SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes pipe, fittings, and connections for sprinkler systems.
   B. Related Sections:
      1. Section 09 90 00 - Painting and Coating: Execution requirements for piping painting specified by this section.

1.2 REFERENCES
   A. American Society of Mechanical Engineers:
      2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
      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 B16.25 - Buttwelding Ends.
      7. ASME B16.4 - Gray Iron Threaded Fittings.
      8. ASME B16.5 - Pipe Flanges and Flanged Fittings.
     10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
   B. ASTM International:
   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.
   D. American Water Works Association:
      1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
   E. National Fire Protection Association:
1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
   C. Product Data: Submit manufacturer’s catalogue information. Indicate valve data and ratings.
   D. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.
   E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
   F. Plans shall be reviewed by Engineer prior to system installation.
   G. Plans shall be reviewed by the local Fire Protection District as a courtesy review.
   H. Final hydraulic calculations are the sole responsibility of the contractor. Any pipe sizing noted on drawings reflects schematic design.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B. Project Record Documents: Record actual locations of components and tag numbering.
   C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE
   A. Provide fire sprinkler piping 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 (1.5 m) when tested in accordance with UL 1887.
   B. Perform Work in accordance with NFPA 13.
   C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
      1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
      2. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
   B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.
1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Deliver and store valves in shipping containers, with labeling in place.
   C. Furnish cast iron and steel valves with temporary protective coating.
   D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

1.10 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish two sets of valve stem packing for each size and type of valve installed.

1.11 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.
PART 2 - PRODUCTS

2.1 VALVES

A. Gate Valves:
   1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
   2. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid bronze or EPDM coated cast iron wedge, flanged or grooved ends.
   3. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze or EPDM coated iron wedge, flanged or grooved ends, iron body indicator post assembly.

B. Globe or Angle Valves:
   1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity packable under pressure.

C. Ball Valves:
   1. Up to and including 2 inches: Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and threaded ends.

D. Butterfly Valves:
   1. Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
   2. Ductile Iron Body: EPDM coated ductile iron disc with integrally cast stem, grooved ends, weatherproof actuator, handwheel with gear drive and integral indicating device, and built-in tamper switches rated 10 amp at 115 volt AC.

E. Check Valves:
   1. 4 inches and Over: Iron body, bronze disc, stainless steel spring, resilient seal, threaded, wafer, or flanged ends, or grooved.

F. Drain Valves:
   1. Compression Stop: Bronze with hose thread nipple and cap.
   2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

2.2 ABOVE GROUND PIPING

   1. Steel Piping:
      a. Up to 2 inches shall be Schedule 40 designed working pressure 175 psi.
      b. 2 1/2 inches and over shall be Schedule 10 designed working pressure 175 psi.
4. Mechanical Grooved Couplings:-Ductile iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, electroplated steel bolts, nuts, and washers.
   a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. (Tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.)
      1) 1-1/4” through 4”: Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 009-EZ.
      2) 1-1/4” through 8”: Victaulic FireLock™ Style 005.
      3) 10” and Larger: Victaulic Zero-Flex Style 07.
   b. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for seismic applications as recommended by the manufacturer.
   c. Mechanical Grooved End Fittings: ASTM A536, short-pattern ductile iron fittings specifically designed for flow equal to standard pattern fittings.
5. Mechanical Formed Fittings: Carbon-steel housing with integral pipe stop and O-ring pocked and O-ring uniformly compressed into permanent mechanical engagement onto pipe.
6. All dry system piping and fitting shall be galvanized inside and out.

2.3 PIPE HANGERS AND SUPPORTS
   A. Conform to NFPA 13.
   B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
   C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
   D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
   F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
   G. Vertical Support: Steel riser clamp.
   H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Ream pipe and tube ends. Remove burrs.
   B. Remove scale and foreign material, from inside and outside, before assembly.
   C. Prepare piping connections to equipment with flanges, grooved joint couplings, or unions.
   D. Degrease and clean surfaces to receive adhesive for identification materials.
3.2 INSTALLATION

A. Install piping in accordance with NFPA 13 for sprinkler systems.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Pipe Hangers and Supports:
   1. Install in accordance with NFPA 13.
   2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Do not penetrate building structural members unless indicated.

K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

L. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

M. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor’s representative is not considered qualified to conduct the training or jobsite visit(s).)

N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
O. Install gate valves for shut-off or isolating service.

P. Install drain valves at main shut-off valves, low points of piping and apparatus.

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

R. Provide at least one flushing connection for each cross-main, per area of the system.

S. The automatic sprinkler contractor shall be responsible during the installation and testing periods of the sprinkler work, for any damage to the work of the owner or other, and to the property and materials of the owner and others caused by leaks in sprinkler equipment, fittings, sprinkler heads, or by disconnect pipes.

T. All exposed pipe which passes through a wall or ceiling shall be equipped with an escutcheon plate.

U. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering apply paint primer before applying labels.

V. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow and direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

W. Provide ceiling tacks to locate valves above t-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.3 INTERFACE WITH OTHER PRODUCTS

A. 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. Install 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.

3.4 CLEANING

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

B. Clean entire system after other construction is complete.

END OF SECTION 210500
SECTION 210513 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes single- and three-phase motors for application on equipment provided under other sections.
   B. Related Sections:
      1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
      2. Section 26 05 53 - Identification for Electrical Systems.

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:

1.3 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 experience.
   B. Testing Agency: Company specializing in testing products specified in this section with minimum three years 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.

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. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
3. 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.
4. Insulation System: NEMA Class B or better.
5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
6. 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.
7. 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.
8. 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 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 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 INSTALLATION
   A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   B. Install engraved plastic nameplates in accordance with Section 26 05 53.
   C. Ground and bond motors in accordance with Section 26 05 26.

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 7.15.

END OF SECTION 210513
SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes wet-pipe sprinkler system, system design, installation, and certification.
   B. Related Sections:
      1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES
   A. National Fire Protection Association:

1.3 SYSTEM DESCRIPTION
   A. New addition to be provided with a sprinkler system. New sprinkler heads/piping installed to provide adequate coverage per NFPA 13 to new addition only.
   B. Provide hydraulically designed system to NFPA 13 occupancy requirements.
   C. Determine volume and pressure of incoming water supply from water flow test data.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Shop Drawings: Indicate layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation. Indicate detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   C. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
   D. Prior to submission to the Architect/Engineer submit shop drawings product data and hydraulic calculations to authority having jurisdiction for a courtesy review. Submit proof of approval to Architect/Engineer.
   E. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
   F. Design Data: Submit design calculations; signed and sealed by professional engineer.
   G. 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 sprinklers and deviations of piping from drawings. Indicate drain and test locations.
   C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE
   A. Perform Work in accordance with NFPA 13 and local authority having jurisdiction.
   B. 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. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
   C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Illinois.

1.8 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Store products in shipping containers until installation.
   C. Furnish piping with temporary inlet and outlet caps until installation.

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 extra sprinklers under provisions of NFPA 13.
   C. Furnish suitable wrenches for each sprinkler type.
   D. Furnish metal storage cabinet located adjacent to riser.
1.12 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 SPRINKLERS

A. Suspended Acoustical Ceiling or Suspended Gypsum Ceiling:
   1. Type: Semi-recessed pendant type with matching push on escutcheon plate.
   2. Finish: Enamel, color white.
   3. Escutcheon Plate Finish: Enamel, color white.
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type:
   1. Type: Standard upright type with guard at location noted on drawings.
   2. Finish: Brass.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Dry Pendant Type:
   1. Type: Dry pendant.
   2. Finish: Brass sprinkler with chrome escutcheon.
   3. Escutcheon Plate Finish: Chrome finish.
   4. Fusible Link: Fusible solder link or glass bulb type temperature rated for specific hazard, and correct barrel length.
   5. Refer to drawings for additional information.
D. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.

   1. Wrenches shall be provided by the sprinkler manufacturer that directly engage the hex-shaped wrench boss integrally cast in the sprinkler body.

E. Guards: Finish to match sprinkler finish.

   1. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

F. Sprinklers subject to mechanical injury shall be protected with listed guards.

G. All sprinklers shall be quick response. The use of extended coverage sprinklers will be permitted, however all extended coverage sprinklers shall be quick response. Extended coverage sprinkler heads may be use only if it does not affect other trades devices in the ceilings. This must be coordinate with all trades and architect prior to acceptance.

2.2 SPRINKLER SYSTEM SPECIALTIES

A. Water Flow Switch: Vane type water flow switch for mounting horizontal or vertical, with two contacts; rated 10 amps at 125 volt AC and 2.5 amps at 24 volt DC. Coordinate electrical characteristics with fire alarm contractor/electrical contractor.

B. Supervisory Switches: Switches shall be mounted so as not to interfere with normal operation of the valve. The switch assembly shall include two contacts; rated 10 Amps at 125 Volt AC and 2.5 Amps at 24 Volt DC. Coordinate electrical characteristics with fire alarm contractor/electrical contractor.

C. Strobes: Strobe shall be constructed of a weatherproof box, UL listed, minimum of 110 candella, and 24 volt DC operation. Strobe to be mounted 8'-0" above grade at the fire department connection electrical characteristics with fire alarm contractor/electrical contractor.

D. Bells: Bells shall have underdome strikers and operating mechanism. Size shall be 6" or 10", refer to drawings for locations and sizes. Bells shall be UL listed, 24 volt DC operation, minimum 84 dB, and red in color. Outdoor bells shall be weatherproof.

E. Fire Department Connections:

   1. Type: Solid brass, single clapper Siamese connection type, threads to be compatible with local fire department.

   2. Outlet: 4" NPT x 2-1/2" x 2-1/2” Siamese connection with cap and chain. Thread size to suit fire department hardware; threaded plug and chain of matching material and finish.

   3. Drain: 1/2 inch automatic drip, outside.

   4. Escutcheon to be brass and to read “Auto Sprinkler”.

F. Double Check Detector Assembly Backflow Preventer:

   1. Manufacturers:

      a. Ames 3000-SS.

      b. Watts Regulator.

      c. Febco Valves.

      d. Zurn-Wilkins

      e. Conbraco.
2. ANSI/ASSE 1048; stainless steel body with two positive seating check valves. The check valves shall be of thermoplastic construction with stainless steel hinge pins, cam arm and cam bearing. Assembled with two O.S.Y. gate valves, strainer, and four test cocks. The bypass line shall consist of a meter, double check assembly, isolation valves and test cocks.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with NFPA 13.
   B. Place pipe runs to minimize obstruction to other work.
   C. Install piping in concealed spaces above finished ceilings.
   D. Flush entire piping system of foreign matter.
   E. Center sprinklers in two directions in ceiling tile and install piping offsets.
   F. Install guards on sprinklers as indicated on Drawings.
   G. Hydrostatically test entire system per NFPA 13 and NFPA 25.
   H. Require test be witnessed by Authority having jurisdiction.
   I. Inspectors test connections shall be located as shown on drawings.
   J. All pipe, fittings, valves, etc. shall be installed in a rust-free condition.
   K. Placards displaying pertinent hydraulic data shall be affixed to all new system risers.
   L. All piping and components necessary for installation may be fabricated. However, the contractor must willing to rework the prefabricated piping, fittings, and the like, as necessary to constitute a proper approved installation, existing site conditions notwithstanding, at no additional cost to the owner.
   M. System components shown including but not limited to control valves, check valves, flow switches, sprinkler heads, inspectors test, supervisory switches, strobes, bells, etc. are minimums. Contractor shall provide all necessary components for a complete operating system in accordance with NFPA 13 and authority having jurisdiction.

3.2 INTERFACE WITH OTHER PRODUCTS
   A. Verify signal devices are installed and connected to fire alarm system.

3.3 CLEANING
   A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
   B. Flush entire piping system of foreign matter.
3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 211313
SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes dry-pipe sprinkler system, system design, installation, and certification.
   B. Related Sections:
      1. Section 21 05 13 - Common Motor Requirements for Fire-Suppression Equipment: Product requirements for motors for placement by this section.
      2. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES
   A. National Fire Protection Association:

1.3 SYSTEM DESCRIPTION
   A. System to provide coverage for building areas noted.
   B. Provide hydraulically designed system to NFPA 13 occupancy requirements.
   C. Determine volume and pressure of incoming water supply from water flow test data.
   D. Interface system with building fire and smoke alarm system.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Shop Drawings: Indicate layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation. Indicate detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   C. Product Data: Submit data on sprinklers, valves, pumps, compressors and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
   D. Design Data: Submit design calculations, signed and sealed by sprinkler contractor professional engineer.
   E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
   F. Prior to submission to the Architect/Engineer submit shop drawings product data and hydraulic calculations to authority having jurisdiction, Fire Marshall and Owner’s insurance underwriter for approval. Submit proof of approval to Architect/Engineer.
   G. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
   C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE
   A. Perform Work in accordance with NFPA 13 and local authority having jurisdiction.
   B. 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. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
   C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Illinois.

1.8 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Store products in shipping containers until installation.
   C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

1.11 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish extra sprinklers under provisions of NFPA 13.
   C. Furnish suitable wrenches for each sprinkler type.
D. Furnish metal storage cabinet in location designated.

PART 2 - PRODUCTS

2.1 DRY TYPE SYSTEM SPECIALTIES

A. Dry Type Sprinkler Valve: Differential, check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, water pressure gauges, air pressure gauges and all trim devices. Coordinate electrical requirements/characteristics with fire alarm contractor/electrical contractor.

B. Air Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch, unloader valve and inlet filter. Electrical characteristics: 3/4 HP, single-phase, 120 Volts. Air compressor to be sized for associated dry pipe system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 13.

B. Install approved back-flow preventer assembly at sprinkler system water source connection.

C. Install piping to minimize obstruction with other work.

D. Install piping in concealed spaces above finished ceilings.

E. Hydrostatically test entire system.

F. Require test be witnessed by Authority having jurisdiction.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Verify devices are installed and connected to fire alarm system.

3.3 CLEANING

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

B. Flush entire piping system of foreign matter.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

END OF SECTION 211316
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 piping within 5 feet of building.
4. Sanitary sewer piping, above grade.
5. Storm sewer piping within 5 feet of building.
6. Storm sewer piping, above grade.
7. Storm sewer, drain tile.
8. Equipment drains and over flows.
9. Flue and combustion air piping.
10. Unions and flanges.

B. Related Sections:

1. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
2. Section 22 07 00 - Plumbing Insulation: Product requirements for piping insulation for placement by this section.
3. Refer to civil drawings for additional information - Soils for Earthwork: Soils for backfill in trenches.
4. Refer to civil drawings or civil specifications for additional information - Aggregates for Earthwork: Aggregate for backfill in trenches.
5. Refer to civil drawings civil specifications for additional information - Excavation: Product and execution requirements for excavation and backfill required by this section.
6. Refer to civil drawings civil specifications for additional information - Trenching: Execution requirements for trenching for underground piping systems.
7. Refer to civil drawings civil specifications for additional information - Fill: Execution requirements for backfilling required by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

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:


C. American Water Works Association:


D. Cast Iron Soil Pipe Institute:

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. 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.

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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
      1. Fittings: AWWA C110, ductile iron, standard thickness.
      2. Joints: AWWA C111, rubber gasket with rods.
   B. Copper Tubing: ASTM B88, Type K annealed.
      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.
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.

B. Ductile Iron Pipe: ASTM A746, service weight, bell and spigot ends.
   1. Fittings: AWWA C110, ductile iron, standard thickness.

C. PVC Pipe: ASTM D2665, Polyvinyl Chloride (PVC) material.
   1. Fittings: ASTM D2665, PVC.

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.

C. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2665, PVC.
   3. Note: PVC can be installed if allowed by local authority having jurisdiction.
   4. Note: PVC piping is not allowed in mechanical return plenum ceilings. Refer to mechanical drawings for locations of return plenums.

2.5 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74, service weight, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.
   2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

B. PVC Pipe: ASTM D2665 or ASTM D3034, polyvinyl chloride (PVC) material.
   1. Fittings: PVC, ASTM D2665 or ASTM D3034.

2.6 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight, bell and spigot ends.
   1. Fittings: Cast iron, ASTM A74.
   2. Joints: ASTM C564, neoprene gasket system or lead and oakum.
B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron, CISPI 301.

C. PVC Pipe: ASTM D2665 or ASTM D3034, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2665 or ASTM D3034, PVC.
   3. Note: PVC can be installed if allowed by local authority having jurisdiction.
   4. Note: PVC piping is not allowed in mechanical return plenum ceilings. Refer to mechanical drawings for locations of return plenums.

2.7 STORM SEWER PIPING, DRAIN TILE
A. PVC under drain pipe shall be manufactured as prescribed in ASTM-1785 and shall meet all the requirements of ASTM D2665. Perforation pattern shall consist of a maximum 5/16” diameter hole and not less than a minimum 3/16” diameter hole. Holes shall be 3” apart, center to center, along rows. Rows shall be 1 1/2” apart and arranged in a staggered pattern. The rows shall be spaced over not more than 155 degrees of the circumference. (Black, flexible corrugated pipe shall not be considered as an equal).
   1. Fittings: PVC, Solid with no perforations.
   2. Joints: To be compatible with the drain tile piping system or ASTM D2855, solvent weld with ASTM D2564 solvent cement.
   3. Perforation pattern (holes, slots, etc.) to be face down at installation.

2.8 EQUIPMENT DRAINS AND OVERFLOWS
   1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
B. Copper Tubing: ASTM B88, Type DWV, K, L, or M, 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.
   1. Fittings: ASTM D2466, Schedule 40, PVC.

2.9 FLUE AND COMBUSTION AIR PIPING
A. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
B. PVC Pipe: ASTM D1785, Schedule 80, polyvinyl chloride (PVC) material.
   1. Fittings: [ASTM D2467, Schedule 80, PVC] [ASTM D2464 PVC, threaded].
2.10 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.

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.

2.11 UNDERGROUND PIPE MARKERS

A. Furnish materials in accordance with Illinois Department of Public Health 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.

2.12 BEDDING AND COVER MATERIALS

A. Bedding: Refer to civil drawings or civil specifications for additional information.

B. Cover: Refer to civil drawings or civil specifications for additional information.

C. Soil Backfill from Above Pipe to Finish Grade: Refer to civil drawings or civil specifications
   for additional information.

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 per drawings.
C. Excavate pipe trench in accordance with civil drawings.
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 in accordance with Section 22 05 23.
J. Install plastic ribbon tape continuous over top of pipe. Buried 6 inches below finish grade, above pipe line; refer to civil drawings or civil specifications for additional information. Refer to Section 22 05 53.
K. Pipe Cover and Backfilling:
   1. Backfill trench: refer to civil drawings or civil specifications for additional information.
   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

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. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 21 05 16.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.

G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

I. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients unless noted otherwise on drawings.

J. Slope piping and arrange systems to drain at low points.

K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Install valves in accordance with Section 22 05 23.

N. Install piping specialties in accordance with Section 23 21 16.

O. Insulate piping. Refer to Section 22 07 00.

P. Install pipe identification in accordance with Section 22 05 53.

Q. Sleeve pipes passing through partitions, walls and floors.

R. Plumbing contractor is responsible for all cutting and patching of existing walls/floor required to perform any new or demolition plumbing work.

S. PVC piping is not allowed in mechanical return plenum ceilings. Refer to mechanical drawings for locations of return plenum ceilings.

T. When PVC is used at sanitary and storm applications, all vertical and horizontal piping shall be insulated.

U. PVC shall not be used for any sanitary drainage piping capable of receiving waste with a temperature exceeding 120 degrees. PVC serving floor drains in mechanical room with boilers or water heaters will not be accepted.

V. 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 contractors 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.

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.

3.7 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS
   A. Install storm drainage piping systems piping in accordance with ASME B31.9.
   B. Install storm drainage piping systems in accordance with Section 22 14 00.
   C. Install bell and spigot pipe with bell end upstream.
   D. Support cast iron drainage piping at every joint.

3.8 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.

3.9 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 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

   B. Related Sections:

       1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
       2. Section 26 05 53 - Identification for Electrical Systems.

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:


1.3 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 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.
1.5 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
   3. 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.
   4. Insulation System: NEMA Class B or better.
   5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
   6. 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.
7. 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.

8. 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 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 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 in accordance with Section 26 05 53.

C. Ground and bond motors in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Section 01 14 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 7.15.

END OF SECTION 220513
SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gate valves.
   2. Ball valves.
   3. Check valves.

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.
   2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product and installation requirements for pipe hangers and supports.
   3. Section 22 07 00 - Plumbing Insulation: Product and installation requirements for insulation for valves.
   4. Section 22 11 00 - Facility Water Distribution: Product and installation requirements for piping specialties and equipment used in domestic water systems.
   5. Section 22 13 00 - Facility Sanitary Sewerage: Product and installation requirements for piping specialties and equipment used in sanitary waste and vent systems.

1.2 REFERENCES

A. American National Standards Institutes:

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
   2. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
   3. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Record actual locations of valves.
   C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

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: Requirements for transporting, handling, storing, and protecting products.
   B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
   C. Provide temporary protective coating on cast iron and steel valves.

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

1.9 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
   B. Furnish two packing kits for each size valve.

1.10 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GATE VALVES
   A. Manufacturers:
      1. Apollo.
      2. Milwaukee.
   B. MSS SP-70, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends.
   C. Sizes: 4 inches and larger.

2.2 BALL VALVES
   A. Manufacturers:
      1. Apollo.
      2. Milwaukee.
   B. 3 Inches and Smaller, Construction: MSS SP-110, 600 psi, bronze, two piece body, stainless steel ball, full port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle and solder ends.

2.3 CHECK VALVES
   A. Manufacturers:
      1. Apollo.
      2. Milwaukee.
   B. Up To and including 2 Inches: MSS SP-80, bronze body and cap, bronze swing disc with rubber seat, solder ends.
C. 2 1/2 Inches and Larger: MSS SP-71, iron body, bronze swing disc, renewable disc seal and seat.


2.4 CIRCUIT BALANCING VALVES

A. Manufacturers:
   1. Bell & Gossett.
   2. Dunham Bush.
   3. Armstrong.
   4. Illinois.
   5. HCI.

B. Orifice principle by-pass circuits with direct reading gage, soldered or flanged piping connections for 125 psig 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 Inches 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.

E. Provide manufacturer furnished molded insulated valve covers.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 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.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

F. Refer to Section 22 05 29 for pipe hangers.

G. Refer to Section 22 07 00 for insulation requirements for valves.
H. Refer to Section 22 05 03 for piping materials applying to various system types.


3.3 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install ball valves and gate valves in domestic water systems for shut-off service.

END OF SECTION 220523
SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING 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. Sleeves.
   6. Mechanical sleeve seals.
   7. Formed steel channel.
   8. Firestopping relating to plumbing work.
   10. Equipment bases and supports.

B. Related Sections:
   1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of inserts and sleeves in concrete forms specified by this section.
   2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
   3. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
   4. Section 07 90 00 - Joint Protection: Product requirements for sealant materials for placement by this section.
   5. Section 09 00 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
   6. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Execution requirements for placement of hangers and supports specified by this section.
   7. Section 22 11 00 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
   8. Section 22 13 00 - Facility Sanitary Sewerage: 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:

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.
D. FM Global:

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.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   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, 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. Firestopping Materials: ASTM E119, ASTM E814, UL 263, and UL 1479 to achieve fire ratings of adjacent construction in accordance with FM, UL, and Design Numbers.

C. Surface Burning: ASTM E84 and UL 723 with maximum flame spread / smoke developed rating of 25/450.

D. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM 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: 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 or 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.
   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. Perform Work in accordance with applicable authority 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.
D. Provide ventilation in areas to receive solvent cured 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)


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


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. Carpenter & Paterson Inc.
   2. Creative Systems Inc.
   3. Flex-Weld, Inc.
   4. Glope Pipe Hanger Products Inc.
   5. Michigan Hanger Co.

B. Plumbing Piping:
   1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
   9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   10. 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.
   11. 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. Manufacturers:
   1. Bolt Products, Inc.
   2. Fastenal Fasteners.
   3. Atwood Industries.
B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING
A. Metal Flashing: 26 gauge thick galvanized steel.
B. Metal Counterflashing: 22 gauge 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 compatible with roofing.
E. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

2.5 SLEEVES
A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge thick galvanized steel.
B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gauge thick galvanized steel.
C. Sealant: Acrylic refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS
A. Manufacturers:
   1. Thunderline Link-Seal, Inc.
   2. NMP Corporation.
   3. Substitutions: Section 01 60 00 - Product Requirements.
B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL
A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   4. Unistrut Corp.
   5. Substitutions: Section 01 60 00 - Product Requirements.
B. Product Description: Galvanized 12 gauge thick steel with holes 1-1/2 inches on center.
2.8 FIRESTOPPING

A. Manufacturers:

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

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

1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single 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.

2.9 FIRESTOPPING ACCESSORIES

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

B. Dam Material: Permanent:

1. Sheet metal.
2. 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 piping is exposed.

F. 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 materials to arrest liquid material leakage.
D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
E. Do not drill or cut 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 recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS
A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
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 horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide sheet lead packing between hanger or support and piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. 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. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

D. 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 penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower, and mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 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 penetrates floor, ceiling, or wall, close off space between pipe 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 escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping 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.

D. 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, bus, cable bus, conduit, wireway, trough, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

E. 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 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: Seal pipe penetrations at clean rooms, laboratories, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

A. Section 01 14 00 - Quality 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. Pipe Hanger Spacing

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Maximum Hanger Spacing Feet</th>
<th>Hanger Rod Diameter Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron (All sizes)</td>
<td>5</td>
<td>5/8</td>
</tr>
<tr>
<td>Cast Iron (All sizes) with 10’ length of pipe</td>
<td>10</td>
<td>5/8</td>
</tr>
<tr>
<td>Copper Tube, 1-1/4 inches and smaller</td>
<td>6</td>
<td>1/2</td>
</tr>
<tr>
<td>Copper Tube, 1-1/2 inches and larger</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>PVC (All sizes)</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>Steel, 3 inches and smaller</td>
<td>12</td>
<td>1/2</td>
</tr>
<tr>
<td>Steel, 4 inches and larger</td>
<td>12</td>
<td>5/8</td>
</tr>
</tbody>
</table>

END OF SECTION 220529
SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

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

1.2 REFERENCES

A. American Society of Mechanical Engineers:

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.

