.
4. Or approved as equal.

B. General Description:

1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, gas heaters, exhaust fans, and unit controls.
2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
6. Installation, Operation and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

C. Construction:

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.

6. Access to filters, dampers, cooling coils, heaters, exhaust fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

D. Electrical:

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
2. Unit shall be provided with a factory installed and field wired 115V, 13 amp GFI outlet disconnect switch in the unit control panel.

E. Supply Fans:

1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

F. Exhaust Fans:

1. Exhaust dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
5. Unit shall include belt driven, unhooded, backward curved, plenum exhaust fans.
6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

G. Cooling Coils:

1. Evaporator Coils:
 - a. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
 - b. Coils shall have interlaced circuitry and shall be 6 row high capacity.
 - c. Coils shall be helium leak tested.
 - d. Coils shall be furnished with factory installed thermostatic expansion valves.

H. Refrigeration System:

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection, independently circuited and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
8. Each refrigeration circuit shall be equipped with a liquid line sight glass.
9. First capacity stage shall be provided with on/off condenser fan cycling and adjustable compressor lockout to allow cooling operation down to 35°F.

I. Condensers:

1. Air-Cooled Condenser:

- a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
- b. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
- c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- d. Coils shall be helium leak tested.
- e. Provide hail guards.

J. Gas Heating:

1. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
2. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
3. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
4. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
5. Natural gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. 195 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity.

K. Filters:

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the cooling coil.
2. Unit shall include a clogged filter switch.

L. Outside Air/Economizer:

1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return enthalpy activated fully modulating
2. Economizer shall be furnished with return air CO2 override.

M. Controls:

1. Provide factory mounted DDC controls BAS interface (LON).

2.2 ROOF CURBS

A. Manufacturers:

1. Thybar.
2. Or approved as equal.

B. Curb shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

C. **Oversized return air plenum vibro-curb** shall be factory assembled and fully lined with neoprene coated fiberglass insulation and include a wood nailer strip. Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications. Curb to be a minimum of 18" above high point of roof.

D. The designated contractor shall supply and install a factory-fabricated roof mounting curb.

E. Base shall be designed so that it can be re-roofed without disturbing the rooftop unit.

F. The roof curb shall be supplied complete with wood nailing strip unit shall be weather tight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as recommended by manufacturer.

3.2 INSTALLATION

A. Roof Curb:

1. Install roof curb level.
2. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
3. Install gasket material between unit base and roof curb.

B. Connect units to supply and return ductwork with flexible connections.

C. Install components furnished loose for field mounting.

D. Install electrical devices furnished loose for field mounting.

- E. Install control wiring between unit and field installed accessories.
- F. Remove from roof and dispose off-site panels removed from units during installation of all accessories.

3.3 INSTALLATION - NATURAL GAS HEATING SECTION

- A. Connect natural gas piping in accordance with NFPA 54.
- B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
- C. Install natural gas piping accessories.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install new throwaway filters in units at Substantial Completion.
- D. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer shall furnish a factory trained service engineer without additional charge to start the units. Package rooftop unitary manufacturers shall maintain service capabilities no more than 100 miles from the jobsite.
- B. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner. All training shall be videotaped by a professional service.

END OF SECTION 238103

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.

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