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

1.9 REGULATORY REQUIREMENTS
A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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:
   2. Safety Sign Co.
B. Product Description: Laminated three-layer plastic with engraved (see drawings for color) letters on light contrasting background color.
2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      b. Safety Sign Co.
      c. Seton Identification Products.
      d. Substitutions: Not Permitted.

   2. Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter. See drawings for color.

B. Metal Tags:
   1. Manufacturers:
      b. Safety Sign Co.
      c. Seton Identification Products.
      d. Substitutions: Not Permitted.

   2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

2.3 PIPE MARKERS


B. Plastic Pipe Markers:
   1. Manufacturers:
      b. Safety Sign Co.
      c. Seton Identification Products.
      d. Substitutions: Not Permitted.

   2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Manufacturers:
      b. Safety Sign Co.
      c. Seton Identification Products.
      d. Substitutions: Not Permitted.

   2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.4 LABELS

A. Manufacturers:
   2. Safety Sign Co.

B. Description: 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.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09 90 00.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow and direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.3 SCHEDULES

A. Identification:

1. See drawings for details.

END OF SECTION 220553
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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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:
   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 indicated as scheduled in 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:

<table>
<thead>
<tr>
<th>Service</th>
<th>Normal Work Pressure psig</th>
<th>Hydrostatic Test Pressure psig</th>
<th>Pneumatic Test Pressure psig</th>
<th>Maximum Allowable Pressure Drop psig</th>
<th>Minimum Test Time Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water: Potable Water</td>
<td>To 125</td>
<td>175</td>
<td>---</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

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 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

5. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
B. National Fire Protection Association:

C. Underwriters Laboratories Inc.:

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

1.10 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURER
   A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
      1. CertainTeed.
      2. Knauf.
      4. Owens-Corning.
   B. Manufacturers for Closed Cell Elastomeric Insulation Products:
      2. Armacell, LLC. Armaflex.
C. Manufacturers for Polyisocyanurate Foam Insulation Products:
   1. Dow Chemical Company.

D. Manufacturers for Extruded Polystyrene Insulation Products:
   1. Dow Chemical Company.

2.2 PIPE INSULATION
A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.

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 white molded type fitting covers, sheet material, on all pipe fittings, valves, and straight runs.
   2. Insulated piping systems concealed above ceilings or in mechanical rooms to have PVC plastic pipe jacketing at fittings.
   3. Insulated piping systems exposed (Kitchen Area) to have PVC plastic pipe jacketing at fittings, valves, and straight lengths of pipe.

2.4 PIPE INSULATION ACCESSORIES
A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. 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.

C. 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.


2.5 EQUIPMENT INSULATION
A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
   1. Thermal Conductivity: 0.24 at 75 degrees F.
   2. Operating Temperature Range: 0 to 450 degrees F.
   3. Density: 1.5 pound per cubic foot.
B. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1784, sheet material, off-white color.
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 150 degrees F.
   4. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
   5. Thickness: 20 mil.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping and equipment 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. Piping exposed to view in finished spaces shall have PVC insulated fitting covers on all pipe fittings, flanges, valves and pipe terminations. PVC insulation jacketing on all straight runs of piping. Solvent welding adhesives shall be used to permanently seal all PVC lap joints in the system

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, 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 less 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. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

E. 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.

F. Inserts and Shields:
   1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized 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 galvanized steel shield between roller and inserts.

G. 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.

H. 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.

I. High Temperature Pipe Insulation:
   1. Install in multiple layers to meet thickness scheduled.
   2. Attach each layer with bands. Secure first layer with bands before installing next layer.
   3. Stagger joints between layers.
   4. Finish with canvas jacket sized for finish painting.
J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
   1. Insulate entire equipment surfaces.
   2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
   3. 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.
   4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F or Less:
   1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
   2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
   3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:
   1. Insulate flanges and unions with removable sections and jackets.
   2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
   3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers

H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

J. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.
### 3.4 SCHEDULES

**A. Water Supply Services Piping Insulation Schedule:**

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Insulation Type</th>
<th>Pipe Thickness</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Hot Water</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
<tr>
<td>Supply and Recirculation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Cold Water</td>
<td>P-1</td>
<td>2” and smaller</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-1/2” and larger</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**B. Drainage Services Piping Insulation Schedule:**

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Insulation Type</th>
<th>Pipe Thickness</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer Piping – cast iron, PVC or copper piping receiving chilled water, condensate, water below ambient temperatures (insulate all horizontal suspended piping and all vertical piping)</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
<tr>
<td>Sanitary Sewer Piping – PVC pipe (insulate all suspended piping and all vertical piping for sound deadening purposes except PVC routed in masonry walls or chases)</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
<tr>
<td>Sanitary Sewer Piping – copper pipe (insulate all suspended piping and all vertical piping)</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
<tr>
<td>Storm Piping &amp; Storm Overflow Piping – cast iron pipe (insulate all horizontal suspended piping and down 1’-0” vertical drop)</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
<tr>
<td>Storm Piping &amp; Storm Overflow Piping – PVC pipe (insulate all horizontal suspended piping and all vertical piping for sound deadening purposes except PVC routed in masonry walls or chases)</td>
<td>P-1</td>
<td>All sizes</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**C. Equipment Insulation Schedule:**

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Drain Bodies</td>
<td>E-8</td>
</tr>
</tbody>
</table>
SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pressure gages.
   2. Pressure gage taps.
   3. Thermometers.
   4. Thermometer supports.
   5. Test plugs.
   6. Relief valves.
   7. Strainers.
   8. Hydrants.
  10. Thermostatic mixing valves.
  11. Diaphragm-type compression tanks.
  12. System lubricated circulators.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads 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 22 05 13 - Common Motor Requirements for Plumbing Equipment: Product requirements for motors for placement by this section.
   4. Section 22 05 23 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
   5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
   6. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
   7. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
   8. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
   9. Refer to civil drawings for additional information - Soils for Earthwork: Soils for backfill in trenches.
  10. Refer to civil drawings for additional information - Aggregates for Earthwork: Aggregate for backfill in trenches.
  11. Refer to civil drawings for additional information - Excavation: Product and execution requirements for excavation and backfill required by this section.
  12. Refer to civil drawings for additional information - Trenching: Execution requirements for trenching required by this section.
  13. Refer to civil drawings for additional information - Fill: Requirements for backfill to be placed by this section.
1.2 REFERENCES

A. American National Standards Institute:

B. American Society of Mechanical Engineers:
   1. ASME B31.9 - Building Services Piping.
   2. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
   3. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
   4. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. American Society of Sanitary Engineering:
   1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
   2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
   3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
   4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
   5. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.
   6. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).
   7. ASSE 5015 - Performance Requirements for Testing Double Check Backflow Prevention Assemblies (DC) and Double Check Fire Protection Backflow Prevention Assemblies (RPDF).

D. ASTM International:

E. American Water Works Association:
   1. AWWA C651 - Disinfecting Water Mains.
   2. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
   3. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
   4. AWWA C702 - Cold-Water Meters - Compound Type.
   5. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.

F. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. Plumbing and Drainage Institute:
H. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.3 SUBMITTALS

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

B. 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.

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

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 valves and equipment.

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

1.5 QUALITY ASSURANCE


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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.
PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
   1. Ashcroft.
   3. Marshalltown Instruments, Inc.
   4. Taylor.
   5. Substitutions: Not Permitted.

B. Gage: ASME B40.1, UL 393 and UL 404 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   2. Bourdon Tube: Brass.
   3. Dial Size: 4 inch diameter.
   4. Mid-Scale Accuracy: One percent.
   5. Scale: Both psi and kPa.

2.2 PRESSURE GAGE TAPS

A. Manufacturers:
   1. Peterson Equipment Co.
   2. Sisco.
   3. Trerice.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 300 psi.
C. Ball Valve: Brass, 1/8 inch 1/4 inch NPT for 250 psi.
D. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.
E. Siphon: Brass, 1/4 inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Ashcroft.
   2. Taylor.
   3. Weiss Instruments, Inc.

B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
   1. Size: 7 inch scale.
   2. Window: Clear glass.
   4. Accuracy: ASTM E77 2 percent.
   5. Calibration: Both degrees F and degrees C.
2.4 THERMOMETER SUPPORTS
   A. Socket: Brass separable sockets for thermometer stems with or without extensions.
   B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

2.6 RELIEF VALVES
   B. Pressure Relief:
      1. Bronze body, Teflon seat, steel stem and springs, automatic, direct pressure actuated at maximum 60 psi, UL listed for fuel oil, capacities ASME certified and labeled.
   C. Temperature and Pressure Relief:
      1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME certified and labeled.

2.7 STRAINERS
   A. Manufacturers:
      1. Apollo.
      2. Milwaukee.
   B. 2 1/2 Inches and Smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

2.8 WATER HAMMER ARRESTORS
   A. Manufacturers:
      1. Sioux Chief
      2. Precision Plumbing Products.
      3. Watts.
   B. ANSI A112.26.1M; sized in accordance with PDI WH-201, precharged, permanently sealed, suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.
2.9 WALL HYDRANTS (WH-1)

A. Manufacturers:
   1. Woodford, Model B65.
   2. Zurn.
   3. J.R. Smith.

B. ANSI/ASSE 1019; non-freeze, self-draining type with chrome plated steel lockable recessed box hose thread spout, lockshield and removable key, and integral self-draining vacuum breaker.

2.10 ROOF HYDRANTS (RH-1)

A. Manufacturers:
   1. Woodford, Model SRH-MS.

B. ANSI/ASSE 1052; non-freeze, pedestal type with galvanized casing, one piece variable flow plunger with large cushion type seal, automatically drains when shut-off, deck mounting system and 1/8” drain hole. No Drain Line Required.

2.11 THERMOSTATIC MIXING VALVES

A. Thermostatic Mixing Valve (TMV-1):
   1. Manufacturers:
      a. Powers, Model LFE480.
      b. Bradley.
      c. Leonard.
   2. ASSE 1070; rough bronze finish, locking temperature regulator, integral temperature adjustment and integral check valves on inlets.
   3. Accessories:
      a. Cold water bypass
      b. Mounting bracket

B. Thermostatic Mixing Valve (TMV-2):
   1. Manufacturers:
      a. Powers, Model LFLM495.
      b. Bradley.
      c. Leonard.
   2. ASSE 1070; rough bronze finish, locking temperature regulator, integral temperature adjustment and integral check valves on inlets.
   3. Accessories:
      a. Cold water bypass
      b. Mounting bracket
2.12 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Domestic Water Expansion Tank (DWET)
   1. Manufacturers:
      a. Amtrol.
      b. Wessels.
   2. Construction: Welded steel, tested and stamped in accordance with Section 8D of ASME Code; rated for working pressure of 150 psig, with heavy duty butyl bladder (FDA approved).
   3. Accessories: Pressure gage and air-charging fitting; precharged.
   4. Size: Refer to drawings.

2.13 SYSTEM LUBRICATED CIRCULATORS (DWP)

A. Manufacturers:
   1. Bell & Gossett.
   B. Pumps shall be of the horizontal system lubricated type. Pump shall have ceramic shaft supported by carbon bearings. Bearings are to be lubricated by the circulating fluid. Pump body shall be lead-free bronze. Motor starter to be isolated from circulating fluid through use of stainless steel can. Rotor to be sheathed in stainless steel. Motors shall be non-overloading at any point on the pump curve. Motor to have built-in impedance protection.
   C. Size: Refer to drawings.

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.
B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
B. Install gage taps in piping.
C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage.
D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.


3.4 INSTALLATION - ABOVE GROUND PIPING

A. Provide flow controls in water circulating systems as indicated on Drawings.

B. 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.

C. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.

D. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping.

E. Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.


3.5 INSTALLATION - PUMPS

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

B. Provide line sized shut-off valve on pump suction, and line sized soft seat check valve, and shut-off valve on pump discharge. Refer to Section 23 21 16.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

D. Lubricate pumps before start-up.


3.6 FIELD QUALITY CONTROL

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

3.7 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. Floor drains.
   2. Cleanouts.
   3. Floor sinks.

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 22 05 13 - Common Motor Requirements for Plumbing Equipment: Product requirements for motors for placement by this section.
   4. Section 22 05 23 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
   5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
   6. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
   7. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
   8. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
   9. Refer to civil drawings for additional information - Soils for Earthwork: Soils for backfill in trenches.
   10. Refer to civil drawings or civil specifications for additional information - Aggregates for Earthwork: Aggregate for backfill in trenches.
   11. Refer to civil drawings or civil specifications for additional information - Excavation: Product and execution requirements for excavation and backfill required by this section.
   12. Refer to civil drawings or civil specifications for additional information - Trenching: Execution requirements for trenching required by this section.
   13. Refer to civil drawings or civil specifications for additional information - 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. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
C. 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

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.

1.12 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

A. Floor Drain (FD-1):
   1. Manufacturers:
      a. Wade, Model 1100STD-MS6-SS.
      b. Zurn.
      c. J.R. Smith.
   2. ANSI A112.21.1; lacquered, cast iron two piece body with anchor flange, weep holes, and heavy duty polished 6”x6” square adjustable stainless steel strainer with stainless steel vandal proof screws.

B. Floor Drain (FD-2)
   1. Manufacturers:
      a. Wade, Model 1340TD.
      b. Zurn.
      c. J.R. Smith.
   2. ANSI A112.21.1; duco cast iron body with flashing collar and ductile iron grate, and sediment bucket.

2.2 CLEANOUTS

A. Floor Cleanout (FCO):
   1. Manufacturers:
      a. Wade, Model 6000Z.
      b. Zurn.
      c. J.R. Smith.
2. Interior Finished Floor Areas (FCO): Lacquered cast iron, two piece body with double
drainage flange, and heavy duty 6”x6” square adjustable stainless steel scoriated cover
assembly with stainless steel vandal proof screws and PVC gasket plug.

B. Wall Cleanouts (WCO):
   1. Manufacturers:
      a. Wade, Model 8560.
      b. Zurn.
      c. J.R. Smith.
   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.

C. Yard Cleanouts (YCO):
   1. Manufacturers:
      a. Wade, Model 6000Z.
      b. Zurn.
      c. J.R. Smith.
   2. ANSI A112.21.1: Duco cast iron, flange body, PVC gasketed plug and adjustable extra
heavy duty ductile iron cover with secured nickel bronze vandal-proof scoriated cover.

2.3 FLOOR SINKS
   A. Square Floor Sinks (FS-1)
      1. Manufacturers:
         b. Zurn.
         c. J.R. Smith.
      2. ANSI A112.21.1; cast iron flanged 12” square receptor with seepage holes, acid
resistant coated interior, stainless steel frame and secured square stainless steel half
grate. Aluminum dome bottom strainer.

2.4 GREASE INTERCEPTOR (GI-1)
   A. Manufacturer:
   B. Grease interceptor made of seamless, rotationally molded, 100% non-corrosive, high density
polyethylene construction with 3/8” uniform wall thickness. Interceptor shall be furnished for
above or below grade installations and meet ASME A112.14.3 (Type C) certification with
internal flow control, built-in test caps, flow diffusers (in lieu of baffles) to minimize grease
layer disturbance and three outlet options. Gasketed, high density polyethylene cover shall be
rated for 500 lb. load capacity and be secured with stainless steel bolts. Interceptor shall have
4” inlet/outlet connections, 50 gallon per minute flow rate, 52 gallon liquid holding capacity
and 249 lb. grease capacity.
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.
   E. Install grease interceptor per manufacturer's instructions.

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

END OF SECTION 221300
SECTION 221400 - FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Roof drains.
2. Downspout nozzles.
3. 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 22 05 13 - Common Motor Requirements for Plumbing Equipment: Product requirements for motors for placement by this section.
4. Section 22 05 23 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports [and firestopping] for placement by this section.
6. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
7. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
8. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
9. Refer to civil drawings or civil specifications for additional information - Soils for Earthwork: Soils for backfill in trenches.
10. Refer to civil drawings or civil specifications for additional information - Aggregates for Earthwork: Aggregate for backfill in trenches.
11. Refer to civil drawings or civil specifications for additional information - Excavation: Product and execution requirements for excavation and backfill required by this section.
12. Refer to civil drawings or civil specifications for additional information - Trenching: Execution requirements for trenching required by this section.
13. Refer to civil drawings or civil specifications for additional information - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A112.21.2M - Roof Drains.
2. ASME B31.9 - Building Services Piping.

1.3 SUBMITTALS

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

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sump-pumps, catch basins and manholes.
C. Product Data:
   1. Storm 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 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,

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

1.7 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
B. Protect 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.
1.12 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROOF DRAINS

A. Roof Drain (RD-1)
   1. Manufacturers:
      a. Wade, Model 3000.
      b. Zurn.
      c. J.R. Smith.
   5. Accessories: Coordinate with roofing type, refer to:
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable under deck clamp.
      c. Waterproofing flange.

B. Roof Drain (RD - 2).
   1. Manufacturers:
      a. Wade, Model 3000-D.
      b. Zurn.
5. Accessories: Coordinate with roofing type, refer to:
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. 2" high integral dam.
   d. Waterproofing flange.

2.2 DOWNSPOUT NOZZLES

A. Downspout Nozzle (DSN-1)

1. Manufacturers:
   a. Wade, Model 3940.
   b. Zurn.
   c. J.R. Smith.

2. Cast bronze nozzle and flange with stainless steel birdscreen. Refer to drawings for sizes.

2.3 CLEANOUTS

A. Refer to Section 221300 - Facility Sanitary Sewerage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013000 - 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 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

   1. Test storm drainage piping system in accordance with local authority having jurisdiction.

END OF SECTION 221400
SECTION 223400 - FUEL FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
   2. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment: Product requirements for pump motors for placement by this section.
   3. Section 22 07 00 - Plumbing Insulation: Field applied insulation for domestic water heaters.
   4. Section: 22 11 00 - Facility Water Distribution: Supply connections to domestic water heaters.
   5. Section 23 11 23 - Facility Natural-Gas Piping: Execution requirements for gas piping connections specified by this section.
   6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

A. American National Standards Institute:
   2. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.

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

C. American Society of Mechanical Engineers:
   1. ASME PTC 25 - Pressure Relief Devices.
   2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Fire Protection Association:
   1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.

E. United States Department of Energy:
1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
   C. Product Data:
      1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.
      2. Pumps: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   D. Manufacturer's Installation Instructions: Submit mounting and support requirements.
   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. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE
   A. Conform to ASME for construction of water heaters. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

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 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.
   B. Accept water heaters on site in original labeled cartons. Inspect for damage.
   C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

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.

1.12 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED WATER HEATERS
   A. Acceptable Manufacturers:
      1. A.O. Smith.
   B. Type: Automatic gas burner, natural gas-fired, vertical storage.
   C. Tank: Glass lined ASME labeled; inlet/outlet openings, thermally insulated with glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs; hand hole cleanout.
   D. Other Features: Sealed combustion direct venting, drain valve, multiple anodes for cathodic, and temperature and pressure relief valve.
E. Approval: By AGA as automatic storage water heater.

F. Controls: Integrated solid state temperature and ignition control, manual reset high temperature control, gas pressure regulator to 13” W.C. coated sealed gas burner, gas pressure regulator and ASME rated temperature relief valve.

G. Venting System: PVC Schedule 40 (ASTM D-1785), Cellular Core Schedule 40 DWV (ASTM F-891), CPVC Schedule 40 (ASTM F-411), or ABS (ASTM D-2661). The fittings, other than the terminations should be equivalent to PVC-DWV meeting ASTM D-2665. Proper cement must be used for all joints.

H. Capacity: Refer to drawings.

I. Location: Refer to drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install water heater on concrete housekeeping pad, minimum 4 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.

C. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.

D. Connect domestic hot water and domestic cold water piping to cold and hot heater connections.

E. Install the following piping accessories. Refer to Section 22 11 00.
   1. On supply:
      a. Check valve.
      b. Shutoff valve.
   2. On return:
      a. Thermometer well and thermometer.
      b. Shutoff valve.
      c. Check valve.

F. Install discharge piping from relief valves and drain valves to nearest floor drain.

G. Install circulator and diaphragm expansion tank on water heater.

H. Install water heater trim and accessories furnished loose for field mounting.

I. Install electrical devices furnished loose for field mounting.

J. Install control wiring between water heater control panel and field mounted control devices.

K. Connect flue to water heater outlet, full size of outlet.


END OF SECTION 223400
SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Urinals.
   3. Wash fountains.
   4. Mop basins.
   5. Electric water coolers/hydration stations.
   6. Sink.

B. Related Sections:
   1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
   2. Section 22 11 00 - Facility Water Distribution: Supply connections to plumbing fixtures.
   3. Section 22 13 00 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
   4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. American National Standards Institute:

B. Air-Conditioning and Refrigeration Institute:
   1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:
   1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
   2. ASME A112.18.1 - Plumbing Fixture Fittings.
   3. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
   4. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.
   5. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
   6. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.3 SUBMITTALS

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

B. Product Data: Submit catalog illustrations of fixtures, sizes, [rough-in dimensions,] utility sizes, trim, and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE


B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., as suitable for purpose specified and indicated.

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 fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

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

1.9 EXTRA MATERIALS

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

B. Supply 1 set of faucet repair kit of each type specified.

1.10 REGULATORY REQUIREMENTS

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

B. Conform to (IMC) International Mechanical Code. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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


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


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

PART 2 - PRODUCTS

2.1 FLUSH VALVE HANDICAP WATER CLOSETS (HWC-1)

A. Bowl:
   1. Manufacturer:
      a. Kohler, Model K-4325.

   2. ASME A112.19.2; wall hung, siphon jet, 1.6 gallon flush, white vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud.

B. Exposed Flush Valve:
   1. Manufacturer:
      a. Sloan, Model Royal G2 Optima Plus 8111-1.6.

   2. ASME A112.18; exposed chrome plated, 1-1/2 top spud, battery powered, top mounted sensor operated, 1.6 gallon flush, escutcheon, integral screwdriver stop and vacuum breaker.

C. Seat:
   1. Manufacturer:
      a. Bemis, Model 2155-SSC.
      b. Church.
      c. Olsonite.

   2. Solid black plastic, open front, extended back, self-sustaining hinge, stainless steel posts and anti-microbial agent.

D. Wall Mounted Carrier:
   1. Manufacturer:
      a. Wade.
      b. J.R. Smith.
      c. Zurn.

   2. ASME A112.6.1: Commercial closet carrier, iron frame, lugs for wall attachment, threaded fixture studs with nuts and washers.
E. Mounting Height: Fixture mounted at ADA compliant height. Refer to architectural drawings for exact height.

2.2 FLUSH VALVE WATER CLOSETS (WC-1)

A. Bowl:
   1. Manufacturer:
      a. Kohler, Model K-4325.
   2. ASME A112.19.2; wall hung, siphon jet, 1.6 gallon flush, white vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud.

B. Exposed Flush Valve:
   1. Manufacturer:
      a. Sloan, Model Royal G2 Optima Plus 8111-1.6.
   2. ASME A112.18; exposed chrome plated, 1-1/2 top spud, battery powered, top mounted sensor operated, 1.6 gallon flush, escutcheon, integral screwdriver stop and vacuum breaker.

C. Seat:
   1. Manufacturer:
      a. Bemis, Model 2155-SSC.
      b. Church.
      c. Olsonite.
   2. Solid black plastic, open front, extended back, self-sustaining hinge, stainless steel posts and anti-microbial agent.

D. Wall Mounted Carrier:
   1. Manufacturer:
      a. Wade.
      b. J.R. Smith.
      c. Zurn.
   2. ASME A112.6.1: Commercial closet carrier, iron frame, lugs for wall attachment, threaded fixture studs with nuts and washers.

E. Mounting Height: Fixture mounted at standard height. Refer to architectural drawings for exact height.

2.3 WALL HUNG HANDICAP URINAL (HU-1)

A. Urinal:
   1. Manufacturer:
      a. Kohler, Model K-4972-T.
      c. Zurn.
2. ASME A112.19.2; vitreous china, wall hung blow-out urinal, 1.0 gallon flush, integral trap, and 1 1/4 inch top spud.

B. Exposed Flush Valve:

1. Manufacturer:
   a. Sloan, Model Royal G2 Optima Plus 8180-1.0.

2. ASME A112.18.1; exposed chrome plated, 1 1/4” top spud, battery back-up powered, sensor operated, 1.0 gallon flush, escutcheon, integral screwdriver stop, vandal resistant stop cap, and vacuum breaker.

C. Wall Mounted Carrier:

1. Manufacturer:
   a. Wade.
   b. J.R. Smith.
   c. Zurn.

2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, and bearing studs.

D. Mounting Height: Fixture mounted at ADA compliant height. Refer to architectural drawings for exact height.

2.4 WALL HUNG URINAL (U-1)

A. Urinal:

1. Manufacturer:
   a. Kohler, Model K-4972-T.
   c. Zurn.

2. ASME A112.19.2; vitreous china, wall hung blow-out urinal, 1.0 gallon flush, integral trap, and 1 1/4 inch top spud.

B. Exposed Flush Valve:

1. Manufacturer:
   a. Sloan, Model Royal G2 Optima Plus 8180-1.0.

2. ASME A112.18.1; exposed chrome plated, 1 1/4” top spud, battery back-up powered, sensor operated, 1.0 gallon flush, escutcheon, integral screwdriver stop, and vacuum breaker.

C. Wall Mounted Carrier:

1. Manufacturer:
   a. Wade.
   b. J.R. Smith.
   c. Zurn.
2. ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, and bearing studs.

D. Mounting Height: Fixture mounted at standard height. Refer to architectural drawings for exact height.

2.5 WASH FOUNTAINS (WF-1 TWO STATION and WF-2 THREE STATION)

A. Manufacturer:

1. Bradley Image Lavatory System, Model MG-2-IR-TMA and MG-3-IR-TMA.

B. Bowl shall be a cast polyester resin complying with ANSI Z124.6. Panels and bowl shall be secured to a 16-gauge stainless steel support frame mounted to wall. Lavatories shall be constructed on 30 inch centers and comply with ANSI and ADA Accessibility Standards. Each spray nozzle shall be served by an independent solenoid valve and actuated by an infrared sensing module with two zone focused transmitting beams not exceeding the bowl perimeter. Each sensor shall have a 2-3 second turn-off delay; and automatically shut-off after 30-45 seconds of continuous operation. Lavatory system shall include P-trap, two flexible supply connections. 110/240 VAC plug-in transformer and thermostatic mixing valve with combination stop strainer and check valves and integral soap dispenser.

C. Color by Architect.

2.6 MOP BASIN

A. Mop Basin (MB-1):

1. Manufacturers:
   a. Fiat Model TSB3012.
   b. Acorn.
   c. Florestone.
   d. Creative Industries Terrazzo Products, Inc.

2. One piece precast Terrazzo Mop Basin. 36” x 36” x 12” high sides with 6” drop front, stainless steel threshold, removable stainless steel strainer, and stainless steel wall guards.

B. Trim:

1. Manufacturer:
   a. Chicago Faucet Model 897.

2. ASME A112.18.1 exposed wall type supply with 369 handles, spout wall brace, vacuum breaker, hose end spout, and escutcheon plates.

2.7 ELECTRIC WATER COOLER (EWC-1)

A. Fountain:

1. Manufacturer:
   a. Elkay Model LZSTL8WSLK.
   b. Halsey Taylor.
2. ARI 1010; Two level wall mounted stainless steel electric water cooler, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser. Lower unit on right when facing dual height electric water coolers. Push button on front. Unit to have complete filtered cooler and bottle filling station, no-touch, sensor activated with 30 second shut-off timer, mounted directly top of electric water cooler. Bottle fill station on higher electric water cooler.
   a. Capacity: 8.0 gpm of 50 degree F. water with inlet at 80 degree F. and room temperature of 90 degree F.
   b. Electrical: Maximum 1/5 HP compressor, 2 foot cord and plug for connection to electric wiring system including grounding connector.
   c. Stainless steel lower shroud on each unit.
   d. Water sentry plus filter.

B. Accessories:
   1. Chrome plated 17 gage brass P-trap with cleanout plug and arm with escutcheon.
   2. NSF/ANSI Standard 61; All lead free brass construction chrome plated quarter turn ball valve.
   3. Chrome plated rigid supplies.

2.8 HAND SINK (HS-1)

A. Single Compartment, Wall Hung:
   1. Manufacturer:
      a. Advance Tabco, Model 7-PS-68.

B. ASME A112.19.3; single bowl, 18 gauge, 304 stainless steel sink, wall hung, 8” high backsplash, overall dimensions: 17 1/4” x 15 1/4”, sink bowl dimensions: 10”x14”x5” deep, and 4” O.C. backsplash mounted gooseneck faucet, wristblade handles, chrome plated with aerator.

2.9 TRIPLE COMPARTMENT SINK

A. Triple Compartment Sink (TCS-1):
   1. Manufacturers:
      a. Advance Tabco Model 93-3-54-18RL.
   2. Triple bowl, 16 gauge, 304 stainless steel sink, overall dimensions: 91” x 27”, sinks bowl dimensions: 20” x 16” x 15” deep, NSF, and faucet drillings as required for specified faucet.

B. Trim:
   1. Manufacturer:
      a. Chicago Faucet Model 445-DJ18E1CP.
      2. ASME A112.18.1M; solid brass body, polished chrome plated finish, double jointed swing spout, with lever handles, and escutcheon plates.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
   B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
   C. Verify electric power is available and of correct characteristics.
   D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

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

3.3 INSTALLATION
   B. Install each fixture with trap, easily removable for servicing and cleaning.
   C. Provide chrome plated rigid to fixtures with loose key stops and escutcheons.
   D. Install components level and plumb.
   E. Install and secure fixtures in place with floor secured carriers and bolts.
   F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.
   G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS
   A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING
   A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
   B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING
   A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
   B. Clean plumbing fixtures and equipment.
3.7 PROTECTION OF INSTALLED CONSTRUCTION
   A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
   B. Do not permit use of fixtures before final acceptance.

3.8 SCHEDULES
   A. Fixture Rough-In:

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Hot Inches</th>
<th>Cold Inches</th>
<th>Waste Inches</th>
<th>Vent Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Closet (Flush Valve):</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Urinal (Flush Valve):</td>
<td>3/4</td>
<td>2</td>
<td>1-1/2</td>
<td></td>
</tr>
<tr>
<td>Wash Fountains:</td>
<td>1/2</td>
<td>1/2</td>
<td>1-1/2</td>
<td>1-1/4</td>
</tr>
<tr>
<td>Sink:</td>
<td>1/2</td>
<td>1/2</td>
<td>1-1/2</td>
<td>1-1/4</td>
</tr>
<tr>
<td>Mop Basin:</td>
<td>1/2</td>
<td>1/2</td>
<td>3</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Electric Water Cooler:</td>
<td>1/2</td>
<td>1-1/4</td>
<td>1-1/4</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 224000
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:

1.3 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.


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 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

B. Related Sections:

1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for piping hangers and supports.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
3. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic heating and cooling systems.

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.
4. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:

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

1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:

1. Installation Temperature: 50 degrees F.
2. Hot Water Heating System Temperature: 190 degrees F.
3. Safety Factor: 30 percent.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion compensators, loops, offsets and swing joints.
C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations.

E. Manufacturer's Installation Instructions: Submit special procedures.

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

G. Welders’ Certificate: Include welders’ certification of compliance with ASME Section IX.

H. Manufacturer’s Field Reports: Indicate results of inspection by manufacturer’s representative.

1.5 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

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

C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work.

1.8 DELIVERY, STORAGE, AND HANDLING

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

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.
1.9 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

1.10 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

1.11 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS
   A. Steel Piping:
      1. Inner Hose: Carbon Steel.
      2. Exterior Sleeve: Braided stainless steel.
      3. Pressure Rating: 200 psig WOG and 250 degrees F.
      5. Size: Use pipe-sized units.
      6. Maximum offset: 3/4 inch on each side of installed center line.
B. Copper Piping:
   1. Inner Hose: Bronze.
   2. Exterior Sleeve: Braided bronze.
   3. Pressure Rating: 200 psig WOG and 250 degrees F.
   5. Size: Use pipe sized units.
   6. Maximum offset: 3/4 inch on each side of installed center line.

2.2 EXPANSION JOINTS
   A. Stainless Steel Bellows Type:
      1. Pressure Rating: 200 psig WOG and 250 degrees F.
      5. Size: Use pipe sized units.
      6. Application: Steel piping 3 inches and smaller.

2.3 ACCESSORIES
   A. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
   B. Swivel Joints: Fabricated steel and Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install Work in accordance with ASME B31.1.
   B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 23 05 48. Provide line size flexible connectors.
   C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
   D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
   E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 22 05 29 for pipe hanger installation requirements.
   F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.
   G. Provide expansion loops as indicated on Drawings.
   H. Install valves upstream and downstream of expansion compensators.
3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 230516
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.
   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:

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
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.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   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.
   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.
   B. Furnish five year manufacturer warranty for pipe hangers and supports.

1.13 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
4. Superior Valve Co.

B. Hydronic Piping:

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.
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.
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.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
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” high.
   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.
   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.
4. Unistrut Corp.

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.

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.
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. 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. Brace and fasten with flanges bolted to structure.
D. 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:

<table>
<thead>
<tr>
<th>Pipe Size Inches</th>
<th>Copper Tubing Maximum Hanger Spacing Feet</th>
<th>Steel Pipe Maximum Hanger Spacing Feet</th>
<th>Copper Tubing Hanger Rod Diameter Inches</th>
<th>Steel Pipe Hanger Rod Diameter Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>5</td>
<td>7</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>3/4</td>
<td>5</td>
<td>7</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>7</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/4</td>
<td>7</td>
<td>7</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>8</td>
<td>9</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>10</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2</td>
<td>9</td>
<td>11</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>12</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>14</td>
<td>1/2</td>
<td>5/8</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>16</td>
<td>1/2</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>17</td>
<td>5/8</td>
<td>3/4</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>19</td>
<td>3/4</td>
<td>3/4</td>
</tr>
<tr>
<td>10</td>
<td>18</td>
<td>22</td>
<td>3/4</td>
<td>7/8</td>
</tr>
<tr>
<td>12</td>
<td>19</td>
<td>23</td>
<td>3/4</td>
<td>7/8</td>
</tr>
<tr>
<td>14</td>
<td>22</td>
<td>25</td>
<td>7/8</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>23</td>
<td>27</td>
<td>7/8</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>25</td>
<td>28</td>
<td>1</td>
<td>1-1/4</td>
</tr>
<tr>
<td>20</td>
<td>27</td>
<td>30</td>
<td>1</td>
<td>1-1/4</td>
</tr>
<tr>
<td>24</td>
<td>28</td>
<td>32</td>
<td>1-1/4</td>
<td>1-1/4</td>
</tr>
</tbody>
</table>
B. Plastic Pipe Hanger Spacing:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Maximum Hanger Spacing Feet</th>
<th>Hanger Rod Diameter Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC (All Sizes)</td>
<td>4</td>
<td>3/8</td>
</tr>
</tbody>
</table>

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. Vibration isolating roof curbs.
3. Duct silencers.

B. Related Sections:

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

1.2 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:


E. ASTM International:

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.

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.

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 VIBRATION ISOLATING ROOF CURBS

A. Manufacturers:
   1. Thybar.
   2. Pate.
   3. Mason Industries.

B. General Description:
   1. The roof curbs shall be factory fabricated fully insulated, including the isolator area, weatherproof roof curbs with vibration isolators.
   2. The base shall be designed so that it can be re-roofed without disturbing the rooftop unit.
   3. The vibration eliminating portion of the curb assembly shall be constructed of structural steel and designed to match the bottom of the rooftop unit. The vibration isolators shall provide a minimum isolation, efficiency of 90% with 2" deflection.
   4. The roof curb shall be supplied complete with wood nailing strip and continuous 9” rubber counter flashing for watertight construction.
   5. The base of the curb shall have solid bottom with openings for the rooftop supply and return connection.
   6. The contractor shall field install layers of 12” thick sound batt insulation to fill in the base of the curb.
   7. Curbs shall match the pitch of the roof.

2.3 DUCT SILENCERS

A. Manufacturers:
   2. Dynasonic.
   3. Industrial Acoustic Company.

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.

4. Duct silencers shall be shipped to the job site with the openings sealed from the factory.

5. Duct silencers shall be stored inside out of the weather and protected from damage.

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:

   a. 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
   - **Corridor:** NC40 to NC45

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 manufacturer 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:

1.3 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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   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:
      2. Safety Sign Co.
   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
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, exhaust fans, intake hoods, gas shut-off valves, etc. with plastic nameplates.
F. In addition to providing engraved plastic name plates on the VAV boxes provide engraved plastic name plates on the ceiling grid below the VAV box. The name plate shall be no wider than the width of the grid (white with black letters).
G. Identify control panels and major control components outside panels with plastic nameplates.
H. Identify valves in main and branch piping with tags.
I. Tag automatic controls, instruments, and relays. Key to control schematic.
J. 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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:
   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:

<table>
<thead>
<tr>
<th>Service</th>
<th>Normal Work Pressure psig</th>
<th>Hydrostatic Test Pressure psig</th>
<th>Maximum Pneumatic Test Pressure psig</th>
<th>Allowable Pressure Drop psig</th>
<th>Minimum Test Time Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating and Cooling Systems:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Water</td>
<td>To 100</td>
<td>150</td>
<td>---</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1. Natural Gas</td>
<td></td>
<td></td>
<td>100</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

---

**Hagney Architects, LLC**

**TESTING OF PIPING**

**Job #1741**

---

**Issued for Bid and Permit - 5-21-2013**

---

Auburn High School
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 from all equipment, pipes, valves and 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 230923 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
   2. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Associated Air Balance Council:

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

C. Natural Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Section 013300 - 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. Independent Test and Balance.
B. Aero Test and Balance.
C. Superior Test and Balance.
D. Professional System Analysis.
E. Airdronic.
F. International.

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

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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. Proper strainer baskets are clean and in place or in normal position.
14. 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. Exhaust Fans.
2. Packaged Roof Top Heating/Cooling Units.
3. Air Coils.
4. Terminal Heat Transfer Units.
5. Fans.
6. Air Filters.
7. Air Terminal Units.
8. Air Inlets and Outlets.

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. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
   j. Water flow, design and actual
   k. Water pressure drop, design and actual
   l. Entering water temperature, design and actual
   m. Leaving water temperature, design and actual
   n. Saturated suction temperature, design and actual
   o. 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
   m. kW input/output

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. Exhaust Fan Data:
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Air flow, specified and actual
    f. Total static pressure (total external), specified and actual
    g. Inlet pressure
    h. Discharge pressure
    i. Sheave Make/Size/Bore
    j. Number of Belts/Make/Size
    k. Fan RPM

11. 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

12. Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Inlet static pressure
13. 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

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:


B. Sheet Metal and Air Conditioning Contractors’:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
C. Underwriters Laboratories Inc.:

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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   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.
       5. Armstrong.
   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.
   2. ASTM C195; hydraulic setting on mineral wool.

2.2 CELLULAR FOAM - TYPE B

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
   1. 'K' Value: ASTM C177 or C518; 0.27 at 75 degrees F.
   2. Minimum Service Temperature: -20 degrees F.
   3. Maximum Service Temperature: 220 degrees F.
   4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent pipe by volume, 1.0 percent (sheet) by volume.
   5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
   7. Maximum Smoke Developed: ASTM E84; 50.

B. Elastomeric Foam Adhesive:
   1. Air dried, contact adhesive, compatible with insulation.
   2. Vapor coating mastic shall be manufactured by Childers (CP-35) or approved equal.

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.

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.
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.


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. 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.

3.3 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.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

3.4 PIPE SYSTEMS INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Piping Systems</th>
<th>Insulation Type</th>
<th>Pipe Size</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating/Cooling Systems:</td>
<td></td>
<td>Inch</td>
<td>Inch</td>
</tr>
<tr>
<td>Heating Supply and Return</td>
<td>A</td>
<td>Up to 1-1/2” 2” and Up 2”</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>Metallic Condensate Piping</td>
<td>B</td>
<td>Up to 4”</td>
<td>3/4”</td>
</tr>
</tbody>
</table>

3.5 DUCT SYSTEMS INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>Ductwork</th>
<th>Type</th>
<th>Thickness Finish Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Supply Ducts</td>
<td>D-3</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>2. Return Duct</td>
<td>D-3</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>3. Mixed Air Ductwork</td>
<td>D-2</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>4. Outside Air Ducts</td>
<td>D-2</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>5. HVAC Plenums</td>
<td>D-2</td>
<td>2”</td>
</tr>
<tr>
<td>6. Transfer Duct</td>
<td>D-3</td>
<td>1”</td>
</tr>
<tr>
<td>7. VAV Box Coils</td>
<td>D-1</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>8. Exhaust ductwork from louver or roof curb to backdraft damper.</td>
<td>D-1</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>9. Concealed Round Branch Ductwork</td>
<td>D-1</td>
<td>1-1/2”</td>
</tr>
</tbody>
</table>

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.
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:


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:

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
   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.

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

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

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

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

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

H. Duct Mount Sensors.
   1. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
   2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

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

A. Differential Pressure Transmitters.

1. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
2. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
4. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible. Low Differential Water Pressure Applications (0" - 20" w.c.).
5. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
6. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
   a. 0.01-20" 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: +0.02% 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.

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 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 variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, air handling units, chillers, pumps, unit ventilators, 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.
   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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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:
      1. 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. Radiant ceiling panels.
   c. Electric cabinet unit heaters.
   d. Electric suspended unit heaters.
   e. Gas fired unit heaters.
   f. VAV boxes.
   g. Exhaust fans.
   h. Destratification fans.
   i. Occupancy sensors.
   j. Phase monitoring.
   k. Exterior lighting.

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 30 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate mechanical system controlled and control system components.

1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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, etc. necessary for a complete operating system. At contractor’s option, entire control system specified herein may 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 ROOFTOP UNITS

A. Constant Volume Rooftop Unit (AHS.RTU-1):

1. The system will function as programmed at the unit controller by unit manufacturer. The Building Automation System will interface with the RTU through the LON data connection. All available points from manufacturer LON communication module shall be mapped into the BAS.

2. BAS contractor shall mount and wire all loose manufacturer supplied components.

3. Occupied Mode: The occupancy mode shall be controlled via a network input.

4. Unoccupied Mode: The unit shall cycle to maintain unoccupied zone setpoints during unoccupied periods.

5. Activation of any return or supply air smoke detector shall shut down system, signal BAS alarm, and signal fire alarm system.

6. Warmup / cooldown mode: The warmup/cooldown mode will be initiated by the network input. The unit will control to discharge air setpoints during warmup and cooldown cycles. The BAS shall measure the space temperature and the outside air temperature to determine the minimum runtime to warm the space to setpoint. When the computed start time is reached the BAS shall enabled the RTU. Reset space temperature setpoint to occupied space temperature setpoint.

7. Minimum OA Control: The fresh air intake of the unit shall be limited to prevent the preheat temperature from falling below the low limit setpoint. CO2 return air sensor shall reduce the damper position below minimum setting as long as the levels do not exceed acceptable levels per ASHRAE recommendations.

8. Economizer Control: When enabled via the network command, the economizer shall act as the initial stage of cooling, working in sequence with the cooling coil. The return air CO2 sensor shall be used to reset the damper below minimum position unless RTU is operating in economizer mode. The outside air damper shall close whenever the freezestat is tripped.

9. Supply Fan Control: The supply fan will be started based on occupancy schedule. When the supply fan status indicates the fan started, the control sequence will be enabled. Upon a loss of airflow, the system will automatically restart.

10. Relief Fan Control: When the unit is in Economizer mode, the relief fan will modulate to maintain the building static pressure at setpoint.

11. Temperature Control: The discharge air temperature setpoint shall reset as the outdoor air temperature changes.

12. Pre-heat: The gas furnace shall be modulated to maintain the minimum discharge air temperature setpoint.

13. Night Setback: The unit will cycle to maintain unoccupied zone setpoints during unoccupied periods.

14. Input/Output Schedule (minimum points required):

<table>
<thead>
<tr>
<th>BAS Hardwired Points</th>
<th>MFG Supplied and LON Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Name</td>
<td>AI</td>
</tr>
<tr>
<td>Filter Differential Pressure</td>
<td>x</td>
</tr>
<tr>
<td>Space Air Temp</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Carbon Dioxide PPM</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Temp</td>
<td>x</td>
</tr>
<tr>
<td>Supply Air Temp</td>
<td>x</td>
</tr>
<tr>
<td>Damper(s) Control</td>
<td>x</td>
</tr>
</tbody>
</table>
**BAS Hardwired Points**  |  **MFG Supplied and LON Points**
--- | ---
Point Name | AI | AO | DI | DO | AV | BV | Loop | Sched | Trend | Alarm | Show On Graphic
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
High Static Shutdown | x | x | x
Supply Fan Status | x | x | x
Exhaust Fan Status | x | x | x
Cooling /Each Stage | x | x | x
Supply Air Temp Setpoint | x | x | x
Outside Air Temp DB | x | x
Return Air Humidity | x | x | x
Low Supply Air Temp | x
Outside Air WB | x | x
Freezestat | x | x

**B. Roof Mounted Air Handling Units (AHS.RTU-2 thru AHS.RTU-7):**

1. The system will function as programmed at the unit controller by unit manufacturer. The Building Automation System will interface with the RTU through the LON data connection. All available points from manufacturer LON communication module shall be mapped into the BAS.
2. BAS contractor shall mount and wire all loose manufacturer supplied components.
3. During occupied mode, both supply and exhaust fans shall operate continuously.
4. Economizer Control: The economizer will provide ambient air cooling to maintain discharge air setpoint. Economizer control shall be enabled based on outside air temperature. The modulating powered exhaust fan shall run during economizer mode to control room pressure.
5. Temperature Control: The discharge air temperature setpoint will be reset as the zone temperature changes. RTU controller shall modulate the internal components of the RTU to maintain discharge air setpoint as commanded by the BAS.
6. Warmup Mode: The warmup mode will be initiated by the network input. The unit will control to discharge air setpoints during warmup and cooldown cycles. The BAS shall measure the space temperature and the outside air temperature to determine the minimum runtime to warm the space to setpoint. When the computed start time is reached the BAS shall enabled the RTU. Reset space temperature setpoint to occupied space temperature setpoint.
7. Occupied Mode: The occupancy mode will be controlled via a network input. The occupancy mode can also be overridden by a network input.
8. Unoccupied Mode: The unit will cycle to maintain unoccupied zone setpoints during unoccupied periods.
9. Heating Control:
   a. The RTU microprocessor shall stage/modulate operation of the gas heating to maintain discharge air temperature set-point as commanded by the BAS input.
10. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:
   a. Occupied Mode: The unit shall maintain
      1) A 70°F (adj.) heating setpoint.
   b. Unoccupied Mode (night setback): The unit shall maintain
      1) A 55°F (adj.) heating setpoint.

11. Alarms shall be provided as follows:
   a. High Zone Temp: If the zone temperature is greater than the setpoint by a user definable amount (adj.).
   b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

12. CO2 and Outside Air Damper Control:
   a. 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.
   b. At no time shall the outside air dampers go above the minimum setting unless the outside air conditions are appropriate for economizer operation.

13. Zone Setpoint Adjust:
   a. The zone temperature heating setpoints shall be adjustable at the BAS operator workstation.

14. Smoke Detection:
   a. The unit shall shut down and generate an alarm upon receiving signal from a duct smoke detector.

15. Supply Fan:
   a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime. Alarms shall be provided as follows:
      1) Supply Fan Failure: Commanded on, but the status is off.
      2) Supply Fan in Hand: Commanded off, but the status is on.
      3) Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

16. Cooling Stages:
   a. Provisions shall be incorporated in the controls to facilitate the addition of cooling in the future.

17. Gas Heating:
   a. The unit shall modulate gas heat to maintain discharge air temperature setpoint command from BAS.
18. Economizer:
   a. The RTU microprocessor controller shall monitor discharge air temperature set-point command received from the BAS and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position whenever occupied. The economizer shall be enabled whenever:
      1) Outside air temperature is less than 95°F (adj.).
      2) AND the supply fan status is on.
   b. The economizer shall close whenever:
      1) Mixed air temperature drops from 45°F to 40°F (adj.).
      2) OR on loss of supply fan status.
      3) OR the freezestat is on.

19. Input/Output Schedule (minimum points required):

<table>
<thead>
<tr>
<th>Point Name</th>
<th>BAS Hardwired Points</th>
<th>MFG Supplied and LON Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Differential Pressure</td>
<td>AI: x</td>
<td></td>
</tr>
<tr>
<td>Space Air Temp</td>
<td>AO: x</td>
<td></td>
</tr>
<tr>
<td>Return Air Carbon Dioxide PPM</td>
<td>DI: x</td>
<td></td>
</tr>
<tr>
<td>Return Air Temp</td>
<td>DO: x</td>
<td></td>
</tr>
<tr>
<td>Supply Air Temp</td>
<td>AV: x</td>
<td></td>
</tr>
<tr>
<td>Exhaust Fan VFD Speed</td>
<td>BV: x</td>
<td></td>
</tr>
<tr>
<td>Damper(s) Control</td>
<td>Loop: x</td>
<td></td>
</tr>
<tr>
<td>High Static Shutdown</td>
<td>Sched: x</td>
<td></td>
</tr>
<tr>
<td>Supply Fan VFD Fault</td>
<td>Trend: x</td>
<td></td>
</tr>
<tr>
<td>Supply Fan Status</td>
<td>Alarm: x</td>
<td></td>
</tr>
<tr>
<td>Exhaust Fan VFD Fault</td>
<td>Show On Graphic: x</td>
<td></td>
</tr>
<tr>
<td>Exhaust Fan Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling /Each Stage (future)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Air Temp Setpoint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Air Temp DB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Static Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Supply Air Temp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Air WB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freezestat</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Variable Air Volume Rooftop Unit (AHS.RTU-8, and AHS.RTU-9):

1. The system will function as programmed at the unit controller by unit manufacturer. The Building Automation System will interface with the RTU through the LON data connection. All available points from manufacturer LON communication module shall be mapped into the BAS.
2. BAS contractor shall mount and wire all loose manufacturer supplied components.
3. Occupied Mode: The occupancy mode shall be controlled via a network input.
4. Unoccupied Mode: The unit shall cycle to maintain unoccupied zone setpoints during unoccupied periods.
5. Activation of any return or supply air smoke detector shall shut down system, signal BAS alarm, and signal fire alarm system.
6. Warmup / cooldown mode: The warmup/cooldown mode will be initiated by the network input. The unit will control to discharge air setpoints during warmup and cooldown cycles. The BAS shall measure the space temperature and the outside air temperature to determine the minimum runtime to warm the space to setpoint. When the computed start time is reached the BAS shall enabled the RTU. Reset space temperature setpoint to occupied space temperature setpoint.
7. Minimum OA Control: The fresh air intake of the unit shall be limited to prevent the preheat temperature from falling below the low limit setpoint. CO2 return air sensor shall reduce the damper position below minimum setting as long as the levels do not exceed acceptable levels per ASHRAE recommendations.
8. Economizer Control: When enabled via the network command, the economizer shall act as the initial stage of cooling, working in sequence with the cooling coil. The return air CO2 sensor shall be used to reset the damper below minimum position unless RTU is operating in economizer mode. The outside air damper shall close whenever the freezeingstat is tripped.
9. Supply Fan Control: The variable speed supply fan will be started based on occupancy schedule. When the supply fan status indicates the fan started, the control sequence will be enabled. The supply fan will modulate to maintain the discharge static pressure at setpoint. Upon a loss of airflow, the system will automatically restart.
10. Relief Fan Control: When the unit is in Economizer mode, the relief fan will modulate to maintain the building static pressure at setpoint. On an increase in building static pressure, the relief fan VFD shall be ramped up.
11. Temperature Control: The discharge air temperature setpoint shall reset as the outdoor air temperature changes.
12. Pre-heat: The gas furnace shall be modulated to maintain the minimum discharge air temperature setpoint.
13. Night Setback: The unit will cycle to maintain unoccupied zone setpoints during unoccupied periods.
14. Input/Output Schedule (minimum points required):

<table>
<thead>
<tr>
<th>Point Name</th>
<th>BAS Hardwired Points</th>
<th>MFG Supplied and LON Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Differential Pressure</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Space Air Temp</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Carbon Dioxide PPM</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Temp</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Supply Air Temp</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Exhaust Fan VFD Speed</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
D. Rooftop Unit (AHS.RTU-10):

1. The system will function as programmed at the unit controller by unit manufacturer. The Building Automation System will interface with the RTU through the LON data connection. All available points from manufacturer LON communication module shall be mapped into the BAS.

2. BAS contractor shall mount and wire all loose manufacturer supplied components.

3. During occupied mode, both supply and exhaust fans shall operate continuously.

4. Economizer control: The economizer will act as the initial stage of cooling, working in sequence with the condenser to maintain discharge air setpoint. Economizer control shall be enabled based on outside air enthalpy. The modulating powered exhaust fan shall run during economizer mode to control room pressure.

5. Temperature control: The discharge air temperature setpoint will be reset as the zone temperature changes. RTU controller shall modulate the internal components of the RTU to maintain discharge air setpoint as commanded by the BAS.

6. Warmup / cooldown mode: The warmup/cooldown mode will be initiated by the network input. The unit will control to discharge air setpoints during warmup and cooldown cycles. The BAS shall measure the space temperature and the outside air temperature to determine the minimum runtime to warm the space to setpoint. When the computed start time is reached the BAS shall enabled the RTU. Reset space temperature setpoint to occupied space temperature setpoint.

7. Occupied mode: The occupancy mode will be controlled via a network input. The occupancy mode can also be overridden by a network input.

8. Unoccupied mode: The unit will cycle to maintain unoccupied zone setpoints during unoccupied periods.

9. Heating/Cooling Control

   a. The RTU microprocessor shall stage operation of condenser and/or gas heating to maintain discharge air temperature set-point as commanded by the BAS input.
10. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:
   a. Occupied Mode: The unit shall maintain
      1) A 74°F (adj.) cooling setpoint
      2) A 70°F (adj.) heating setpoint.
   b. Unoccupied Mode (night setback): The unit shall maintain
      1) A 85°F (adj.) cooling setpoint.
      2) A 55°F (adj.) heating setpoint.

11. Alarms shall be provided as follows:
   a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
   b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

12. CO2 and Outside Air Damper Control:
   a. 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.
   b. At no time shall the outside air dampers go above the minimum setting unless the outside air conditions are appropriate for economizer operation.

13. Zone Setpoint Adjust:
   a. The zone temperature heating and cooling setpoints shall be adjustable at the BAS operator workstation.

14. Smoke Detection:
   a. The unit shall shut down and generate an alarm upon receiving signal from a duct smoke detector.

15. Supply Fan:
   a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime. Alarms shall be provided as follows:
      1) Supply Fan Failure: Commanded on, but the status is off.
      2) Supply Fan in Hand: Commanded off, but the status is on.
      3) Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

16. Cooling Stages:
   a. The unit shall modulate/stage DX cooling to maintain discharge air setpoint command from BAS.

17. Gas Heating:
   a. The unit shall modulate gas heat to maintain discharge air temperature setpoint command from BAS.
18. **Economizer:**

   a. The RTU microprocessor controller shall monitor discharge air temperature set-point command received from the BAS and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position whenever occupied. The economizer shall be enabled whenever:

   1) Outside air temperature is less than 65°F (adj.).
   2) AND the supply fan status is on.

   b. The economizer shall close whenever:

   1) Mixed air temperature drops from 45°F to 40°F (adj.).
   2) OR on loss of supply fan status.
   3) OR the freezestat is on.

19. **Input/Output Schedule (minimum points required):**

<table>
<thead>
<tr>
<th>Point Name</th>
<th>BAS Hardwired Points</th>
<th>MFG Supplied and LON Points</th>
<th>Show On Graphic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filter Differential Pressure</td>
<td>AI AO DI DO AV BV Loop Sched Trend Alarm</td>
<td>x x x</td>
<td></td>
</tr>
<tr>
<td>Space Air Temp</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Carbon Dioxide PPM</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Return Air Temp</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Supply Air Temp</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Exhaust Fan VFD Speed</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Damper(s) Control</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>High Static Shutdown</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Supply Fan VFD Fault</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Supply Fan Status</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Exhaust Fan VFD Fault</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Exhaust Fan Status</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Cooling /Each Stage</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Supply Air Temp Setpoint</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Outside Air Temp DB</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return Air Humidity</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Building Static Pressure</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Low Supply Air Temp</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Air WB</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freezestat</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Recovery Wheel Status</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3 RADIANT CEILING PANELS

A. Radiant Ceiling Panels (AHS.RCP-1 thru AHS.RCP-5):
   1. BAS shall provide 2-way modulating control valve in sequence with associated rooftop unit to maintain setpoint. Radiant Ceiling Panels shall be the first stage of heat.

B. Input/Output Schedule (minimum points required):

<table>
<thead>
<tr>
<th>Description</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Temperature</td>
<td>AI</td>
</tr>
<tr>
<td>Space Temperature Setpoint</td>
<td>AI</td>
</tr>
<tr>
<td>RCP Control Valve</td>
<td>AO</td>
</tr>
<tr>
<td>Computer Graphic Display Of System</td>
<td>All Points</td>
</tr>
</tbody>
</table>

3.4 ELECTRIC CABINET UNIT HEATERS

A. Electric Cabinet Unit Heaters (AHS.ECUH-1 thru AHS.ECUH-7):
   1. Single temperature electric wall mounted thermostat (where indicated in the drawing) set at 68 degrees F (adj.) maintains constant space temperature by cycling unit fan motor and heating elements.

3.5 ELECTRIC SUSPENDED UNIT HEATER (AHS.ESUH-1 thru AHS.ESUH-3)

A. The temperature control contractor shall furnish, install and wire new wall mounted thermostats for the electric ceiling heaters. Provide all necessary hardware as required. Refer to schedules for units with factory furnished thermostats.

B. The temperature control contractor shall provide tamperproof guards for the wall mounted thermostats in public areas.

3.6 GAS FIRED UNIT HEATERS (AHS.GUH-1 thru AHS.GUH-9)

A. Two stage thermostat set at 68 degrees F (adj.) maintains constant space temperature by cycling unit fan motor and gas valve.

B. Units shall have remote-mounted or unit mounted thermostats as shown on plan.

3.7 VAV BOXES (AHS.VAV-1 thru AHS.VAV-13. See control diagram on drawings):

A. Box Damper/Hot Water Coil/Valve Control:
   1. If the occupancy is off, then the box damper shall be 100% open.
   2. If occupied, the box damper shall modulate between minimum and maximum positions to maintain the associated space temperature setpoint (adj.). On a call for heating, the box damper (through a reversing relay) shall modulate open from minimum position in sequence with associated box stages of electric heat (through SSR controller) as required to maintain room thermostat setpoint.

B. BAS contractor shall coordinate and provide all wiring, contactors, relays, etc. to interface with occupancy sensor (furnished by electrical contractor) to revert to unoccupied temperatures (adj.) when the system is in the occupied mode and the room is unoccupied. Refer to electrical drawings for occupancy sensor locations.

C. Morning Warmup andCooldown:
   1. During morning warmup and cooldown the VAV boxes shall be 100% open.
D. **Input/Output Schedule.** (Minimum points required. Space sensors to be flat plate stainless steel.):

<table>
<thead>
<tr>
<th>Description</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. VAV discharge air temperature (each)</td>
<td>AI</td>
</tr>
<tr>
<td>2. VAV discharge velocity (each)</td>
<td>AI</td>
</tr>
<tr>
<td>3. VAV box heating (each stage of %)</td>
<td>AO</td>
</tr>
<tr>
<td>4. Space temperature (each)</td>
<td>AI</td>
</tr>
<tr>
<td>5. Space temperature setpoint (each)</td>
<td>AO</td>
</tr>
<tr>
<td>6. Damper</td>
<td>AO</td>
</tr>
<tr>
<td>7. Occupancy Status</td>
<td>DI</td>
</tr>
<tr>
<td>8. Graphic display</td>
<td>---</td>
</tr>
</tbody>
</table>

3.8 **EXHAUST FANS** (AHS.EF-1 thru AHS.EF-7):

A. Exhaust fan (AHS.EF-1, AHS.EF-3, and AHS.EF-4) on/off status, shall start/stop by BAS.

B. Exhaust fan (AHS.EF-2) on/off status, shall enable/disable by BAS. Activation of a local wall switch with pilot light starts/stops fan operation.

C. Exhaust fan (AHS.EF-5 thru AHS.EF-7) status by BAS. On/off by thermostat sensor. Interlock AHS.IH-2 with end switch with operation of AHS.EF-5.

D. **Input/Output Schedule** (minimum points required):

<table>
<thead>
<tr>
<th>Description</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Exhaust Fan Status (each)</td>
<td>DI</td>
</tr>
<tr>
<td>2. Exhaust Fan Start/Stop (AHS.EF-1, EF-3, EF-4)</td>
<td>DO</td>
</tr>
<tr>
<td>3. Exhaust Fan Enable/Disable (AHS.EF-2)</td>
<td>DO</td>
</tr>
<tr>
<td>4. High Temperature Alarm IDF Closet 1424.2</td>
<td>DI</td>
</tr>
<tr>
<td>5. Graphic Display</td>
<td>---</td>
</tr>
</tbody>
</table>

3.9 **DESTRATIFICATION FANS** (AHS.DF-1 thru AHS.DF-8)

A. Destratification fans on/off status shall be by local switches.

B. All destratification fans shall be interlocked to shut down immediately upon receiving a workflow signal from the fire alarm system in accordance with NFPA 72.

C. BAS contractor shall mount and wire fan speed controllers, see plans for locations.

3.10 **OCCUPANCY SENSOR**

A. The BAS contractor shall coordinate and provide all wiring, contactors, relays, etc. to interface with occupancy sensor which is furnished and installed by the electrical contractor. The BAS contractor shall interface with the occupancy sensor to revert to set back temperatures (heating 68 degrees; cooling 77 degrees) for the space. The occupancy sensor will also turn off the lights (wiring to the lighting system shall be performed by the electrical contractor). When the room becomes occupied again and the system is in the occupied mode, the VAV boxes/units will resume to normal mode of operation.

B. **Equipment List:**

1. AHS.VAV-2.
2. AHS.VAV-4.
3. AHS.VAV-5.
4. AHS.VAV-6.
5. AHS.VAV-7.
6. AHS.VAV-8.
7. AHS.VAV-9.
8. AHS.VAV-10.
9. AHS.VAV-11.
10. AHS.RTU-10 the outside air damper shall be closed.

3.11 POWER/PHASE MONITORING

A. A phase monitor (Hawk Eye or approved equal for a 208V 2000 amp) 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. Rooftop units
2. Exhaust fans (3Ø only)
3. Pumps
4. Boilers
5. Variable frequency drives

3.12 EXTERIOR LIGHTING

A. On/off status of exterior lighting shall be programmed into BAS and connected to each exterior lighting master and/or slave control panel and lighting contactor.

B. Input/Output Schedule (minimum points required):

<table>
<thead>
<tr>
<th>Description</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior lighting zone 1 on/off</td>
<td>DO</td>
</tr>
<tr>
<td>Exterior lighting zone 1 status</td>
<td>DI</td>
</tr>
</tbody>
</table>

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.

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:


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:


D. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
E. American Water Works Association:

F. National Fire Protection Association:

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
   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.
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.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION - INSERTS

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

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

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient.
D. Install piping to conserve building space and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
I. Provide clearance for installation of insulation and access to valves and fittings.
J. Provide access where valves and fittings are not exposed.
K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
L. Provide support for utility meters in accordance with requirements of utility company.
M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 90 00.

O. Install identification on piping systems including underground piping. Refer to Section 23 05 53.

P. Install valves with stems upright or horizontal, not inverted.

Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

R. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.

S. Install gas pressure regulator with tee fitting not less than 10 pipe diameters downstream of regulator. Cap or plug one opening of tee fitting.

T. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.

U. Provide new gas service complete with gas meter and regulators. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

V. All gas piping within walls shall be welded, not screwed.

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

3.6 FIELD QUALITY CONTROL

A. Pressure test natural gas piping in accordance with NFPA 54.

B. Inspect, test and purge gas piping in accordance with applicable code.

C. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

END OF SECTION 231123
SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

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

1.2 REFERENCES

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

B. ASTM International:
27. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

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: 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
   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.
   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.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

   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.

2.3 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.

2.4 GATE VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO, Inc.
   4. Apollo.

2.5 GLOBE VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO, Inc.
   4. Apollo.

2.6 BALL VALVES

A. Manufacturers: (use only full port ball valves)
   1. Milwaukee Valve Company.
   2. NIBCO, Inc.
   4. Apollo.

2.7 BUTTERFLY VALVES

A. Manufacturers: (use only full lug butterfly valves)
   1. Milwaukee Valve Company.
   2. NIBCO, Inc.
   4. Apollo.

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.

B. Spring Loaded Check Valves:
   1. Manufacturers:
      a. Milwaukee Valve.
      b. NIBCO, Inc.
      c. Stockham Valves & Fittings.
      d. Apollo.
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 and chilled 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. Test plugs.
   2. Air vents.
   3. Strainers.

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:

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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

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

2.2 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.
      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.
2.3 STRAINERS

A. Acceptable Manufacturers:
   1. Nibco.
   2. Milwaukee.

B. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
   1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.4 CIRCUIT BALANCING VALVES

A. Manufacturers:
   1. Bell & Gossett.
   2. Taco.
   3. Armstrong.
   4. Illinois.
   5. HCI.
   6. Oventrop.

B. Orifice principle by-pass circuit with direct reading gage, soldered or flanged piping connections for 125 psig (860 kPa) working pressure, with shut off valves, and drain and vent connections.

C. Direct reading with insert Pitot tube, threaded coupling, for 150 psig working pressure, maximum 240 degrees F, 5 percent accuracy.

D. 2 1/2 Inch and Larger: Cast iron, wafer type, orifice insert flow meter for 250 psig (1720 kPa) working pressure, with read-out valves equipped with integral check valves with gasketed caps. Provide butterfly valve with memory stop for balancing.

E. 2 1/2 Inch and smaller: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.

F. Provide manufacturer furnished molded insulated valve covers.
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 drain and hose connection with valve on strainer blow down connection.

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

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

   H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers,
and expansion tanks.

   I. Select system relief valve capacity greater than make-up pressure reducing valve capacity.
Select equipment relief valve capacity to exceed rating of connected equipment.

   J. Pipe relief valve outlet to nearest floor drain.

   K. Where one line vents several relief valves, make cross sectional area equal to sum of
individual vent areas.

3.2 PROTECTION OF INSTALLED CONSTRUCTION

   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting
installed construction.

END OF SECTION 232116
SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. System cleaner.
   2. Chemicals.
B. Related Sections:
   1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
   2. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES
A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout products.
B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
C. Operation and Maintenance Data: Submit data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
1.5 QUALITY ASSURANCE
   A. Perform Work in accordance with State of Illinois standard for addition of non-potable chemicals to building systems and for discharge to public sewers.
   B. Maintain one copy of each document on site.

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

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

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

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

1.10 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURES

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

2.2 CHEMICALS

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

PART 3 - EXECUTION

3.1 WATER ANALYSIS

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

3.2 INSTALLATION

A. All cleaning, flushing and chemical treatment shall be observed by the chemical treatment representative.
B. Refill all existing systems to the chemical concentration prior to construction.
C. Contractor shall drain, flush, fill, and vent piping systems.
3.3 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components and equipment installation, including piping. Report results in writing.

C. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before initiating water-treatment system.

D. Prior to acceptance by the owner, all grease, dirt, oil and metallic oxides shall be removed from each closed recirculating water system. Mechanical contractor shall inform the water treatment contractor of all the system materials of construction to insure chemical cleaner compatibility. Supervision and cleaner shall be provided by Chemical Treatment Company. The following cleaning procedure shall apply:

E. Closed Recirculating Water Systems Cleaning

1. The system shall be filled through a suitable water meter to determine total water volume, taking care to bleed all air.
2. With the system circulating, flow will be verified throughout the system. All debris shall be flushed from the system and all strainers cleaned.
3. C-312 Multi-Purpose Cleaner shall be added to the system at a dosage rate of twenty (20) gallons per one thousand (1,000) gallons of system volume. The chemical treatment contractor shall verify cleaner strength.
4. Hot water systems shall be heated to 160-180°F and circulated for twenty-four (24) hours.
5. During the cleaning period, system water shall be circulated through the entire system. Mechanical contractor shall insure that all small orifices (control valves, strainers, etc.) remain free of debris. A side stream filter shall be used for removal of suspended solids during the cleaning period. Filter Media shall be changed as required.
6. When cleaning period is complete, the system shall be drained and flushed with fresh water to remove the cleaning solution. Flushing shall continue until the total (M) alkalinity of the system water is within fifty (50) ppm of the total alkalinity of the make-up water.
7. All strainers, dead legs, and areas of low flow shall be thoroughly flushed to remove accumulated debris.
8. Immediately following completion and verification of flushing, certification records covering the cleaning shall be submitted to the mechanical contractor and the owner. Records shall include system volume, cleaner concentration, circulation time, and final alkalinity reading. Each system shall be chemically treated as provided elsewhere in this specification.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-treatment systems and equipment.

B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

C. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 Section "Operation and Maintenance Data."

D. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 232500
SECTION 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 spiral round ducts.
6. Fabric air dispersion.

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:

2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
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, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

B. National Fire Protection Association:

2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
C. Sheet Metal and Air Conditioning Contractors:
   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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MATERIALS
   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.
   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.

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 insure 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.

3. 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 insure 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 an outer pressure shell coupling. The inner liners shall not be fastened together to allow for expansion and contraction.

2.6 FABRIC AIR DISPERSION

A. Manufacturer:

1. Subject to compliance with requirements, choose one of the following:

   a. DuctSox® Corporation
      Phone: (866) DUCTSOX
      Fax: (866) 398-1646
      www.ductsox.com

   b. Engineer approved equal.

B. System:

1. Sedona-Xm Fabric: Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:

   a. Fabric Construction: 100% Flame Retardant and treated with a machine washable anti-microbial agent from the manufacturer.

   b. Weight: 6.75 oz. /yd² per ASTM D3776

   c. Color: Custom color selected by the architect.

   d. Fabric Porosity: 1.5 (+2/-1) cfm/ft² per ASTM D737, Frazier

   e. Temperature Range: 0 degrees F to 180 degrees F

   f. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC167.

   g. Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

C. Systems Fabrication Requirements:

1. Air dispersion accomplished by linear vent and permeable fabric. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.

2. Size of vent openings and location of linear vents to be specified and approved by manufacturer.

3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.

4. Inlet connection includes zipper for easy removal / maintenance.

5. Lengths to include required zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in. w.g. static pressure.

7. End cap includes zipper for easy maintenance.

8. Fabric system shall include connectors to accommodate suspension system listed below.

9. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the DuctSox.

D. Design Parameters:

1. Fabric diffusers shall be designed from 0.25” water gage minimum to 3.0” maximum, with 0.5” as the standard. A pressure drop of 0.40” has been allowed for in the rooftop E.S.P. calculation.

2. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).

3. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.

4. Fabric air ductwork shall distribute air uniformly across the Fieldhouse floor in accordance with ASHRAE recommended terminal velocities.

5. The fabric duct distribution shall not interfere with the destratification fan operation.

E. Suspension Hardware:

1. 3x1 Suspension: System shall include a 3 Row connection to fabric system at 10, 12, and 2 o’clock locations. The powder-coated aluminum hangers are secured and connected to a single (1 Row) tension cable every 3’-0” and connect to the fabric system at the 10 and 2 o’clock locations with detachable D-Clasps. The fabric system will also have intermediate cable clips located at 12 o’clock and between the hangers to attach directly to the single tension cable system located 3” above top-dead-center location of the fabric system. Tension cable hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckles as required.

2. Components Include:
   a. Stainless Steel Cable

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. Installation of Fabric Air Dispersion System:

1. Install suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

L. Cleaning and Protection:

1. Clean air handling unit and ductwork prior to the Duct Sox 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 Duct Sox 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

<table>
<thead>
<tr>
<th>Air System</th>
<th>Material</th>
<th>Pressure Class</th>
<th>Seal Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Ductwork</td>
<td>Galvanized</td>
<td>2”</td>
<td>C</td>
</tr>
<tr>
<td>Supply Ductwork (downstream and VAV box)</td>
<td>Galvanized</td>
<td>2”</td>
<td>C</td>
</tr>
<tr>
<td>VAV Supply Ductwork (between RTU &amp; VAV box)</td>
<td>Galvanized</td>
<td>3”</td>
<td>B</td>
</tr>
<tr>
<td>Transfer Ducts</td>
<td>Galvanized</td>
<td>1”</td>
<td>-</td>
</tr>
<tr>
<td>General Exhaust</td>
<td>Galvanized</td>
<td>2”</td>
<td>C</td>
</tr>
<tr>
<td>Cafeteria Supply</td>
<td>Galvanized</td>
<td>4”</td>
<td>A</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>Fabric (Round)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Galvanized (Rectangular)</td>
<td>2”</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Round Double Wall Insulated Spiral</td>
<td>2”</td>
<td>C</td>
</tr>
</tbody>
</table>

END OF SECTION 233100
SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air turning devices.
   3. Duct access doors.
   4. Flexible duct connections.
   5. Duct test holes.
   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:

C. National Fire Protection Association:
   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. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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


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


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.

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.

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.
   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.
   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.
   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 our 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 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Centrifugal roof exhauster.
   2. Cabinet fans.
   3. Destratification fans.

B. Related Sections:
   1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
   2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
   3. Section 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
   4. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
   5. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
   6. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
   7. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
   8. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
   2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
   5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:

D. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.
   2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.

1.3 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
D. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.
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. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE
A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
B. Sound Ratings: AMCA 301, tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.
C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
D. Balance Quality: Conform to AMCA 204.
E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

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 motors, shafts, and bearings from weather and construction dust.

1.8 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.9 WARRANTY
A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
1.10 EXTRA MATERIALS
A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
B. Furnish one set of belts for each fan.

1.11 REGULATORY REQUIREMENTS
A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF EXHAUSTERS
A. Manufacturers:
   1. Cook.
   2. Greenheck.
   3. Carnes.
B. Product Requirements:
   1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
   2. Sound Ratings: AMCA 301, tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.
   3. Fabrication: Conform to AMCA 99.
4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

C. Fan Unit: V-belt as indicated, with spun aluminum housing; resilient mounted motor; 2 inch, 16 gage aluminum birdscreen; square base to suit roof curb with continuous curb gaskets.

D. Roof Curb: 18 inch high galvanized steel above high point of roof line with continuously welded seams, built in cant strips, 1-1/2” insulation and curb bottom, and factory installed nailer strip. (Refer to detail)

E. Electrical Characteristics and Components

1. Electrical Characteristics: See schedule
2. Motor: Refer to Section 23 05 13.
3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
4. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.

F. Backdraft Damper: Gravity or spring actuated, aluminum multiple blade construction, felt edged with nylon bearings. (Refer to detail).

G. Sheaves: Browning cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

H. Provide belt tensioner.

2.2 CABINET FANS

A. Manufacturers:

1. Cook.
2. Greenheck.
3. Carnes.

B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, backdraft damper, bottom access and hanging vibration isolators.

C. Electrical Characteristics and Components


E. Motor: Refer to Section 15170.

F. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

G. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and unit mounted switch.

H. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; fan shaft with self-aligning pre-lubricated ball bearings.
2.3 DESTRATIFICATION FANS

A. Manufacturers:

1. Delta T Corporation, PO Box 11307, Lexington, Kentucky 40575. Phone (877) 244-3267. Fax (859) 233-0139.

B. General:

1. The fan shall be High Volume, Low Speed Fans - Isis Model.

C. Complete Unit:

1. The fan shall be ETL certified and built pursuant to construction guidelines set forth by UL standards 507 and CSA standard C22.2 No. 113-08. The fan shall be designed to move an effective amount of air for destratification in the Fieldhouse. The fan, in operation, shall not disturb other hanging objects 2' (61 cm) outside of its circumference to a distance of 3' (91 cm) below its airfoils. The fan shall incorporate a direct drive system designed specifically for high volume, low speed fans to ensure silent operation. The sound levels from the fan operating at maximum speed shall not exceed 40 dBA (measured 20' (6.1 cm) below the blades and 20' (6.1 cm) horizontally from the center of the fan).

D. Airfoils:

1. The fan shall be equipped with ten (10) high volume, low speed airfoils of precision extruded aluminum alloy. Each airfoil shall be of the high performance MiniTEC design. The airfoils shall be connected by means of two (2) sets of bolts and lock washers per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.

E. Winglets:

1. The fan shall be equipped with ten (10) MiniTEC winglets designed to redirect outward airflow into downward airflow, thereby enhancing the efficiency and effectiveness of the fan. The winglets shall be molded polyethylene terephthalate thermoplastic polyester resin. A winglet shall be attached at the tip of each airfoil. The color of the winglets shall be as specified by the architect.

F. Motor:

1. The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0-100% without the use of a gearbox or other mechanical means of control. The motor shall operate from any voltage ranging from 100-130 VAC, 1 ø, and 60Hz, without requiring adapters or customer selection. The motor shall be a non-ventilated, heat sink design with the capability of continuous operation in -40°F to 131°F ambient conditions.

G. Hub:

1. The fan hub shall be constructed of steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly. The hub shall incorporate five (5) safety retaining clips made of 1/8” thick steel that shall restrain the hub/airfoil assembly in case of shaft failure.
H. Mounting System:
   1. The fan mounting system shall be designed for quick and secure installation from the structure. All components in the mounting system shall be of welded construction using low carbon steel no less than 3/16” (0.5 cm) thick and powder coated or plated for corrosion resistance and appearance. All mounting bolts shall be SAE Grade 8 or equivalent.

I. Safety Cable:
   1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 3/16” (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel. The loops shall be secured with swaged Nicopress fittings, pre-loaded and tested to 3,000 lb·f.
   2. Field construction of safety cables is not permitted.

J. Controller:
   1. The fan controller shall be incorporated into the fan assembly. The controller shall be factory programmed to minimize starting and braking torques. The controller shall be equipped with a simple diagnostic program and an LED light to identify and relay faults in the system. The controller shall be housed in an enclosure independent of the motor to prevent overheating or electrical interference.

K. Wall Control:
   1. The fan shall be equipped with a remote wall control. The wall control shall be capable of mounting to a standard electrical box and shall include operator controls and display for controlling the fan’s power and speed. Communication with the fan drive and controller shall be by a standard (14 Ga/3 wire with ground), line voltage cable that is field installed and provided by the installer.

L. Warranty:
   1. The manufacturer shall replace any products or components defective in material or workmanship, free of charge to the customer (including transportation charges within the USA, F.O.B. Lexington, KY).
      a. Airfoils Limited Lifetime (Parts)
      b. Hub Limited Lifetime (Parts)
      c. Motor 10 years (Parts)
      d. Controller 10 years (Parts)
      e. Labor 1 year

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Secure roof exhausters with stainless steel lag screws to roof curb.
   C. Extend ducts to roof exhausters into roof curb. Counterflash duct to opening.
   D. Install flexible connections specified in Section 23 33 00 between fan inlet and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
E. Provide sheaves required for final air balance.

F. Install backdraft dampers on inlet to roof exhausters.

3.2 INSTALLATION FOR DESTRATIFICATION FANS

A. The fan shall be mounted to an angle iron or I-beam structure, supplemental steel shall be provided by the contractor. Consult the manufacturer’s Installation Guide for proper sizing and placement of angle iron for a span mount. The project structural engineer shall be consulted for installation methods outside the manufacturer’s recommendation and a certification submitted prior to installation.

B. The fan installation area shall be free of obstructions such as lights, cables, sprinklers or other building structures; with the airfoils at least 2’ clear of all obstructions.

C. If the fan is hung from an extension tube that measures 5’ or longer, it will be necessary to provide guy cables or struts to limit potential lateral movement of the fan. A stiffening strut braced against a beam will be required if there is a close clearance situation.

D. The design criteria for the fan mounting system shall be capable of handling 40 ft·lbs

E. Coordinate the installation with the electrical, fire protection and ductwork installations.

END OF SECTION 233400
SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Variable volume terminal units.

B. Related Sections:
   1. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with air terminal units.
   2. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
   3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
   4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to air terminal units specified by this section.

1.2 REFERENCES

A. American Refrigeration Institute:
   1. ARI 880 - Air Terminals.
   2. ARI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:

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

1.3 SUBMITTALS

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

B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, heating coil capacity and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

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 units.
   C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating
      instructions, maintenance and repair data, and parts lists. Include directions for resetting
      constant volume regulators.

1.5 QUALITY ASSURANCE
   A. Test and rate air terminal units performance for air pressure drop, flow performance, and
      acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each
      terminal unit.

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

1.7 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product
      bonds.
   B. Furnish one year manufacturer warranty for air terminal units.

1.8 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code
      120)
   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. Nailor.
C. Carnes.
D. Price.

2.2 MANUFACTURED UNITS
A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls, and electric heating coils.
B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set air flow, minimum factory set air flow, and coil type.

2.3 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL UNITS
A. General:
   1. Terminals shall be certified under the ARI Standard 880-94 Certification Program and carry the ARI Seal.
B. Basic Assembly:
   1. The damper shall be heavy gauge steel with shaft rotating in Delrin or bronze oilite self-lubricating bearings.
   2. Actuators shall be capable of supplying at least 35 in. lb. of torque to the damper shaft and shall be mounted externally for service access.
   3. At an inlet velocity of 2000 fpm, the differential static pressure required to operate any terminal size shall not exceed 0.18” wg. for the basic terminal.
   4. Provide with factory installed acoustical/thermal lining and integral duct liner.
C. Accessories:
   1. Provide an access panel on the inlet side of the heating coil.
   2. Electric Heating Coil:
      a. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
         1) Primary and secondary over-temperature protection.
         2) Minimum airflow switch.
         3) SCR controls.
D. Fiber-Free Liner:

1. The terminal casing shall be minimum 22 gauge galvanized steel, internally lined with non-porous, sealed liner which complies with UL 181 and NFPA 255 (25/50). Insulation shall be 1 1/2 lb. density. Exposed insulation shall be non-fibrous or fiberglass insulation shall be sealed from the airstream with a foil reinforced liner or solid metal lining. The terminal shall have a round duct connection and a rectangular discharge suitable for slip and drive connection. The casing shall be designed for hanging by sheet metal straps.

E. Controls:

1. The terminals shall be equipped with pressure independent direct digital controls supplied by the control contractor and mounted by the terminal unit manufacturer. Control contractor shall provide data sheets on all components to be mounted, indicating component dimensions, mounting hardware, and methods, as well as wiring and piping diagrams for each application identified by unit tag per the schedule in the drawings, to the terminal manufacturer.

2. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03" w.g. at an inlet velocity of 500 fpm.

3. Controls shall be field set by control contractor for the scheduled minimum and maximum flow rates. Flow measuring taps and flow curves will be supplied with each terminal for field balancing airflow. Each terminal shall be equipped with labeling showing unit location, size and scheduled cfm.

4. The terminal manufacturer shall provide a disconnect switch and terminals suitable for connection of 24V. power by T.C. contractor. Actuator shall be direct connection shaft mount type without linkage. All controls shall be installed in approved NEMA type sheet metal enclosure by terminal manufacturer.

F. Automatic Damper Operator:

1. Electric Actuator: Furnished by the Building Automation System contractor to the box manufacturer for mounting in the factory.

2. Velocity Reset Controller and Probe:
   a. Calibration pressure taps for pressure independent control to compensate for varying inlet static pressure.
   b. Minimum and maximum limits set at reset device.
   c. Maintain air flow to within 5 percent of set point with inlet static pressure variations up to 4 inches.
   d. Reset span shall remain constant regardless of minimum or maximum setting. Reset start point shall be adjustable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions. Provide minimum manufacturer required length of straight ductwork upstream of the VAV box.

B. Provide ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Connect to ductwork in accordance with Section 23 31 00.
E. Verify that electric power is available and of the correct characteristics.

F. Contractor shall provide all necessary support vibration insulation and fastening hardware as required.

G. Bottom of VAV boxes shall be mounted a maximum of 2'-0" above the finish ceiling.

H. All coils on VAV boxes shall be externally insulated. Refer to Section 23 07 00.

I. Provide manufacturer required service clearances and minimum required lengths of straight ductwork upstream of VAV box inlet.

3.2 ADJUSTING

A. Adjust volume with damper operator attached to assembly allowing flow range modulation from the maximum design air flow to minimum air flow as scheduled on drawings. In heating mode, set units with heating coils for the scheduled heating air flow.

B. Verify box is performing per sequence of controls in cooling and heating modes.

END OF SECTION 233600
SECTION 233700 - AIR OUTLET AND INLETS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Diffusers.
      2. Registers
      4. Roof intake hoods.
   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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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. Price.
D. Nailor.
E. Seiho.

2.2 CEILING EXHAUST AND RETURN REGISTERS

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 35 degrees, vertical face.
B. Frame: 1-1/4 inch margin with countersunk screw mounting.
C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel with 20 gage minimum frame, with factory off-white enamel finish.
D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
2.3 PLENUM SLOT DIFFUSERS
   A. Type: Continuous with adjustable vanes for left, right, or vertical discharge.
   B. Fabrication: Steel with factory off-white enamel finish.
   C. Frame: 1-1/4 inch margin with support clips for T-bar mounting and gasket, or trim border for gypsum ceiling mitered end border and end cap. Refer to schedule and drawings for type and location.
   D. Plenum: Integral, galvanized steel, insulated. Provide center notch as required.

2.4 CEILING GRID CORE RETURN REGISTERS/GRILLES
   A. Type: Fixed grilles of 1/2" x 1/2" grid 1" high or Fixed grilles of 1/2" x 1/2" grid 1/2" high with 45 degree angle blades.
   B. Frame: 1-1/4 One inch margin with lay-in frame for suspended grid ceilings.
   C. Fabrication: Aluminum with factory off-white enamel finish.

2.5 PLAQUE CEILING DIFFUSERS
   A. Type: Square, plaque, air deflector to discharge air in 360 degree pattern.
   B. Frame: To match ceiling type.
   C. Fabrication: Steel with baked enamel finish as selected by Architect.
   D. Accessories: Redial opposed blade damper.

2.6 HEAVY DUTY RETURN REGISTERS/GRILLES
   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.

2.7 HEAVY DUTY ALUMINUM RETURN REGISTERS/GRILLES
   A. Type: Streamlined blades, 1/2 inch maximum spacing with 30° deflection.
   B. Frame: 1 3/8 inch margin with countersunk screw and gasket mounting.
   C. Fabrication: Aluminum with 16 gage minimum frames and 14 gage minimum blades and corners securely fastened to be immobile.

2.8 SUPPLY AND RETURN GRILLES AND REGISTERS
   A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, horizontal face.
   B. Frame: 1-1/4 inch margin with countersunk screw mounting.
   C. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades. Steel and aluminum with 20 gage minimum frame, or Aluminum extrusions, with factory clear lacquer finish.
D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.9 ALUMINUM SPOTDIFFUSER
   A. Type: Round adjustable with a minimum 66° rotation angle.
   B. Frame: Double felt flange body.
   C. Fabrication: Heavy gage aluminum with volume damper. Color and finish shall be selected by architect.

2.10 VAV CEILING DIFFUSERS
   A. Type: Square, thermally powered with variable air volume modulation. Thermostats are self-contained and controls both heating and cooling.
   B. Frame: Inverted t-bar type.
   C. Fabrication: Steel with baked enamel finish as selected by Architect.
   D. Warranty: Ten years.

2.11 ROOF HOODS
   A. Manufacturers:
      1. Cook.
      2. Greenheck.
      3. Carnes.
   B. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards.
   C. Fabricate of galvanized steel, minimum 16 gauge base and 20 gauge hood, or aluminum, minimum 16 gauge base and 18 gauge hood; suitably reinforced; with removable hood; birdscreen with 2 inch square mesh for exhaust and 3/4 inch for intake, and factory baked enamel finish. Color of hood shall be selected by the architect.
   D. Mount unit on minimum 18 inch high curb base with insulation between duct and curb.
   E. Make hood outlet area minimum of twice throat area.
   F. Refer to drawings for type.

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. 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.

C. 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
SECTION 235500 - GAS FIRED UNIT HEATER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Separated combustion gas fired unit heaters.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI Z83.8 - Gas Unit Heaters.
2. ANSI Z83.9 - Gas-Fired Duct Furnaces.

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


C. National Fire Protection Association:

1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
4. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

D. Underwriters Laboratories Inc.:

1. UL 727 - Oil-Fired Central Furnaces.
2. UL 729 - Oil-Fired Floor Furnaces.
3. UL 731 - Standard for Safety for Oil-Fired Unit Heaters.

1.3 SUBMITTALS

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

B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

D. Manufacturer's Installation Instructions: Submit Indicate rigging and assembly.

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 thermostats or other products not mounted on unit.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.5 QUALITY ASSURANCE

A. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

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

B. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

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

B. Furnish five year manufacturer warranty for heat exchanger.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
PART 2 - PRODUCTS

2.1 GAS FIRED UNIT HEATERS

A. Manufacturers:
   1. Modine.
   2. Reznor.
   3. Serling.

B. Mechanical Configuration:
   1. Furnace section with 80% minimum efficiency provided by an indirect-fired tubular 709 stainless steel heat exchanger with individually fired tubes for maximum heat transfer with minimal noise of flame ignition/extinction.

C. Venting/Combustion Air Arrangement:
   1. The unit shall be separated combustion and no field modifications or additions shall be required or allowed to meet the ANSI Z83.8 - latest revision definition of separated combustion. The venting shall be a power exhausted arrangement with a separate combustion air intake pipe connection to allow for fresh combustion air from outside the conditioned space. The unit shall be tested to insure proper ignition when the unit is subjected to 40 mile per hour wind velocities. The unit shall also include a factory mounted differential pressure switch designed to prevent main burner ignition until positive venting has been proven.

D. Unit Casing:
   1. The unit heater(s) casing shall be constructed of not less than 22 gauge aluminized steel with minimization of exposed fasteners.
   2. All exterior casing parts shall be cleaned of all oils and a phosphate coating applied prior to painting. The exterior casing parts shall then be painted with an electrostatically applied baked-on gray-green polyester powder paint (7-mil thickness) for corrosion resistance.
   3. The unit shall be furnished with horizontal and vertical air deflectors.

E. Furnace Section:
   1. The heat exchanger(s) shall be made of 409 stainless steel.
   2. The thermal efficiency of the unit(s) shall be a minimum of 80% efficient for all air flow ranges.
   3. Each heat exchanger tube shall be individually and directly flame-fired. The heat exchanger tube shall be crimped to allow for thermal expansion and contraction. The flue collector box shall be made of 20 gauge aluminized steel.
   4. The heat exchanger(s) seams and duct connections shall be certified to withstand 0.9" W.C. external static pressure without burner flame disturbance.
   5. The burner(s) shall be in-shot type, directly firing each heat exchanger tube individually and is designed for good lighting characteristics without noise of extinction for both natural and propane gas.
   6. The ignition controller(s) shall be 100% shut-off with continuous retry.
   7. The gas pressure shall be between 6-7” W.C for natural gas.
   8. The solid state ignition system shall directly light the gas by means of a direct spark igniter each time the system is energized.
9. The unit gas controls shall be provided with the following:
   a. Two-stage gas controls with a two-stage combination gas control, an ignition control, and a two-stage low voltage thermostat. The unit fires at 50% fire on low stage or 100% fire on high stage of the unit based on the call for heat from either a room or duct thermostat. An automatic reset high limit switch mounted in the air stream to shut off the gas supply in the event of overheating.
   b. A time delay relay that delays the start of the air mover to allow the heat exchanger a warm-up period after a call for heat. The time delay relay shall also continue the air mover operation after the thermostat has been satisfied to remove any residual heat in the heat exchanger.
   c. The unit shall be orificed for 0-2000 feet elevation above sea level.

F. Electrical:
   1. All electrical components shall carry UL, ETL, or CSA listing.
   2. A low voltage terminal board shall be provided for direct wiring connection to an external thermostat.
   3. A single 115V to 24V step down transformer shall be provided for all unit controls.

G. Air Mover:
   1. The motor wiring shall be in flexible metal BX conduit.
   2. The motor shall be controlled by a time delay relay.
   3. Propeller fan.
   4. The motor type shall be Single-Speed, Totally Enclosed.

H. Mounting:
   1. The unit shall be equipped with mounting brackets to allow for threaded rod suspension or to be bolted directly to the ceiling support structure allowing 1" of top clearance.

I. Accessories:
   1. Provide a vertical concentric vent kit to allow the vent outlet and combustion air inlet pipes to penetrate the building roof through one opening.
   2. Provide vertical and horizontal louvers.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
   B. Verify space is ready for installation of units and openings are as indicated on shop drawings.
3.2 INSTALLATION

A. Install units in accordance with the manufacturer’s installation manual.

B. Installation - Natural Gas Piping:
   1. Connect natural gas piping in accordance with NFPA 54.
   2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
   3. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23.
      a. Strainer.
      b. Shutoff valve.

C. Install vent connections in accordance with NFPA 211. Install vents and stacks.

D. Provide hangers and supports for suspended units. Provide additional supports and bracing to stabilize unit heaters.

E. Provide connection to electrical power systems.

END OF SECTION 235500
SECTION 237310 - ROOF MOUNTED AIR HANDLING UNIT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof mounted air handling unit.
   2. Roof curb.
   3. Rooftop unit screen.

B. Related Sections:
   1. Section 23 05 53 - Mechanical Identification
   2. Section 23 05 93 - Testing, Adjusting, and Balancing.
   3. Section 23 07 00 - Ductwork Insulation.
   4. Section 23 09 00 - Instrumentation and Controls.
   5. Section 26 05 03 - Equipment Wiring Systems.

1.2 REFERENCES

B. ARI 360 - Unitary Air-Conditioning Equipment.
D. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
E. ARI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment
F. California Administrative Code - Title 24 establishes the minimum efficiency requirements for HVAC equipment installed in new buildings in the State of California.

1.3 SUBMITTALS

A. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
B. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.
C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

1.5 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.6 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
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 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 ROOF MOUNTED AIR HANDLING UNIT

A. Acceptable Manufacturers:

1. Aaon.
2. Carrier.

B. General Description:

1. Outdoor air handling unit shall include filters, supply fans, dampers, direct expansion cooling coil section, gas heaters, exhaust fans, and unit controls.
2. Unit shall be factory assembled and tested including 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 pipe stub outs, 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. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
5. Access to filters, dampers, coil section, heaters, exhaust fans, 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.
6. 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.
7. Units shall include cooling coil sections with double sloped 304 stainless steel drain pans for future ‘DX’ cooling coil.
8. 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.

9. Unit shall include lifting lugs on the top of the unit.

10. Unit base shall be fabricated of 3 inch thick double wall, impact resistant, rigid polyurethane foam panels.

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, unhoused, 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. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

G. 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 two gas connections 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 full 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. 90 MBH, 150 MBH, 195 MBH, 210 MBH, 270 MBH, 292.5 MBH, 390 MBH, 540 MBH, 800 MBH, 1600 MBH, and 2400 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity. 405 MBH and 810 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity. 1080 MBH gas heating assembly shall be capable of operating at any firing rate between 100% and 15% of its rated capacity.
H. 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 future cooling coil location.
2. Unit shall include a clogged filter switch.

I. 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 and end seals. Damper blades shall be gear driven and designed to meet smoke damper Class-1 leakage specifications in accordance with U.L. 555S at 4 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.

J. Controls:

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

2.2 ROOF CURBS

A. Curb shall be fully insulated and 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.

B. Solid bottom curb shall be factory assembled and fully lined with neoprene coated fiberglass insulation and include a wood nailer strip. Curb shall be pitched to match the roof.

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

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

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

2.3 ROOFTOP UNIT SCREEN (Eclipse screen systems or approved equal)

A. The rooftop unit system shall incorporate the screen wall as described below:

1. Pre-formed metal panels for enclosing rooftop mechanical equipment.
2. Galvanized curb mounted assembly framing for direct attachment of screening panels to structural roof curb; installation requiring fastening and/or penetrating mechanical equipment is not acceptable.
3. Assembly made to permit easy access to mechanical equipment for servicing.
4. Touch-up painting required for scratches and screw heads.

B. Design Criteria:

1. Manufacturer is responsible for the structural design of an materials, assembly and attachment to resist snow, wind, suction and uplift loading at any point without damage or permanent set

C. Coordination:

1. Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.
2. Submit shop drawing; to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication
D. Warranty:

1. If any part of the rooftop equipment screen fails because of a manufacturer defect within one year from the date of substantial completion, the manufacturer will furnish without charge the required part(s). Any local transportation, related service labor or diagnostic call charges are not included.
2. This warranty does not cover failure of your rooftop equipment screen if it is damaged by the Owner, or if failure is caused by improper installation, in no event shall Warrantor be liable for incidental or consequential damages.

E. Materials:

1. Metal Panels: Fabricated from rigid galvalume metal sheets. Plastic not acceptable.
2. Framing: Minimum 18 gauge LFQ, CQ, G-90 galvanized steel or heavier gauge (as required).
3. Frame fasteners shall be a low carbon HEX head tap bolt.
4. Panel fasteners to be painted TEK screws.

F. Construction:

1. Provide factory metal formed panel system: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.
2. Trim: Fabricated from galvanized metal, and finished with the manufacture’s standard coating system, unless shown otherwise on drawings.
3. Framing: Fabricate and assemble in largest practical sizes, for delivery to the site.

G. Finishes:

1. Panel Coating: Siliconized polyester, factory applied with 40-year warranty.
2. Equipment manufacturer shall provide a custom color which will be selected by architect.

H. Examination:

1. Installer's Examination: Examine conditions under which construction activities of this section are to be performed.
2. Submit written notification to Architect and Screen manufacturer if such conditions are unacceptable.
3. Beginning erection constitutes installer's acceptance of conditions.

I. Installation:

1. The curb mounted screen system must be installed in accordance with factory instructions and as detailed in drawings.

J. Cleaning and Protection:

1. Ensure that finishes and structure of installed system are not damaged by subsequent construction activities.
2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.
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 void of roof curb between bottom of unit and top of roof deck with sound batt insulation.
      3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
      4. Install gasket material between unit base and roof curb.
   B. Connect units to supply and return ductwork with flexible connections.
   C. Provide 6” batt insulation and 2-layers of 5/8” exterior rated gyp. board in void between bottom of rooftop and roof membrane.
   D. Install components furnished loose for field mounting.
   E. Install electrical devices furnished loose for field mounting.
   F. Install control wiring between unit and field installed accessories.
   G. 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 237310
SECTION 238103 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - SMALL CAPACITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged rooftop unit.
   2. Roof curb.
   3. Rooftop unit screen.

B. Related Sections:
   1. Section 23 05 53 - Mechanical Identification
   2. Section 23 05 93 - Testing, Adjusting, and Balancing.
   3. Section 23 07 00 - Ductwork Insulation.
   4. Section 23 09 00 - Instrumentation and Controls.
   5. Section 26 05 03 - Equipment Wiring Systems.

1.2 REFERENCES

B. ARI 360 - Unitary Air-Conditioning Equipment.
D. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
E. ARI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment
F. California Administrative Code - Title 24 establishes the minimum efficiency requirements for HVAC equipment installed in new buildings in the State of California.

1.3 SUBMITTALS

A. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
B. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.
C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

1.5 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.6 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
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 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 (Lobby)

A. Acceptable Manufacturers:

1. Aaon.
2. Carrier.

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, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced 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, unhoused, 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. 90 MBH, 150 MBH, 195 MBH, 210 MBH, 270 MBH, 292.5 MBH, 390 MBH, 540 MBH, 800 MBH, 1600 MBH, and 2400 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity. 405 MBH and 810 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity. 10 80 MBH gas heating assembly shall be capable of operating at any firing rate between 100% and 15% of its 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. 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.

   B. See Specification Section 23 05 48, paragraph 2.2 Vibration Isolating Roof Curbs.

2.3 ROOFTOP UNIT SCREEN (Eclipse screen systems or approved equal)
   A. The rooftop unit system shall incorporate the screen wall as described below:
      1. Pre-formed metal panels for enclosing rooftop mechanical equipment.
      2. Galvanized curb mounted assembly framing for direct attachment of screening panels to structural roof curb; installation requiring fastening and/or penetrating mechanical equipment is not acceptable.
      3. Assembly made to permit easy access to mechanical equipment for servicing.
      4. Touch-up painting required for scratches and screw heads.

   B. Design Criteria:
      1. Manufacturer is responsible for the structural design of an materials, assembly and attachment to resist snow, wind, suction and uplift loading at any point without damage or permanent set
C.  Coordination:
   1.  Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.
   2.  Submit shop drawing; to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication

D.  Warranty:
   1.  If any part of the rooftop equipment screen fails because of a manufacturer defect within one year from the date of substantial completion, the manufacturer will furnish without charge the required part(s). Any local transportation, related service labor or diagnostic call charges are not included.
   2.  This warranty does not cover failure of your rooftop equipment screen if it is damaged by the Owner, or if failure is caused by improper installation, in no event shall Warrantor be liable for incidental or consequential damages.

E.  Materials:
   1.  Metal Panels: Fabricated from rigid galvalume metal sheets. Plastic not acceptable.
   2.  Framing: Minimum 18 gauge LFQ, CQ, G-90 galvanized steel or heavier gauge (as required).
   3.  Frame fasteners shall be a low carbon HEX head tap bolt.
   4.  Panel fasteners to be painted TEK screws.

F.  Construction:
   1.  Provide factory metal formed panel system: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.
   2.  Trim: Fabricated from galvanized metal, and finished with the manufacture’s standard coating system, unless shown otherwise on drawings.
   3.  Framing: Fabricate and assemble in largest practical sizes, for delivery to the site.

G.  Finishes:
   1.  Panel Coating: Siliconized polyester, factory applied with 40-year warranty.
   2.  Equipment manufacturer shall provide a custom color which will be selected by architect.

H.  Examination:
   1.  Installer's Examination: Examine conditions under which construction activities of this section are to be performed.
   2.  Submit written notification to Architect and Screen manufacturer if such conditions are unacceptable.
   3.  Beginning erection constitutes installer's acceptance of conditions.

I.  Installation:
   1.  The curb mounted screen system must be installed in accordance with factory instructions and as detailed in drawings

J.  Cleaning and Protection:
   1.  Ensure that finishes and structure of installed system are not damaged by subsequent construction activities.
2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.

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 void of roof curb between bottom of unit and top of roof deck with sound batt insulation.
3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
4. Install gasket material between unit base and roof curb.
B. Connect units to supply and return ductwork with flexible connections.
C. Provide 6” batt insulation and 2-layers of 5/8” exterior rated gyp. board in void between bottom of rooftop and roof membrane.
D. Install components furnished loose for field mounting.
E. Install electrical devices furnished loose for field mounting.
F. Install control wiring between unit and field installed accessories.
G. 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 238106 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - MEDIUM CAPACITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged rooftop unit.
   2. Roof curb.
   3. Rooftop unit screen.

B. Related Sections:
   1. Section 23 05 53 - Mechanical Identification
   2. Section 23 05 93 - Testing, Adjusting, and Balancing.
   3. Section 23 07 00 - Ductwork Insulation.
   4. Section 23 09 00 - Instrumentation and Controls.
   5. Section 26 05 03 - Equipment Wiring Systems.

1.2 REFERENCES

B. ARI 360 - Unitary Air-Conditioning Equipment.
D. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
E. ARI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment
F. California Administrative Code - Title 24 establishes the minimum efficiency requirements for HVAC equipment installed in new buildings in the State of California.

1.3 SUBMITTALS

A. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
B. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.
C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

1.5 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.6 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
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 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 UNITS (Single Zone Unit)

A. Acceptable Manufacturers:

1. Aaon.
2. Carrier.

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 D-1929 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.
12. RTU-2: Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.

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, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced 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 direct drive, axial flow exhaust fans. Blades shall be adjustable pitch.
6. Unit shall include belt driven, un-housed, backward curved, plenum exhaust fans.
7. 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 standard capacity.
   c. Coils shall be 6 row.
   d. Coils shall be helium leak tested.
   e. 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.
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. Each refrigeration circuit shall be equipped with a liquid line sight glass.
8. 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. Air-Cooled Condenser:

1. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
2. 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.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be helium leak tested.
5. Provide hail guards.

J. Gas Heating:

1. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty.
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. 90 Mbtu/h, 150 Mbtu/h, 195 Mbtu/h, 210 Mbtu/h, 270 Mbtu/h, 292.5 Mbtu/h, 390 Mbtu/h, and 540 Mbtu/h gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity. 405 Mbtu/h and 810 Mbtu/h gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity. 1080 Mbtu/h gas heating assembly shall be capable of operating at any firing rate between 100% and 15% of its 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. Energy Recovery (Cafeteria AHS.RTU-10):

1. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
3. Wheel shall be wound continuously with one flat and one structured layer in parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
4. Wheel shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
5. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
6. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
7. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard parts warranty. The 5 year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty.
8. Unit shall include 2 inch thick, pleated panel outside air and exhaust air filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the wheels.
9. Hinged service access doors shall allow access to the wheel.
10. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

11. Unit shall include energy recovery wheel defrost control which includes an adjustable temperature sensor and timer wired to periodically stop the wheel rotation, which allows the warm exhaust air to defrost the wheel.

N. Controls:

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

2.2 ROOFTOP UNITS (VAV Units)

A. Acceptable Manufacturers:

1. Aaon.
2. Carrier.

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, unhoused, 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, unhoused, 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. 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. 90 MBH, 150 MBH, 195 MBH, 210 MBH, 270 MBH, 292.5 MBH, 390 MBH, 540 MBH, 800 MBH, 1600 MBH, and 2400 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity. 405 MBH and 810 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity. 1080 MBH gas heating assembly shall be capable of operating at any firing rate between 100% and 15% of its 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.
3. Outside Air/Economizer
4. 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
5. Economizer shall be furnished with return air CO2 override.

L. Controls:

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

2.3 ROOF CURBS

A. 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.

B. Solid bottom 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.

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

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

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

2.4 ROOFTOP UNIT SCREEN (Eclipse screen systems or approved equal)

A. The rooftop unit system shall incorporate the screen wall as described below:

1. Pre-formed metal panels for enclosing rooftop mechanical equipment.
2. Galvanized curb mounted assembly framing for direct attachment of screening panels to structural roof curb; installation requiring fastening and/or penetrating mechanical equipment is not acceptable.
3. Assembly made to permit easy access to mechanical equipment for servicing.
4. Touch-up painting required for scratches and screw heads.
B. Design Criteria:
   1. Manufacturer is responsible for the structural design of materials, assembly and attachment to resist snow, wind, suction and uplift loading at any point without damage or permanent set.

C. Coordination:
   1. Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.
   2. Submit shop drawing to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication.

D. Warranty:
   1. If any part of the rooftop equipment screen fails because of a manufacturer defect within one year from the date of substantial completion, the manufacturer will furnish without charge the required part(s). Any local transportation, related service labor or diagnostic call charges are not included.
   2. This warranty does not cover failure of your rooftop equipment screen if it is damaged by the Owner, or if failure is caused by improper installation, in no event shall Warrantor be liable for incidental or consequential damages.

E. Materials:
   1. Metal Panels: Fabricated from rigid galvalume metal sheets. Plastic not acceptable.
   2. Framing: Minimum 18 gauge LFQ, CQ, G-90 galvanized steel or heavier gauge (as required).
   3. Frame fasteners shall be a low carbon HEX head tap bolt.
   4. Panel fasteners to be painted TEK screws.

F. Construction:
   1. Provide factory metal formed panel system: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.
   2. Trim: Fabricated from galvanized metal, and finished with the manufacturer’s standard coating system, unless shown otherwise on drawings.
   3. Framing: Fabricate and assemble in largest practical sizes, for delivery to the site.

G. Finishes:
   1. Panel Coating: Siliconized polyester, factory applied with 40-year warranty.
   2. Equipment manufacturer shall provide a custom color which will be selected by architect.

H. Examination:
   1. Installer's Examination: Examine conditions under which construction activities of this section are to be performed.
   2. Submit written notification to Architect and Screen manufacturer if such conditions are unacceptable.
   3. Beginning erection constitutes installer's acceptance of conditions.

I. Installation:
   1. The curb mounted screen system must be installed in accordance with factory instructions and as detailed in drawings.
J. Cleaning and Protection:
   1. Ensure that finishes and structure of installed system are not damaged by subsequent construction activities.
   2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect.

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 void of roof curb between bottom of unit and top of roof deck with sound batt insulation.
      3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
      4. Install gasket material between unit base and roof curb.
   B. Connect units to supply (horizontal) and return (vertical) ductwork with flexible connections.
   C. Provide 6” batt insulation and 2-layers of 5/8” exterior rated gyp. board in void between bottom of rooftop and roof membrane.
   D. Install components furnished loose for field mounting.
   E. Install electrical devices furnished loose for field mounting.
   F. Install control wiring between unit and field installed accessories.
   G. 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 238106
SECTION 238200 - CONVECTION HEATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric cabinet unit heaters.
2. Radiant ceiling panels.
3. Electric suspended unit heaters.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
3. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
5. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:


B. 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 cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.

C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

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 components and locations of access doors in radiation cabinets required for access to valves.
   C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

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

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Accept units on site in factory packing. Inspect for damage. Store under roof.
   C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.7 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.8 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish two sets of filters.

1.9 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)

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

PART 2 - PRODUCTS

2.1 ELECTRIC CABINET UNIT HEATERS

A. Manufacturers:
   1. Markel.
   2. Berko.
   3. Q-Mark.

B. Assembly: UL listed and labeled assembly with terminal box and cover, and built-in controls.

C. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material. The heating elements shall be warranted for five years and shall be of non-glowing design consisting of 80-20 Ni/Cr-resistance wire enclosed in a steel sheath to which steel plate fins are brazed. The heating element shall be located directly in front of the blower discharge air for uniform heating.

D. Cabinet: 16 gauge steel with easily removed front panel with integral air outlet and inlet grilles.

E. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

F. Fan: Forward curve double inlet, statically and dynamically balanced, with fan guard. The motor(s) shall be two speed 1/8 H.P. with automatic reset overload protection. The motor shall be vented and mounted in the air stream to provide maximum cooling of the motor. Motor fuse protection shall be provided to meet UL, cUL and NEC requirements.

G. Motor: Permanently lubricated, sleeve bearings for horizontal models, ball bearings for vertical models.

H. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Provide thermal overload.

I. Filters: Permanent.

J. Fully recessed ceiling unit with recessing flange to mate with a 2'-0” x 2'-0” lay-in ceiling grid.

2.2 RADIANT CEILING PANEL

A. Manufacturers:
   1. Aerotech.
   2. Sun-El.
   3. Airtex.
B. Extruded Aluminum Panels:

1. Extrusion panel thickness approximately 0.100".
2. Panel Tube: 0.500" I.D. copper.
3. Panels have a “U” shaped channel on the back of the extrusion into which the copper tube is inserted. The “U” shaped channel is then formed more than half way around the copper tube for increased thermal conduction and to eliminate any separation of the copper and the aluminum strip. The use of adhesive or hold-down clips to attach copper tubing to the aluminum extrusion is not acceptable.
4. Panels are made of multiples of 5”, 6” or 8” extrusions.
   a. Assembled in factory.
   b. Return bends factory installed.
   c. Cross bar to maintain flatness and provide anchor point for panel suspension.
   d. Alligator type spring clips for joining extrusions are not acceptable.
   e. Apply two coats baked enamel paint only to the finished side of panels after assembly. Paint on plenum side of panel not acceptable.
   f. Maximum length, 12 feet or as scheduled.
5. Face configuration: V-groove.
6. Panel heating capacity: As scheduled.

C. Interconnecting Tube:

1. Type “L” copper 1/2” (0.625 O.D.), to type “M” hard copper 1/2” nominal (0.625 O.D.) 0.028 wall thickness.
2. Solder 95/5 tin antimony.

D. Insulation:

1. Fiberglass: 3/4 pound per cubic foot density.
2. Thickness: 1” nominal.

E. Suspension Wire:

1. Galvanized, soft-annealed steel wire, 12 gauge.

F. Spacing not to exceed four feet on center.

2.3 ELECTRIC SUSPENDED UNIT HEATERS

A. Manufacturers:

1. Markel.
2. Berko.
3. Q-Mark.

B. Assembly: UL Listed and labeled assembly with disconnect, unit mounted thermostat unless noted or shown otherwise.

C. Heating Elements: High mass, all steel tubular type.

D. Louvers: Adjustable discharge louvers shall be adjustable and made of heavy gauge steel.

E. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

F. Fan: Axial flow type design with fan guard.
G. Motor: Permanently lubricated, sealed bearings.

H. Hanging Bracket: Provide wall or ceiling mounting brackets.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. For recessed units, verify recess dimensions are correct size.

C. Verify wall construction is ready for installation.

D. Verify ductwork is ready for installation.

E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

A. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

B. Install coils level.

C. Make connections to coils with unions and flanges.

D. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.

E. On water heating coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.

F. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.

G. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.

H. Protection: Install finished cabinet units with protective covers during remainder of construction.

I. Hydronic Units: Install with shut-off valve on supply and return piping and circuit balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. Refer to Section 23 21 13.

J. Electric Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

K. Use temporary filters for equipment start-up. After owner acceptance install final filters.

L. Radiant ceiling panels: install 1" thick fiberglass insulation on top of each panel.

M. Electric Duct Coils: Wire in accordance with NFPA 70.
3.3 CLEANING

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

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

D. Install new filters.

END OF SECTION 238200
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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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. Substitutions: Section 01 60 00 - Product Requirements.

B. Attachment Plug Construction: Conform to NEMA WD 1.
C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
D. Cord Construction: Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

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:


1.2 REFERENCES

A. International Electrical Testing Association:


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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
   7. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Single conductor insulated wire.
C. Conductor: Copper.
D. Insulation Voltage Rating: 600 volts.
E. Insulation Temperature Rating: 90 degrees C.
F. Insulation Material: Thermoplastic.

2.2 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. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.

B. Related Sections:

1. Section 03 20 00 - Concrete Reinforcing: Bonding or welding bars when reinforcing steel is used for electrodes.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:

2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:


C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES
   A. Manufacturers:
      1. Apache Grounding/Erico Inc.
      2. Copperweld, Inc.
      3. Erico, Inc.
      4. O-Z Gedney Co.
      5. Thomas & Betts, Electrical.
      6. Substitutions: Section 01 60 00 - Product Requirements.
   B. Product Description:
      1. Material: Copper-clad steel.
      3. Length: 10 feet.
   C. Connector: Connector for exothermic welded connection.

2.2 ACTIVE ELECTRODES
   A. Manufacturers:
      1. Apache Grounding/Erico Inc.
      2. Copperweld, Inc.
      3. Erico, Inc.
      4. O-Z Gedney Co.
      5. Thomas & Betts, Electrical.
      6. Substitutions: Section 01 60 00 - Product Requirements.
   B. Product Description:
      2. Shape: Straight.
      3. Length: 8 feet
2.3 WIRE
   A. Material: Stranded copper.
   B. Foundation Electrodes: 4 AWG.
   C. Grounding Electrode Conductor: Copper conductor bare.
   D. Bonding Conductor: Copper conductor bare.

2.4 GROUNDING WELL COMPONENTS
   A. Well Pipe: 8 inches NPS (DN200) by 24 inches long clay tile pipe with belled end.
   B. Well Cover: Cast iron or Fiberglass with legend "GROUND" embossed on cover.

2.5 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. Substitutions: Section 01 60 00 - Product Requirements.
   B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.6 EXOTHERMIC CONNECTIONS
   A. Manufacturers:
      1. Apache Grounding/Erico Inc.
      2. Cadweld, Erico, Inc.
      3. Copperweld, Inc.
      4. ILSCO Corporation.
      5. O-Z Gedney Co.
      6. Thomas & Betts, Electrical.
      7. Substitutions: Section 01 60 00 - Product Requirements.
      8. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

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.
   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:

B. FM Global:

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   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 gauge 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.

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 gauge 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. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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


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


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. Substitutions: Section 01 60 00 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   4. Unistrut Corp.
   5. Substitutions: Section 01 60 00 - Product Requirements.

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

2.3 SPRING STEEL CLIPS

A. Manufacturers:
   2. Erico, Inc.
   3. Thomas & Betts Corp.
   4. Substitutions: Section 01 60 00 - Product Requirements.

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. Substitutions: Section 01 60 00 - Product Requirements.

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

2.6 FIRESTOPPING

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

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

1. Silicone Firestopping Elastomeric Firestopping: Silicone elastomeric compound and compatible silicone sealant.
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.
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.
      5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
      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.
   4. Section 26 05 53 - Identification for Electrical Systems.
   5. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

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

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

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide rigid steel conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal boxes or nonmetallic handhole.

C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Thin-wall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal or nonmetallic metal 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.


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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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. Substitutions: Section 01 60 00 - Product Requirements.
B. Rigid Steel Conduit: ANSI C80.1.
C. Rigid Aluminum Conduit: ANSI C80.5.
D. Intermediate Metal Conduit (IMC): Rigid steel.
E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Anamet Electrical.
   2. Electricflex Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.
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.
4. Substitutions: Section 01 60 00 - Product Requirements.

**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. Substitutions: Section 01 60 00 - Product Requirements.

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

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

### 2.5 NONMETALLIC CONDUIT

**A. Manufacturers:**

1. Cantex.
2. Carlon-Lamson and Sessions.
3. Petroflex.
4. Substitutions: Section 01 60 00 - Product Requirements.

**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:**

2. Hubbell.
3. Substitutions: Section 01 60 00 - Product Requirements.

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

**C. Size:** 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.
   4. Substitutions: Section 01 60 00 - Product Requirements.

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

C. Knockouts: Manufacturer's standard.

D. Size: As indicated on Drawings.

E. Cover: Hinged cover.

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

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

2.8 OUTLET BOXES

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

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

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

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

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

2.9 PULL AND JUNCTION BOXES

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

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

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

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 260534 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes floor boxes.
   B. Related Sections:
      1. Section 07 84 00 - Firestopping: Firestopping for electrical work.
      2. Section 26 05 29 - Hangers and Supports for Electrical Systems: Firestopping for electrical work.
      3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
      4. Section 26 27 26 - Wiring Devices: Receptacles for installation in floor boxes.

1.2 REFERENCES
   A. National Electrical Manufacturers Association:
      1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Product Data: Submit catalog data for floor boxes service fittings.
   C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

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

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

1.7 REGULATORY REQUIREMENTS
   A. Conform to Health/Life Safety Code for Public Schools.
   B. Conform to (IMC) International Mechanical Code. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)

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


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


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

PART 2 - PRODUCTS

2.1 FLOOR BOXES

A. Manufacturers:
   1. Hubbell.
   2. Wiremold.
   3. Substitutions: Section 01 60 00 - Product Requirements.

B. Floor Boxes: NEMA OS 1, provide number of gangs as indicated on the drawings. Provide deep boxes whenever possible. Shallow boxes shall be acceptable in minimum concrete depth areas only.

C. Adjustability: Fully adjustable.

D. Material:
   1. In slab on grade; cast metal.

E. Configuration: Provide configuration of receptacles, scoreboard controls, and microphone as indicated on drawings.

F. Shape: Rectangular, unless indicated otherwise on drawings.

G. Cover: Flush, flip top cover with flange as required. All exposed metal trim shall be brass.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify locations of floor boxes and outlets prior to rough-in.
3.2 INSTALLATION

A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet to accommodate intended purpose.

B. Floor Box Requirements: Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

C. Set floor boxes level.

D. Cut wood floor to allow floor box cover to recess flush with top of floor.

E. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 07 84 00.

F. Install protective rings or split nozzle on active flush cover service fittings.

3.3 ADJUSTING

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

B. Adjust floor box flush with finish flooring material.

3.4 CLEANING

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

B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION 260534
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Labels.
   3. Wire markers.
   5. Stencils.
   7. Lockout Devices.

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. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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

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

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
E. Furnish materials in accordance with industry standards.
F. Description: Labels fastened with adhesive or stencils.
G. Color:
   1. 480 Volt System: Black lettering on white background.
   2. 208 Volt System: Black lettering on white background.

H. 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.

2.5 UNDERGROUND WARNING TAPE
   A. Description: 4 inch wide plastic tape, detectable type, colored red or yellow with suitable warning legend describing buried electrical lines.

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

PART 3 - EXECUTION

3.1 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:

H. 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 260573 - ARC FLASH HAZARD ANALYSIS/SHORT-CIRCUIT/COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes short circuit and protective device coordination study encompassing portions of electrical distribution system.

B. Related Sections:
   1. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.
   2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
   4. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   5. Section 26 22 00 - Low-Voltage Transformers.
   7. Section 26 24 16 - Panelboards.
   8. Section 26 28 13 - Fuses.

1.2 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by Square D Engineering Services or approved equal.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.

C. The scope of the studies shall include new distribution equipment supplied by Square D Company under this contract.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
   6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
   1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
   2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. The National Fire Protection Association (NFPA)

1.4 SUBMITTALS FOR REVIEW/_APPROVAL

A. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall be provided upon request.

B. The report shall include the following sections:
1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
2. Short-Circuit Methodology Analysis Results and Recommendations
3. Short-Circuit Device Evaluation Table
4. Protective Device Coordination Methodology Analysis Results and Recommendations
5. Protective Device Settings Table
6. Time-Current Coordination Graphs and Recommendations
7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
8. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.
C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

E. The engineering firm shall have a minimum of twenty-five (25) years’ experience in performing power system studies.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program.

PART 2 - PRODUCTS

2.1 STUDIES

A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies. All studies to be prepared by Square D Engineering Services.

2.2 DATA

A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis
4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
   3. Square D shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
   1. Electric utility’s overcurrent protective device
   2. Medium voltage equipment overcurrent relays
   3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
   4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
   5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
   6. Medium voltage conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points, where applicable
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
G. Provide the following:

1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.

5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

6. Square D shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04)

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. Circuits 240V or less where available bolted short circuit current is less than 10 kA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E Table 130.7(C)(9)(a), including footnote 3.

D. Circuits 240V or less fed by transformers 112.5 kVA or less may be omitted from the computer model and will be assumed to have a hazard risk category 0 per IEEE 1584.

E. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

F. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

G. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.
The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 5 cycles.

For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment’s main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

Miscoordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.

The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Field adjustments to be completed by Square D Services.

C. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

D. Square D shall notify Owner in writing of any required major equipment modifications.
3.2 ARC FLASH LABELS

A. Square D Engineering Services shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electric Code) – Article 110.16

C. The label shall include the following information:

1. System Voltage
2. Flash protection boundary
3. Personal Protective Equipment category
4. Arc Flash Incident energy value (cal/cm²)
5. Limited, restricted, and prohibited Approach Boundaries
6. Study report number and issue date

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment - Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Label Installation:

1. Labels shall be field installed by Square D Services. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course with includes NFPA 70E material including the selection of personal protective equipment.

3.3 ARC FLASH TRAINING

A. The vendor supplying the Arc Flash Hazard Analysis shall train the owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent. The trainer shall be an authorized OSHA Outreach instructor.

B. The vendor supplying the Arc Flash Hazard Analysis shall offer instructor led and online NFPA 70E training classes.

END OF SECTION 260573
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED
   A. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.
   B. Contractor/Supplier shall examine all general specification provisions and drawings for related electrical work required as work under Division 26.
   C. Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems.

1.2 EQUIPMENT QUALIFICATION
   A. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.
   B. All components shall be U.L. listed, offer a five (5) year warranty and meet all state and local applicable code requirements.
   C. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
   D. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.3 SYSTEM DESCRIPTION
   A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
   B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.
   C. Contractor shall warrant all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The supplier’s obligation shall include repair or replacement, and testing without charge to the owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the owner's acceptance of the project. Warranty on labor shall be for a minimum period of one (1) year.

1.4 SUBMITTALS
   A. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.
B. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor.

C. Submit any interconnection diagrams per major subsystem showing proper wiring.

D. Submit standard catalog literature, which includes performance specifications indicating compliance to the specification.

E. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.

1.5 SYSTEM OPERATION

A. It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with the occupancy system. Unless specified otherwise, the contractor shall set all time delays to no less than 15 (fifteen) minutes.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROL DEVICES

A. Manufacturers:
   1. Hubbell.
   2. Sensor Switch.
   3. Substitutions: Section 01 60 00 - Product Requirements.

B. The listing of any manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for sensors, which meet or exceed the specifications included herein.

C. All products shall be based on Hubbell product numbers:
   2. Wall Sensors: LHMTS1I, LHIRS1I.
   3. Power and Slave Packs: UVPP, UVPPM, MP347A, MPSA, CU300A.

D. Wall switch sensors shall utilize Passive Infrared sensing technology only to detect motion.

E. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.

F. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180° coverage capability.

G. Wall switch products shall utilize Zero Crossing Circuitry, which increases relay life, protects from the effects of inrush current, and increases sensor = s longevity.

H. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.

I. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.

J. Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.
K. Passive infrared sensors shall utilize Pulse Count Processing and Digital Signature Analysis to respond only to those signals caused by human motion.

L. Passive infrared sensors shall utilize mixed signal ASIC which provides high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line), superior performance, and greater reliability.

M. Passive infrared sensors shall have a multiple segmented Lodif Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.

N. Where specified, passive infrared and dual technology sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.

O. Dual technology sensors shall be corner or recessed mounted to avoid detection outside the controlled area when doors are left open. Sensors shall have auto on or manual on feature.

P. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.

Q. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout controlled space.

R. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

S. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.

T. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

U. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

V. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

W. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.

X. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

Y. All sensors shall have UL rated, 94V-0 plastic enclosures.
2.2 CIRCUIT CONTROL HARDWARE - CU

A. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2” knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of two (2) sensors.

B. Relay Contacts shall have ratings of:

13A - 120 VAC Tungsten
20A - 120 VAC Ballast
20A - 277 VAC Ballast

C. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFロン jacketed cable suitable for use in plenums, where applicable.

D. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the contractor's responsibility to locate and aim sensory in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms, which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room. Power/switch packs may or may not be indicated on the drawings. It shall be the contractor's responsibility to provide and install all power/switch packs required to make the system fully operational. Locations of power/switch packs may be determined in the field by the contractor unless specified otherwise, but must be readily accessible for future servicing. Usually, a minimum of one (1) power/switch pack is required per circuit and/or area of control. However, in some cases additional power/switch packs may be required. Contact manufacturer for final determination of power/switch packs required for this project.

B. It is the contractor’s responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the owner's facility, to verify placement of sensors and installation criteria.

C. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

END OF SECTION 260923
SECTION 262200 - LOW VOLTAGE TRANSFORMER

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes two-winding transformers and harmonic mitigating transformers (for non-linear loads).

B. Related Sections:
   1. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
   2. NEMA ST 20 - Dry Type Transformers for General Applications.

B. International Electrical Testing Association:

1.3 SUBMITTALS

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

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

1.4 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of transformers.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.
1.7 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
   1. District Standard:
      a. Square D.
   2. Acceptable Substitution:
      b. General Electric.

B. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated.
C. Voltage: 480 volts, 3 phase primary to 208Y/120 volts, 3 phase secondary or 480 volts, 1 phase primary to 120/240 volts, 1 phase secondary as indicated on the drawings.
D. Insulation system and average winding temperature rise for rated kVA as follows:
   1. 16-500 kVA: Class 220 with 80 degrees C rise.
E. Case temperature: Transformer shall be capable of carrying a continuous 30% overload without exceeding 150 degree C rise.
F. Winding Taps:
   1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

G. Sound Levels: NEMA ST 20. Maximum sound levels are as follows:
   1. 1-50 kVA: 45 dB.
   2. 51-150 kVA: 50 dB.
   3. 151-300 kVA: 55 dB.

H. Basic Impulse Level: 10 kV.

I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

J. Mounting:
   1. 1-15 kVA: Suitable for wall mounting.
   2. 16-45 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 45 kVA: Suitable for floor or trapeze mounting.

K. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

L. Enclosure: NEMA ST 20, Type 1. Provide lifting eyes or brackets.

M. Isolate core and coil from enclosure using vibration-absorbing mounts.

N. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 26 05 33, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Support transformers in accordance with Section 26 05 29.
   1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
   2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.
3. Mount trapeze-mounted transformers as indicated on Drawings.

D. Provide seismic restraints.

E. Install grounding and bonding 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 7.2.1.

3.4 ADJUSTING
   A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
   B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 262200
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.

B. Institute of Electrical and Electronics Engineers:
   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:

1.3 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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 SWITCHBOARD

A. Manufacturers:

1. District Standard:
   a. Square D.

2. Acceptable Substitution:
   b. General Electric.
   d. Illinois Switchboard.

B. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.

C. Ratings: Furnish voltage, configuration, main bus, and integrated equipment rating as indicated on the drawings.

D. Main Section Devices: Individually mounted and compartmented.

E. Distribution Section Devices: Group mounted.

F. Bus Material: Copper, standard size.

G. Bus Connections: Bolted, accessible from front for maintenance.

H. Customer Meter: Square D/Schneider Electric #PM-820 or equal, integral with switchboard.

I. Ground Bus: Extend length of switchboard.

J. Circuit Breakers: NEMA AB 1, molded-case circuit breaker.

K. Field Adjustable Trip Circuit Breakers: Circuit breakers with frame sizes 200 amperes and larger have mechanism for adjusting setting for automatic operation.

L. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials and sizes indicated.

M. Metering Transformer Compartment: For Utility Company's use; compartment size, bus spacing and drilling, door, and locking and sealing requirements in accordance with Utility Company's requirements.

N. Pull Section: Size as shown on drawings or as required to facilitate installation.

P. Enclosure: Type 1 - General Purpose.
   1. Align sections at front and rear.
   2. Switchboard Height: 90 inches, excluding floor sills, lifting members.

Q. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

R. Integrated Surge Protective Device (SPD): Surge current rating shall be 240kA per phase (120kA per mode), Square D/Schneider Electric Surgelogic IMA Series or equal.

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 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards, electronic grade branch circuit panelboards, and load centers.

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. Institute of Electrical and Electronics Engineers:
   1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA 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 KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   6. NEMA PB 1 - Panelboards.
   7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:

D. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:
   1. UL 67 - Safety for Panelboards.
   2. UL 1283 - Electromagnetic Interference Filters.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
C. Product Data: Submit catalog data showing specified features of standard products.

1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
C. Operation and Maintenance Data: Submit 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 MAINTENANCE MATERIALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance products.
B. Furnish two of each panelboard key.

1.7 REGULATORY REQUIREMENTS
A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.
PART 2 - PRODUCTS

2.1 DISTRIBUTION PANELBOARDS - NEW

A. Material and Equipment: Product Options and Substitutions.

B. Manufacturers:
   1. District Standards:
      a. Square D Company.
   2. Acceptable Substitution:
      b. General Electric.

C. Description: NEMA PB 1, circuit breaker type, as indicated.

D. Panelboard Bus: Copper ratings as indicated. Provide copper equipment ground bus in each panelboard.

E. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 240 volt panelboards, 14,000 amperes rms symmetrical for 480 volt panelboards.

F. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

G. Molded Case Circuit Breakers with Current Limiters: NEMA AB 1, circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

H. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

I. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

J. Enclosure: NEMA PB 1, Type 1.

K. Cabinet Front: Surface type, fastened with concealed trim clamps or screws metal directory frame, finished in manufacturer's standard gray enamel.

L. Nameplate: Provide identification nameplates indicating panelboard designation. At distribution devices indicate the designation of the equipment followed by the area served.

2.2 DISTRIBUTION PANELBOARDS - EXISTING

A. Add new thermal-magnetic circuit breaker or fusible switch type branch circuit devices to existing distribution panelboards as required.

B. All new devices shall be of the same manufacturer, type and interrupting capacity as the original equipment.

C. Provide new nameplates upon completion of all wiring. Refer to Section 16195.
2.3 BRANCH CIRCUIT PANELBOARDS - NEW

A. Manufacturers:
   1. District Standards:
      a. Square D Company.
   2. Acceptable Substitution:
      b. General Electric.

B. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper, ratings as indicated. Provide copper equipment ground and neutral in each panelboard. Provide additional copper isolated ground bus where indicated.

D. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 240 volt panelboards, and 14,000 amperes rms symmetrical for 480 volt panelboards unless otherwise indicated larger on the drawings.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

F. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

G. Enclosure: NEMA PB 1, Type 1.

H. Cabinet Box: 6 inches deep, 20 inches wide panelboards.

I. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.


2.4 BRANCH CIRCUIT PANELBOARDS - EXISTING

A. Circuits to existing branch panelboards shall be connected to existing circuit breakers or plug fuses when available. Verify circuit numbers shown, provide new circuit breakers and/or rearrange existing circuit breakers as required.

B. Where new circuit breakers are added to existing panelboards, rearrange or remove existing breakers as required to accommodate the new circuit breakers. Deliver unused/removed circuit breakers to Owner.

C. All new circuit breakers installed in existing panelboards shall be of the same manufacturer, type, and interrupting capacity as the original equipment.

D. Add plug fuses as required.

E. Provide revised typewritten circuit directories upon completion of all wiring.
PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect abandoned panelboards and load centers. Remove and Install blank cover for abandoned panelboards and load centers.

B. Maintain access to existing panelboard and load centers remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing panelboards and load centers to remain or to be reinstalled.

3.2 INSTALLATION

A. Install panelboards and load centers in accordance with NEMA PB 1.1.

B. Install panelboards and load centers plumb.

C. Install recessed panelboards and load centers flush with wall finishes.

D. Height: 6 feet to top of panelboard and load center; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes to balance phase loads.

G. Install engraved plastic nameplates in accordance with Section 26 05 53.

H. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 5 empty 1 inch. Identify each as SPARE.

I. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.

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 circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multi-outlet assembly; and device plates and decorative box covers.

B. Related Sections:
   1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

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 SUBMITTALS

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

B. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

C. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

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

1.5 EXTRA MATERIALS

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

1.6 REGULATORY REQUIREMENTS

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

B. Conform to (IMC) International Mechanical Code. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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

J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. District Standard:
      a. Hubbell Model HBL1221 or HBL1221L.
      b. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA WD 1, specification grade, AC only general-use snap switch.
C. Body and Handle: Ivory plastic with toggle handle.
D. Indicator Light: Lighted handle type switch where indicated on drawings.
E. Ratings: Match branch circuit and load characteristics.
F. Provide similar construction three-way and four-way switches where indicated on drawings.

2.2 WALL DIMMERS

A. Manufacturers:
   1. District Standard:
      a. Hubbell Model AS Series.
      b. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA WD 1; Type as required to be compatible with lamps and/or ballasts.
C. Body and Handle: Ivory plastic with linear slide.
D. Voltage: To match load served.
E. Power Rating: As indicated on Drawings.
F. Accessory Wall Switch: Match dimmer appearance.
2.3 RECEPTACLES

A. Manufacturers:

1. District Standard:
   a. Hubbell Model HBL5252I.
   b. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA WD 1, specification grade receptacle.

C. Device Body: Decora flat face, back wired, ivory color.

D. Configuration: NEMA WD 6, type as indicated on Drawings.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

G. Provide tamper resistant receptacles in areas where students are present.

2.4 WALL PLATES

A. Decorative Cover Plate: In finished areas for switches and receptacles brushed 302 stainless steel. Provide oversized “jumbo plates” for devices on masonry walls, when required to conceal gaps.

B. Surface raceway system plate: Utilize plate specifically designed for raceway system and device.

C. Cover plate: In unfinished area provide cadmium plated steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.
C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Install receptacles with grounding pole on bottom.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

H. Use jumbo size plates for outlets installed in masonry walls to conceal gaps.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified and as indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 16 inches above finished floor.

D. Install convenience receptacle 6 inches above back splash of counter.

E. Install dimmer 48 inches above finished floor.

F. Coordinate installation of wiring devices with underfloor raceway service fittings provided under Section 26 05 39.

3.5 FIELD QUALITY CONTROL

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

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

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

B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

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

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726
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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
   J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
   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. Substitutions: Section 01 60 00 - Product Requirements.

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:

1.3 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. (2009)
   D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
   F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
      b. Substitutions: Section 01 60 00 - Product Requirements.
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.
      b. Substitutions: Section 01 60 00 - Product Requirements.
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:

1.3 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. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
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.
   2. Substitutions: Section 01 60 00 - Product Requirements.

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.

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
SECTION 264313 - SURGE PROTECTION FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for surge protection for low voltage electrical power circuits as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, the following:

1. Requirements for both field-mounted SPDs (externally mounted), and integrated SPDs (installed from the factory) for low voltage power distribution and control equipment.

1.2 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

2. ANSI/IEEE C62.41.2, "Recommended Practice on Characterization of Surges in Low Voltage (1000 V and Less) AC Power Circuits."

C. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems - Requirements."

D. National Fire Protection Association (NFPA):

1. NFPA 70, "National Electrical Code," hereinafter referred to as NEC.

E. Underwriters Laboratories, Inc. (UL):

1. UL 67, "Standard for Panelboards."
2. UL 96A, "Standard for Installation Requirements for Lightning Protection Systems."
3. UL 845, "Motor Control Centers."
4. UL 857, "Busways."
5. UL 891, "Switchboards."
8. UL 1558, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear."
1.3 DEFINITIONS

A. $I_{(n)}$: Nominal discharge current rating.
B. MCOV: Maximum continuous operating voltage.
C. Protection Modes: The pair of electrical connections where the VPR applies.
D. MOV: Metal oxide varistor; an electronic component with a significant non-ohmic current voltage characteristic.
E. OCPD: Overcurrent protective device.
F. SCCR: Short circuit current rating.
G. SPD: Surge protective device.
H. VPR: Voltage protection rating.

1.4 SYSTEM DESCRIPTION

A. General SPD Requirements:

1. SPD with accessories shall be listed and labeled as defined in NEC, by UL, and marked for intended location and application.
2. Comply with UL 1449.
3. Comply with UL 1283 (applies to Type 2 SPDs).
5. SPDs manufacturer shall be ISO 9001 certified.
6. MCOV of the SPD shall not be less than 115 percent for 480Y/277V and 125 percent for 208Y/120V nominal RMS system voltages.
7. SPDs installed internal to the distribution equipment shall be of the same manufacturer as the equipment. The equipment shall be fully tested and certified to the following UL standards:
   b. Motor Control Centers: UL 845.
   d. Switchboards: UL 891.
   e. Switchgear: UL 1558.

1.5 SUBMITTALS

A. General: See Section 01 33 00 - Submittal Procedures.
B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.
   1. For each type of product indicated include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Provide verification the SPD is listed or recognized through UL to the latest safety standard, UL 1449.
C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer’s standard product data.
D. Operation and Maintenance Data: Submit operation and maintenance data for surge protection for low voltage electrical power circuits to include in operation and maintenance manuals.
E. Warranty Data: Submit sample of special warranties.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of surge protection for low voltage electrical power circuits of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
   2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing surge protection for low voltage electrical power circuits similar in type and scope to that required for this Project and shall be approved by the manufacturer.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

C. Single Source Responsibility: Obtain surge protection for low voltage electrical power circuits and required accessories from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the work. Any materials which are not produced by the manufacturer shall be acceptable to and approved by the manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier’s or manufacturer’s original wrappings and containers, labeled with supplier’s or manufacturer’s name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 WARRANTY

A. General: See Section 01 77 00 - Closeout Procedures.

B. Special Warranty: Submit a written warranty executed by the manufacturer, the Installer, and the Contractor, agreeing to repair or replace surge protection for low voltage electrical power circuits that fail in materials or workmanship within the specified warranty period.
   1. Warranty Period: Warranty period shall be 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Product specified is “Surgelogic Surge Protection” as manufactured by Square D by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.
2.2 SERVICE ENTRANCE SUPPRESSORS

A. SPDs: Comply with UL 1449.
   1. SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs.
      SPDs installed on the load side of the service entrance OCPD shall be either Type 1 or
      Type 2 SPDs.
   2. Type 2 SPDs shall also comply with UL 1283.

B. Features and Accessories: SPDs shall provide the following features and accessories:
   1. Internal fusing design capable of disconnecting the SPD before any damaging external
      effects to the suppressor or surroundings occur.
   2. Indicator light(s) display for power and protection status with push-to-test capabilities.
   3. Audible alarm with silencing switch.
   4. Form C contacts; one normally open and one normally closed for remote monitoring of
      protection status. Contacts shall reverse on failure of any surge diversion module or on
      opening of any current-limiting device. Coordinate with building power monitoring and
      control system.
   5. Surge counter with reset switch.
   6. Optional integral disconnect switch for externally mounted SPDs. SPDs integrated into
      factory supplied equipment shall have an input disconnect switch or circuit breaker
      unless indicated on the equipment drawings/data sheets.

C. Surge Current Rating:
   1. The surge current rating of the SPD shall be dependent of its category/location, as
      follows:
      | Category/Location | Application  | Per Phase | Per Mode |
      |-------------------|-------------|-----------|----------|
      | C Service Entrance| 240 kA      | 120 kA    |
      | B Distribution    | 160 kA      | 80 kA     |

D. Protection Modes:
   1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:
      | Modes  | 208Y/120 | 480Y/277 | 600Y/347 |
      | L-N; L-G; N-G | 800 volts | 1200 volts | 1500 volts |
      | L-L    | 1200 volts | 2000 volts | 2500 volts |
   2. UL 1449 VPR for Delta configured circuits shall not exceed the following:
      | Modes  | 240D | 480D | 600D |
      | L-G; N-G | 1200 volts | 2000 volts | 2500 volts |

E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater
   than the available short circuit current at the point on the system where installed.

F. Nominal Discharge Current Rating: 20 kA I(n).
   1. Surge protective devices located at service entrance locations shall carry a minimum
      nominal discharge current rating of 20 kA to meet the requirements of UL 96A.

2.3 DISTRIBUTION/BRANCH PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449.
   1. Type 1 or Type 2 SPDs.
2. Type 2 SPDs shall also comply with UL 1283.

B. Features and Accessories: SPDs shall provide the following features and accessories:

1. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
2. Indicator light(s) display for power and protection status.
3. Audible alarm with silencing switch.
4. Form C contacts; one normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter with reset switch.
6. Optional integral disconnect switch for externally mounted SPDs. SPDs integrated into factory supplied equipment shall have an input disconnect switch or circuit breaker unless indicated on the equipment drawings/data sheets.

C. Surge Current Rating:

1. The surge current rating of the SPD shall be dependent of its category/location, as follows:

<table>
<thead>
<tr>
<th>Category/Location</th>
<th>Application</th>
<th>Per Phase</th>
<th>Per Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Distribution</td>
<td>160 kA</td>
<td>80 kA</td>
</tr>
<tr>
<td>B</td>
<td>Branch</td>
<td>120 kA</td>
<td>60 kA</td>
</tr>
</tbody>
</table>

D. Protection Modes:

1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:

<table>
<thead>
<tr>
<th>Modes</th>
<th>208Y/120</th>
<th>480Y/277</th>
<th>600Y/347</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-N; L-G; N-G</td>
<td>800 volts</td>
<td>1200 volts</td>
<td>1500 volts</td>
</tr>
<tr>
<td>L-L</td>
<td>1200 volts</td>
<td>2000 volts</td>
<td>2500 volts</td>
</tr>
</tbody>
</table>

2. UL 1449 VPR for Delta configured circuits shall not exceed the following:

<table>
<thead>
<tr>
<th>Modes</th>
<th>240D</th>
<th>480D</th>
<th>600D</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-G; N-G</td>
<td>1200 volts</td>
<td>2000 volts</td>
<td>2500 volts</td>
</tr>
</tbody>
</table>

E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.

F. Nominal Discharge Current Rating: 10 kA I(n).

2.4 ENCLOSURES

A. Enclosure shall meet or exceed the ratings for the environment to be installed as indicated on drawings.

1. Indoor Enclosures for Externally Mounted SPDs: NEMA 250, Type 3R.
2. Outdoor Enclosures for Externally Mounted SPDs: NEMA 250, Type 3R, 4X.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Install surge protection for low voltage electrical power circuits in accordance with reviewed product data, final shop drawings, manufacturer’s written instructions and recommendations, and as indicated on the Drawings.

B. Install SPD devices at the service entrance in accordance with NEC. SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. SPDs installed on the load side of the OCPD shall be either Type 1 or Type 2 SPDs.

C. Follow manufacturer’s recommended installation practices.

1. Provide a minimum 30 ampere circuit breaker as a dedicated disconnecting means for the SPD unless otherwise indicated.

2. Install SPDs with properly rated conductors between suppressor and points of attachment as short and straight as possible; adjust circuit breaker positions to achieve shortest and straightest leads.

3. Do not splice and extend SPD leads unless specifically permitted by manufacturer.

4. Twist input conductors together to reduce the input inductance.

3.3 FIELD QUALITY CONTROL

A. See Section 01 45 23 - Inspecting and Testing Services.

B. Perform the following tests and inspections.

1. Compare equipment nameplate data for compliance with the Drawings and the Specifications.

2. Inspect anchorage, alignment, grounding, and clearances.

3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

C. A SPD will be considered defective if it does not pass inspections.

D. Prepare inspection reports.

3.4 DEMONSTRATION

A. Start-Up Service:

1. Complete start-up checks according to manufacturer's written instructions.

2. Do not perform insulation resistance tests of the distribution wiring equipment with SPDs installed. Disconnect all wires, including, but not limited to, neutral of the SPD before conducting insulation resistance tests, and reconnect them immediately after the testing is over.

3. Energize SPDs after power system has been energized, stabilized, and tested.
3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the installer that shall ensure that the surge protection for low voltage electrical power circuits shall be without damage at time of Substantial Completion.

END OF SECTION 264313
SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

B. Related Sections:

1. Section 09 58 00 - Integrated Ceiling Assemblies.
2. Section 23 37 00 - Air Outlets and Inlets: For interface with air handling fixtures.
3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
4. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. American National Standards Institute:

2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1.3 SUBMITTALS

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

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data.

D. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

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

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

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

B. Furnish two of each ballast type.
1.7 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.
B. Refer to Section 01 60 00 - Product Requirements for product options.

2.2 FLUORESCENT BALLASTS

A. Manufacturers:
   1. Osram Sylvania.
   2. Advance.
   3. Universal.
   4. Substitutions: Section 01 60 00 - Product Requirements.
B. Product Description: Electronic ballast, rapid start less than 10 percent THD suitable for lamps specified, with voltage to match luminaire voltage. Reference lighting fixture schedule for specific ballast requirements.
C. All ballast shall be universal voltage type, suitable for 120 and 277 volt operation.
2.3 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:
   1. Osram Sylvania.
   2. Advance.
   3. Universal.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C82.4, metal halide or high pressure sodium lamp ballast, suitable for lamp specified, with voltage to match luminaire voltage.

2.4 FLUORESCENT LAMPS

A. Manufacturers:
   1. Philips.
   2. Osram Sylvania.
   3. GE Lighting.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. The lamp color temperature shall be 5000K color temperature.

2.5 HID LAMPS

A. Manufacturers:
   1. Philips.
   2. Osram Sylvania.
   3. GE Lighting.
   4. Substitutions: Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide a coordinated layout of all gymnasium lighting fixtures and submit to construction manager for review and approval prior to rough-in.

B. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

C. Support luminaires independent of ceiling framing.

D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan drawings.

E. Install pendant and surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

F. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure. Install auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.

G. Install recessed luminaires to permit removal from below.
H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
I. Install clips to secure recessed grid-supported luminaires in place.
J. Install wall-mounted luminaires at height as indicated on Drawings or as scheduled.
K. Install accessories furnished with each luminaire.
L. Connect grid mounted luminaires to branch circuit outlets provided under Section 26 05 33 using flexible conduit.
M. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
N. Install specified lamps in each luminaire.
O. Operate T-5 fluorescent lamps at full intensity for 100 hours or the recommended time from the manufacturer to “Burn-in” or “Season” lamps.
P. Interface with air handling accessories furnished and installed under Section 23 37 00.
Q. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING
A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
B. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING
A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
B. Remove dirt and debris from enclosures.
C. Clean photometric control surfaces as recommended by manufacturer.
D. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK
A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
B. Relamp luminaires having failed lamps at Substantial Completion.

END OF SECTION 265100
SECTION 271343 - COMMUNICATION SERVICES CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Patch panels.
   2. Information outlets, jacks and faceplates.
   3. Information cable.
   4. Terminations.
   5. Testing certification and documentation.

B. Related Sections:
   1. Section 26 05 33 - Raceway and Boxes.
   2. Section 26 27 26 - Wiring Devices: Wall plates.

1.2 REFERENCES

E. ANSI/TIA/EIA-606(A) - The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
F. ANSI/TIA/EIA-607(A) - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide telecommunication cables, termination hardware, devices and equipment that are listed and labeled by Underwriters Laboratories, Inc. (UL).
B. NEC Compliance: Comply with requirements of NFPA 70, National Electrical Code, 1996 edition, as applicable to telecommunication cables.
C. The telecommunication cable installer shall be licensed in the State of Illinois.

D. The contractor shall be certified by the manufacturer of the structured cabling system to be installed and shall submit a copy of this certification in the form of an official authorization or certificate issued by that manufacturer.

1.4 REGULATORY REQUIREMENTS

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

B. Conform to (IMC) International Mechanical Code. (2009)


D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)


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


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


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

1.5 SYSTEM COMPONENTS

A. Service entrance from Telecommunications Utility Company to remain.

B. Backbone Pathway: Conform to ANSI/TIA/EIA 569-B using sleeves and methods as required.

C. Horizontal Pathway: Conform to ANSI/TIA/EIA 569-B using sleeves and methods as required.

D. Backbone Wiring: Complete from entrance equipment to each telecommunications closet.

E. Horizontal Wiring: Complete from telecommunications closet to an outlet.

1.6 SYSTEM DESCRIPTION

A. It is the intent of the Engineer to specify a Category 6 structured cabling system. The contractor shall provide this system based on Category 6 standards available at the time of installation. The Category 6 system will be capable of performing to 250 MHz and characterized out to 750 MHz with documented balance characteristics. The user interface at the telecommunications outlet (TO) for Category 6 will be the 8-position modular jack. It is anticipated that this category will allow both UTP and ScTP cables.
B. Contractor provides all raceways, outlet boxes, cables, termination hardware, patch panels, patch equipment, equipment racks, communication outlets, backboards, cable runway, J-hooks, all supporting hardware, telecommunications system grounding and bonding, testing, certifications and documentation, and identification as required for a complete information system as specified in this section and indicated on the drawings.

C. All drop configurations are as indicated on drawings.

D. All cabling in the building is to be routed to either the main distribution frame (MDF) or intermediate distribution frame (IDF) as indicated on the drawings. Voice/Data cabling is to be terminated on 48 port high density Category 6 patch panels installed in wall or floor mounted 19" racks. Provide racks with cable management sections and rack mounted surge protected power strips.

E. Furnish and install backbone cabling and termination equipment between the wiring closets. Backbone media is to consist of one (1) 12-strand OM4 fiber optic cable. Route fiber optic cable in 1” inner-duct, plenum rated.

F. All drops, patch panels and wiring blocks are to be labeled with machine printed label strips. No hand lettered labeling will be accepted.

G. Front end data network computers and equipment will be furnished and installed by others.

1.7 SUBMITTALS

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

B. Product Data: Submit catalog data for each termination device, cable, and outlet device.

C. Test Reports: Indicate procedures and results for specified field testing and inspection.

1.8 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.9 QUALIFICATIONS

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

B. Installer: Company specializing in installing products specified in this section with minimum three years documented experience and with service facilities within 50 miles of project.

C. Testing Agency: Company or trained licensed contractor specializing in testing products specified in this section with minimum three years’ experience.

1.10 PRE-INSTALLATION MEETING

A. Convene minimum one week prior to commencing Work of this section.

1.11 EXTRA MATERIALS

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

B. Furnish two of each telephone and data outlet configuration installed.
1.12 COORDINATION

A. Coordinate conduit raceway sizes, locations, penetrations, rated partitions, and requirements. Coordinate exact routing with work of other trades.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

A. Provide a complete tested and certified information system including but not limited to:
   1. Category 6 voice cable distribution.
   2. Category 6 data cable distribution.
   3. Fiber backbone cable distribution.
   4. Termination hardware.
   5. Patch equipment.
   6. Supports and mounting hardware.
   7. Telecommunications systems grounding and bonding.
   8. Identification and labeling.

B. Each information outlet shall be configured as indicated on the drawings.

C. All telecommunications cabling work shall be in accordance with ANSI/TIA/EIA standards 568-B.2, 568-B.3 569-B, and 606-A. Grounding and bonding shall be in accordance with the National Electrical Code NFPA 72 2008.

D. End-to-end Category 6 channel must be maintained, including patch panels, jacks and patch cords (of the same manufacturer) and the complete cable installation shall comply with ANSI/TIA/EIA 568-B.2

2.2 SUBMITTALS

A. Prior to Installation:
   1. Manufacturer cut sheets, product performance data, and installation instructions for each component including cables, termination hardware, patch panels, identification labels, racks, etc.
   2. Contractor shall submit construction plans indicating drop locations, labeling, proposed routing, enlarged closet plans, and panel/wiring block usage details. These plans shall be generated on AutoCad 14 or later and submitted on CD-ROM. A hard copy set shall be stamped by a BICSI RCDD and submitted as part of the shop drawings.
   3. Contractor will provide Belden Certification certificates for 25 year warranty Compliance.

B. Project Closeout Submittals:
   1. As-built record drawings including floor plans, telecommunication closet layouts, cable assignment records, cross-connect documentation, cable and termination labeling.
   2. Updated pull schedules reflecting all changes made in the field.
   3. Full documentation of the cable plant test results for Category 6: Must conform to
      a. End-to-end continuity.
      b. End-to-end attenuation.
      c. Requirements listed in 3.03 of this section.
   5. Contractor to Provide 25 year system warranty.
2.3 INFORMATION OUTLETS, JACKS AND FACEPLATES, AND PATCH CORDS

A. Manufacturer:
   1. Belden, district standard.

B. Faceplates: Standard plate (white) or angled plate (white). Provide standard faceplates compatible with the surface metallic raceway system when applicable and match color.

C. Voice Jacks: T568B, Category 6, eight-position/eight-conductor, in color white.

D. Data Jacks: T568B, Category 6, eight-position/eight-conductor, in color blue.

E. Blank inserts for unused ports in outlets, snap-in blank module.

F. Other connection modules as specified on drawings.

2.4 PATCH EQUIPMENT AND COMMUNICATION CLOSET

A. Category 6 LAN Patch Equipment:
   1. Belden, district standard.
      a. Category 6, 110 patch panel kit, T568B wired, mounted on EIA 19” rack. AX103115. Include colored icons to match Voice and Data colored jacks.
      b. Provide adequate number of modular patch panels in rack to allow a minimum of eight (8) unused spare ports in each forty-eight (48) port panel for future use.
      c. Category 6 System Compatible Patch Cords: to be provided by owner.

B. 19” Racks - Floor Mounted:
   1. 19” x height as required aluminum EIA wall mounted swing gate relay rack, for mounting the voice/data cable patch equipment. Hoffman E19SWM or equal. Provide racks with:
      a. One multi-receptacle 19” rack mounted power strip, circuit breaker protected.
      b. Grounding bar with #6AWG insulated equipment grounding conductor bonded to the signal ground bus in the closet.

C. Backboards:
   1. Provide 8’x4’x3/4” fire rated plywood backboard in closet as indicated for telephone service voice cable termination.

D. Cable Runway and D-Rings:
   1. Furnish and install cable runway, minimum 20” wide, within wiring closet above relay racks and backboards utilized to mount cable termination hardware. Secure cable runway to racks and wall with appropriate support kits.
   2. Furnish and install cable management D-rings for routing cable bundles down walls and backboards.

2.5 VOICE AND DATA CABLES

A. UL-Listed 100 ohm four (4) pair UP Category 6, plenum rated cable for data and voice. Belden 3613 D15A1000.

2.6 J-HOOKS

A. Provide manufacturer approved mounting hardware to accommodate installation.

2.7 DISTRICT STANDARD TECHNOLOGY MATERIAL LIST

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable, TIA/EIA Category 6 Complaint UTP, CMP, 23 AWG/4 pair solid copper, jacket color blue</td>
<td>Belden 3613 D15A1000</td>
</tr>
<tr>
<td>Cable, 12-strand 550 Laser Optimized SO/12Sum Multimode OM4 Fiber Optic Cable, OFNP, MIC Tight Buffered, Plenum Rated meeting NEC Article 770.</td>
<td>Belden B9E048</td>
</tr>
<tr>
<td>Faceplate, Wall Telephone Outlet, Stainless Steel</td>
<td>Belden AX102005</td>
</tr>
<tr>
<td>Faceplate, Wireless LAN &amp; Door Outlet, Single Port</td>
<td>Belden AX103922</td>
</tr>
<tr>
<td>Faceplate, Clock/Speaker, Double Port Faceplate, Sloped Inserts</td>
<td>Belden AX103923</td>
</tr>
<tr>
<td>Faceplate, General Data, Four Port Faceplate, Sloped Inserts</td>
<td>Belden AX102248</td>
</tr>
<tr>
<td>RJ-45 Jack, ANSI/TIA-568-C.2 Complaint, CAT 6</td>
<td>Belden AX101320</td>
</tr>
<tr>
<td>RJ-45 Patch Panel, 48 Port, 2 RU, ANSI/TIA-569-C.2-10 Complaint and UL Listed</td>
<td>Belden AX103115</td>
</tr>
<tr>
<td>Cable Management, Horizontal, 1 RU</td>
<td>Hoffman DCHS1</td>
</tr>
<tr>
<td>Fiber Optic Patch Panel and Splice Case</td>
<td>Belden AX104681</td>
</tr>
<tr>
<td>Pre-Polished Duplex LC Fiber Termination, OM4</td>
<td>Belden AX104242-S1</td>
</tr>
<tr>
<td>Telecommunications Main Grounding Busbar (TMGB), 1/4 inch thick by 4 inches</td>
<td>Panduit GB4B0624TPI-1</td>
</tr>
<tr>
<td>Telecommunications Grounding Busbar (TGB), 1/4 inch thick by 2 inches</td>
<td>Panduit GB2B0304TPI-1</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pathways in accordance with ANSI/TIA/EIA 569-B.

B. Install wire and cable in accordance with ANSI/TIA/EIA 568-B.2.

C. Finish paint termination backboards with two coats of durable, fire retardant, white enamel in accordance with Section 09 90 00 prior to installation of cabling hardware or equipment.

D. Install termination backboards and cabinets plumb, and attach securely to building wall at each corner. Install cabinet trim plumb.

E. Install polyethylene pulling string in each empty communications conduit over 10 feet in length or containing bends.
F. Horizontal cable run above the suspended ceiling shall be installed in a neat and organized manner, straight and plumb and shall be when possible routed above accessible corridor areas. Cable drops to wall outlets shall be run in the conduit stub-ups.

G. Horizontal cables shall be run above the suspended ceilings and shall be supported through J-hooks installed at a maximum spacing of 5 foot on-center. Coordinate cable installation with other ceiling installations including HVAC ducts, electrical fixtures and conduits, and sprinkler piping. Cable bundle droop shall not exceed 8" between supports.

H. Voice and data cables shall be run in continuous uninterrupted sections from origin to termination with no splices or couplers.

I. The Contractor shall provide conduit sleeves through all walls and floors to accommodate information cables. All sleeves shall be sized for 50 percent future growth. Fire seal sleeves using approved materials and methods once cables are pulled.

J. Velcro style cable tie wraps shall be utilized within the wiring closet.

K. Tie wraps utilized above ceilings shall be snug without deforming cable jacket.

L. The length of each Horizontal cable run shall not exceed 295 feet. Horizontal cable is defined as that length of cable from the back of the workstation outlet to the back of the Patch Panel or connecting block in the telecommunications closet. Horizontal cable shall be a continuous run of cable with no splices, bridges, or other discontinuities.

M. Maintain cable twist-rate at all termination points. The amount of cable untwist shall be no more than 1/2". Do not strip back the cable jacket any more than is necessary to terminate the individual conductors, 1 inch maximum.

N. All 110 connections shall be installed using a single 110 punch down tool and all terminations shall be trimmed flush with connector blocks.

O. Leave enough cable (approximately 1 foot at the workstation & 4 feet at the backboard or rack) to allow easy termination of the cable.

P. Cables shall not be tie wrapped to electrical or gas conduit.

Q. D-rings will be provided and mounted to route the horizontal cables at the backboard locations (& in chase locations as designated on the Drawings).

R. No communication or data circuit shall be run in the same conduit or raceway with power conductor except where the raceway is separated by a divider.

S. Cable routing shall avoid locations of high RFI/EMI radiation or adverse environmental conditions. Maintain minimum separations of: 6" from fluorescent light fixtures, 12" from open power conductors, 4'-0" from transformers and other high voltage devices.

T. The voice/data cable plant shall be grounded and bonded. Provide a telecommunications main ground bus (TMBG) at main distribution frame (MDF) and a telecommunications ground bus (TGB) at intermediate distribution frame (IDF). Ground each rack to respective ground bus using #6 AWG copper conductor. Connect TGB’s back to TMGB. Provide a complete and effectively grounded system.

3.2 IDENTIFICATION

A. Provide identification labels at all cables, outlets and termination patch panels in accordance with the contract drawings and specifications.
B. Cable labels shall be typed and covered with clear plastic laminate and shall be attached at 6" from the closet termination end and at 2"-4" from the outlet location end. Cable labels shall also be provided at the point where they entered as a bundle into the surface non-metallic raceway system.

C. Provide identification (minimum 1/4" high lettering) at the racks to identify patch panels.

D. Preprinted transparent adhesive labels shall be provided at all communication outlets identifying the outlet designation and the port assignments and shall be coordinated with the Owner’s labeling scheme.

E. Submit samples of all identification labels, for Owners approval prior to installation.

3.3 TESTING AND CERTIFICATION

A. Upon completion of the installation and termination of all communication cables, the cabling plant shall be end-to-end performance tested and certified for the specified cable classification categories and shall be performed in accordance with ANSI/TIA/EIA 568-B.2.

B. All drops are to be tested with a hand held Level III cable tester generating a swept frequency, MHZ, min., signal. The test shall be a Channel Test. Test results shall indicate pass/fail of ANSI/TIA/EIA 568-B.2 limits for Channel Compliance as well as actual values, where applicable, for the following parameters as a minimum:

1. Wire map.
2. Length.
3. Insertion loss
4. Near End Cross Talk (NEXT) from both ends
5. Delay and Delay Skew
6. Power Sum Near End Cross Talk (PSNEXT)
7. Equal Level Far End Cross Talk (ELFEXT)
8. Power Sum Equal Level Far End Cross Talk (PSELFEXT)
9. Return Loss

C. Fiber Optic Cables: Each fiber strand shall be tested after final termination has been completed.

1. End to End attenuation testing shall be performed using an optical power meter in both directions at the specified wavelengths for each fiber in the backbone system. Multimate fibers shall be tested at 850nm and 1300nm. The test results of each fiber shall indicate as a minimum:

   a. Cable Length
   b. AdB@ loss

2. Acceptable connector loss: < 0.5 dB per mated pair; acceptable splice loss: < 0.2 dB; acceptable cable loss: per manufacturers calculated dB loss per 1000’.

D. Test results shall be printed out and assembled in a binder for owner review.

E. Provide certified records of all performance verification tests for Owners record.

3.4 CABLE SCHEDULES

A. The installing contractor shall coordinate with school district representative the exact termination arrangement and identification/administration.
SECTION 283100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
   1. Fire alarm system detection and notification operations.
   2. Control and monitoring of elevators, door hold-open devices, fire suppression systems, and other equipment as indicated in the drawings and specifications.
   3. One-way supervised automatic voice alarm operations.

1.2 SCOPE OF WORK

A. The existing SimplexGrinnell 4020 Fire Alarm system control panel to be removed and replaces with a SimplexGrinnell 4100 ES voice panel. The existing fire alarm components to remain unless specifically indicated otherwise reconnect to new panel.

B. The Field House addition shall include voice notification appliances. The Field House vestibule shall have an annunciator panel with voice capability. Existing annunciators to be replaced with new panels compatible with replaced system.

1.3 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

A. Manufacturers: The equipment and service described in this specification are those supplied and supported by SimplexGrinnell as currently installed within the building.

B. The equipment and service provider shall be a nationally recognized company specializing in fire alarm and detection systems. This provider shall employ factory trained and NICET Level II certified technicians, and shall maintain a service organization within 50 miles of this project location. The equipment and service provider shall have a minimum of 10 years’ experience in the fire protective signaling systems industry.

1.4 RELATED DOCUMENTS

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

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
   1. Division 26: "Basic Electrical Materials and Methods."
   2. Division 26: "Wiring Methods."
   3. Division 21: "Fire Suppression".
   4. Division 23: "HVAC Systems".
   5. Division 23: "Building Automation and Control".
1.5 REGULATORY REQUIREMENTS

A. Conform to Health/Life Safety Code for Public Schools.
B. Conform to (IMC) International Mechanical Code. (2009)
D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2009)
F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.

1. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
2. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.
3. Panels shall be capable of full system operation during new site specific configuration download, master exec downloads, and slave exec downloads.
4. Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications and via TCP/IP Ethernet network communications. Ethernet access to any fire alarm panel shall be capable of providing access only to authenticated users through a cryptographically authenticated and secure SSL tunnel.
5. Panels shall automatically store all program changes to the panel’s non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare any two of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.
6. Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner’s manuals, testing and maintenance records, etc.

7. The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. If the media is removed a trouble shall be reported on the fire alarm control panel.

C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

D. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

E. Wiring/Signal Transmission:
   1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
   2. System connections for initiating device circuits shall be Class B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.
   3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

F. Remote Access:
   1. Fire Alarm Control Panel (FACP) shall provide the necessary hardware to provide a remote service access feature using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3. The Remote Access feature shall provide automatic notification of system faults and remote diagnostics of system status for responding technicians prior to arrival on site.
   2. A standard RJ-45 Ethernet connection shall connect to the owners Ethernet network. Provisions for that connection must be provided at each fire alarm control panel as part of the contract.
   3. The Ethernet access feature shall be agency listed for specific interfaces and for the purpose described in this section. The use of non-listed external third party interfaces is not acceptable.
   4. The internet remote access service function shall provide automated real time off-site reporting of discrete system events to a remote service support center with details of internal FACP fault conditions allowing a pre-site visit analysis of repair requirements.
   5. Existing FACP controls shall be capable of retrofitting the Remote Service module as a plug-in upgrade feature.
   6. The remote service network shall work on the customers Ethernet infrastructure and be Fire-Wall friendly for two-way communications for off-site reporting. The feature shall be compatible with existing proxy servers and firewalls shall not require any special changes or modifications.
   7. The remote service system shall be able to connect to the remote service center without the need for a VPN account or similar tunnel.
   8. The remote service system shall be a non-Windows based application to protect against conventional virus attacks.
   9. The remote service system shall support a secure connection with strong encryption, 128 bit or better, and an optional secondary encryption method if required.
   10. The remote service system shall be compatible with virtual LANS (VLAN).
11. The remote service system shall work on an outbound communication premise (panel calls home) in order to eliminate the possibility of any inbound connection into the network (from trusted or non-trusted sites).

12. The remote service system shall provide an audit trail of all events and service connections.

13. The Remote Service connection will provide access for panel software downloads and uploads for archiving job specific programs back at the enterprise server.

14. The supplier shall provide a service contract for the Remote Service program that provides the following requirements:
   
a. 24/7 recording of FACP service activity.
   b. Off-site diagnostics by a technical specialist to provide repair and parts guidance to the service technician prior to a site visit.

G. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

2. Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.

3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.

4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the type of device, the operational state of the device (i.e alarm, trouble or supervisory) and shall display the custom label associated with the device.

5. General Alarm: A system general alarm shall include:
   
a. Indication of alarm condition at the FACP and the annunciator(s).
   b. Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
   c. Operation of audible and visible notification appliances until silenced at FACP.
   d. Closing doors normally held open by magnetic door holders.
   e. Unlocking designated doors.
   f. Shutting down supply and return fans serving zone where alarm is initiated.
   g. Closing smoke dampers on system serving zone where alarm is initiated.
   h. Initiation of smoke control sequence.
   i. Transmission of signal to the supervising station.
   j. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated, as appropriate.

6. Supervisory Operations: Upon activation of a supervisory device such as a fire pump power failure, Low air pressure switch, and tamper switch, the system shall operate as follows:
   
a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
   b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
   c. Record the event in the FACP historical log.
d. Transmission of supervisory signal to the supervising station.

e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.

7. **Alarm Silencing:** If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.

8. **System Reset**

   a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."

   b. Should an alarm condition continue, the system will remain in an alarmed state.

9. **Alarm Silencing:** If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.

10. **WALKTEST:** The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:

   a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.

   b. Control relay functions associated with one of the 8 testing groups shall be bypassed.

   c. The control unit shall indicate a trouble condition.

   d. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.

   e. The unit shall automatically reset itself after signaling is complete.

   f. Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.

11. **Install Mode:** The system shall have the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to more clearly identify event activations from commissioned points and devices and in occupied areas.

   a. It shall be possible to individually remove points from Install Mode as required for phased system commissioning.

   b. It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.

H. **Analog Smoke Sensors:**

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.

2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.

3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.

5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Supervising Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

6. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.

7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.

8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.

9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

I. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:

1. Biannual sensitivity reading and logging for each smoke sensor.
2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
5. Semi-annual functional testing of each smoke detector or sensor using the manufacturers calibrated test tool.
6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
7. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.

J. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.

1. Automatic Voice Evacuation Sequence:
   a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
   b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
K. Speaker: Speaker notification appliances shall be listed to UL 1480.
   1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
   2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
   3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

L. Manual Voice Paging
   1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
   2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
   3. Total building paging shall be accomplished by the means of an "All Call" switch.

M. Constant Supervision of Non-Alarm Audio Functions:
   1. When required, the system shall be configured to allow Non-Alarm Audio (NAA) functions such as background music or general/public address paging.
   2. During NAA operation, the speaker circuit shall be electrically supervised to provide continuous monitoring of the speaker circuit.
   3. During an alarm condition, supervision shall be disabled and alarm signals delivered to speakers.

N. Fire Suppression Monitoring:
   1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
   2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
   3. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.

O. Power Requirements:
   1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
   2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 60 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
   3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
   4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
   5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
   6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
   7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
   8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.
1.7 SUBMITTALS

A. General: Submit the following according to Conditions of Contract.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

2. Wiring diagrams from manufacturer.

3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.

4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.

5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.

6. Operating instructions for FACP.

7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.

8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.

9. Record of field tests of system.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.9 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.
1.10 EXTRA MATERIALS

A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:

1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
2. Notification Appliances: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of each type and number of units installed but not less than one of each type.
4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of each type and number of units installed but not less than one of each type.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".

B. The following FACP hardware shall be provided:

1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node.
4. 2000 points of annunciation where one (1) point of annunciation equals:
   a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
   b. 1 LED on panel or 1 switch on panel.
5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
7. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
8. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
9. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
10. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
11. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
12. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
13. The FACP shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
15. Programmable DACT for either Common Event Reporting or per Point Reporting.
16. Service Port Modem for dial in passcode access to all fire control panel information.
C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

E. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:

1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.

2. Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.

3. Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio. Up to 8 channels of audio shall be multiplexed on either a style 4 or style 7 twisted pair.

4. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.

5. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.

F. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a (Class B supervised serial communications channel (SLC):

1. Amplifiers, voice and telephone control circuits
2. Addressable Signaling Line Circuits
3. Initiating Device Circuits
4. Notification Appliance Circuits
5. Auxiliary Control Circuits

2.2 REMOTE LCD ANNUNCIATOR

A. Provide a remote LCD Annunciator, with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACP.

B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
E. The LCD shall display the following information relative to the abnormal condition of a point in the system:

1. 40 character custom location label.
2. Type of device (e.g., smoke, pull station, waterflow).
3. Point status (e.g., alarm, trouble).

F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

2.3 EMERGENCY POWER SUPPLY

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 60 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes.

2.4 ADDRESSABLE MANUAL PULL STATIONS

A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

B. Protective Shield: Where required, as indicated on the drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.5 SMOKE SENSORS

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
5. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
6. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
7. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
8. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
9. Removal of the sensor head for cleaning shall not require the setting of addresses.
B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type.

C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

2.6 HEAT SENSORS

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.7 ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of water flow, valve tamper, non-addressable devices, and for control of AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
C. There shall be the following types of modules:

1. **Type 1: Monitor Circuit Interface Module**
   a. For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
   b. For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

2. **Type 2: Line Powered Monitor Circuit Interface Module**
   a. This type of module is an individually addressable module that has both its power and its communications supplied by the two wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
   b. This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

3. **Type 3: Single Address Multi-Point Interface Modules**
   a. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
   b. This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
   c. This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

4. **Type 4: Line Powered Control Circuit Interface Module**
   a. This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

5. **Type 5: 4-20 mA Analog Monitor Circuit Interface Module**
   a. This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.
D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

2.9 STANDARD ALARM NOTIFICATION APPLIANCES

A. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflective system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

B. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480.

1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC.
2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
4. The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.

C. Speaker: Speaker notification appliances shall be listed to UL 1480.

1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
4. The S/V installs directly to a 4" square, 1 ½" deep electrical box with 1 ½" extension.

D. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.

E. Accessories: The contractor shall furnish any necessary accessories.

2.10 NAC POWER EXTENDER

A. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B, Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
B. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.

C. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.

D. For IDNet connected NAC extender panels up to five panels can be connected on a single IDNet channel.

E. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control panel may be used to activate all the circuits on the NAC power extender panel.

F. Alarms from the host fire alarm control panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.

G. The exact quantity of NAC panels to be determined by the equipment and service provider.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, ethernet drops, and all other necessary material for a complete operating system.

B. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.

C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.

D. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.

E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
F. Coordinate the locations of all NAC panels with the owner’s representative.

G. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.

H. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

I. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, duct smoke detectors.

J. Automatic Detector Installation: Conform to NFPA 72.

K. Ethernet Drop: A standard RJ-45 Ethernet connection to the owner’s Ethernet network shall be provided at each fire alarm control panel as part of the contract.

L. The electrical contractor to provide emergency power to all new control panels and NAC panels.

3.3 PREPARATION

A. Coordinate work of this Section with other affected work and construction schedule.

3.4 WIRING INSTALLATION

A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

D. Mount end-of-line device in box with last device or separate box adjacent to last device for Class "B" supervision.

E. Ethernet circuits shall be provided to the Fire Alarm Control Panel.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning

D. Inspection:

1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

E. Acceptance Operational Tests:

1. Perform operational system tests to verify conformance with specifications:
   a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
   b. Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.

2. Provide minimum 10 days’ notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.

H. Final Test, Record of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.6 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.
3.7 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 283100
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.
1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

D. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - EXECUTION

2.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.
2.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

2.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

2.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

2.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.
B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   1. Limit height of topsoil stockpiles to 72 inches
   2. Do not stockpile topsoil within protection zones.
   3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
   4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

2.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

2.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000
SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf, and grasses.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks, pavements
5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487 Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

H. Sand: ASTM C 33; fine aggregate.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned.
by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

3.6 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrades to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than **8 inches** in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698, ASTM D 1557:

   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at **95** percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at **92** percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at **85** percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

   1. Turf or Unpaved Areas: Plus or minus 1 inch
   2. Walks: Plus or minus 1 inch
   3. Pavements: Plus or minus 1 inch

C. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch**.

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

   1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698, ASTM D 1557

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
   3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.
   3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 or less of wall length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000
SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include technical data and tested physical and performance properties.
      2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS
   A. Material Test Reports: For each paving material, by a qualified testing agency.
   B. Field quality-control reports.

1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: IDOT Certified
   B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
   C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of IDOT for asphalt paving work.
1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Shall be in accordance with Article 351 of IDOT Standard Specifications for Road and Bridge Construction

2.2 ASPHALT MATERIALS

A. Shall be in accordance with Article 406 of IDOT Standard Specifications for Road and Bridge Construction

2.3 MIXES

A. Shall be in accordance with Article 406 of IDOT Standard Specifications for Road and Bridge Construction

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

D. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
   1. Clean cracks and joints in existing hot-mix asphalt pavement.
   2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
   3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 PLACING HOT-MIX ASPHALT

A. Shall be in accordance with Article 406 of IDOT Standard Specifications for Road and Bridge Construction

3.6 INSTALLATION TOLERANCES

A. Shall be in accordance with Article 406 of IDOT Standard Specifications for Road and Bridge Construction

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216
SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Driveways.
      2. Walks.

1.3 DEFINITIONS
   A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Other Action Submittals:
      1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified ready-mix concrete manufacturer.
   B. Material Certificates: For the following, from manufacturer:
      1. Cementitious materials.
      2. Steel reinforcement and reinforcement accessories.
      3. Fiber reinforcement.
      4. Admixtures.
      5. Curing compounds.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:
   1. Aggregates

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Shall be in accordance with Section 420 of IDOT Standard Specifications for Road and Bridge Construction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.
3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 CONCRETE PLACEMENT

A. Shall be in accordance with Section 420 of IDOT Standard Specifications for Road and Bridge Construction.

3.5 CONCRETE PROTECTION AND CURING

A. Shall be in accordance with Section 420 of IDOT Standard Specifications for Road and Bridge Construction.

3.6 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
   1. Elevation: 3/4 inch (19 mm).
   2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
   3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/2 inch (13 mm).
   4. Joint Spacing: 3 inches (75 mm).
   5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
   6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

   1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.

      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.8 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313
SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Seeding.
   2. Hydroseeding.
   3. Erosion-control material(s).

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliants, or desiccants.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See [Section 329113 "Soil Preparation"] [Section 329115 "Soil Preparation (Performance Specification)"] and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and
percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: IDOT Class 1 Lawn Mix, IDOT Class 2 Roadside Mix

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch) sieve; soluble salt content of 2 - 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 - 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

A. As noted on plan sheets.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 SEEDING

A. Shall be in accordance with Section 250 of IDOT Standard Specifications for Road and Bridge Construction

3.3 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent and bare spots not exceeding 5 by 5 inches

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.5 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.6 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.
END OF SECTION 329200
SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Pipe and fittings.
      2. Nonpressure transition couplings.
      3. Cleanouts.
      4. Drains.
      5. Manholes.
      6. Channel drainage systems.
      7. Catch basins.
      8. Stormwater inlets.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings:
      1. Manholes: Include plans, elevations, sections, details, frames, and covers.
      2. Catch basins, stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
   B. Protect pipe, pipe fittings, and seals from dirt and damage.
   C. Handle manholes according to manufacturer's written rigging instructions.
PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.

2.2 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).

2.3 CLEANOUTS

A. Plastic Cleanouts:
   1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 MANHOLE

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
   4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
   8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   9. Omit steps if total depth from floor of manhole to finished grade is less than Retain one of two subparagraphs below if required to raise top of manhole to grade.
   10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

3.5 CLEANING

A. Clean interior of piping of dirt and superfluous materials.

END OF SECTION 334100