

---

## SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Sequence of Operation:
  - a. Central heating system.
  - b. Boilers.
  - c. Pumps.
  - d. Variable frequency drives.
  - e. Rooftop units.
  - f. Exhaust fans.
  - g. Finned tube radiation.
  - h. Occupancy sensor.
  - i. Phase monitoring.

B. Related Sections:

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

#### 1.2 SUBMITTALS

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

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

1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Submit valve and damper schedules.

#### 1.3 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)

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

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Temperature control system shall be DDC as specified in Section 23 09 23 "Direct Digital Control System for HVAC" and Section 23 09 00 "Instrumentation and Control for HVAC".
- B. Temperature control system shall be web-based and communicate seamlessly, via LON over the district's Ethernet LAN/WAN. All DDC control points listed in this section shall be performed by the DDC system and displayed on a PC browser with Internet Explorer. For future work, new DDC system software shall have capability and sufficient capacity to control entire building plus 20 percent spare capacity.
- C. All DDC control points listed in this section shall be performed by the DDC system. Any other control work required to complete the sequence of operation herein specified shall be electric temperature controls. Contractor shall provide all wiring, conduit where required, transformers, relays, sensors, etc. necessary for a complete operating system. The entire control system specified herein shall be DDC.
- D. All programming and point mapping shall be performed by the installing BAS contractor. All graphics associated with the controls work will be created and implemented under a separate contract by the school districts existing service provider.

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

- A. Main heating plant shall be in operation below 68 degrees F (adj.) outside air temperature.
- B. Main heating plant equipment shall be enabled when primary and secondary system water flow is established as indicated by flow switch.
- C. Starting of system shall start lead hot water boiler circulation pump. Upon proof of flow based on flow switch, associated boiler shall start on low fire. Hot water boiler and associated boiler circulation pump shall be enabled.

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

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

20.	Secondary hot water supply temperature	AI
21.	Secondary hot water supply temp. setpoint	AO
22.	Secondary hot water return temperature	AI
23.	3-way hot water mixing valve	AO
24.	Outside air temperature	AI
25.	Secondary hot water differential pressure	AI
26.	Combustion air damper status (each)	DI
27.	Graphic Display	--

3.3 ROOFTOP UNITS – Constant Volume Gas Heat/Dx Cooling

- A. These rooftop unit systems contain a self-contained, factory furnished control system including economizer, heating, mechanical cooling, morning warm-up and fan controls. The system shall be indexed from the occupied to the un-occupied modes of operation from the BAS.
- B. This contractor shall install and wire all components shipped loose with the rooftop unit. This includes but is not limited to the following items:
  - 1. Space temperature sensor for reset of discharge air temperature.
  - 2. Space pressure sensor for control of the unit exhaust fan.
  - 3. Tie-in of BAS to interface module provided on the rooftop units to pick up all available control and monitoring points from the rooftop unit.
  - 4. Install and wire remote diagnostic/alarm panel to rooftop unit.
  - 5. CO2 sensor for demand control ventilation operation.
- C. This contractor shall provide and install a dedicated DDC control panel with all the necessary field devices to control and monitor each rooftop unit per the Points List at the end of this section and to pick up control and monitoring points available from the rooftop unit’s interface module. Coordinate installation and other requirements with the rooftop unit manufacturer.
- D. This contractor shall provide all required interlock wiring for ductwork smoke detectors furnished and installed by this contractor. Upon sensing particles of combustion, the smoke detectors shall stop the supply and power exhaust fan. A second set of contacts shall close, providing a smoke alarm signal at the local DDC control panel and the BAS. Smoke detection system to comply with NFPA 90A requirements.
- E. Parallel available rooftop unit alarms and provide alarm to the BAS. Provide the control and monitoring points as listed in the Point List at the end of this section.
- F. The system control panel shall be capable of communicating with the rooftop and monitoring various points. The control manufacturer shall provide one controller for the rooftop that communicates back to the main control panel.
- G. General:
  - 1. Control rooftop units electronically with dedicated stand-alone HVAC controller.
  - 2. Provide graphic display terminal mounted on the controller panel face.
  - 3. Provide optimized start/stop with multiple schedule options for each system through the DDC system on a 365-day annual time of day schedule with four (4) events per day and programming for holidays and up to ten (10) user defined special uses.
  - 4. Provide a timed override mode enabled through a space sensor to return space to occupied mode for 2 hours (adj.) for tenant comfort.
  - 5. All set points will be adjustable through the BAS, at the operator workstation and through a dial-up connection.
- H. System Off:
  - 1. The supply and power exhaust fans shall be off. the outside air damper shall be closed.
  - 2. The return air dampers shall be open.
  - 3. The gas fired heater shall be off.
  - 4. The direct expansion cooling compressor shall be off.

- I. System Start:
  1. When the air-handling unit is indexed to operate, the return fan shall start first. Following a 5-second (adj.) delay, the supply fan shall start.
  2. Upon proof of supply and return fans operation, dampers and control valve shall be indexed to their “System Run” conditions.
  
- J. System Run:
  1. Unoccupied Heating Mode:
    - a. Supply Fan: Supply fan shall cycle to maintain supply air temperature at the unoccupied heating set point (adj.).
    - b. Economizer Dampers: Outside air and exhaust dampers are fully closed and return air damper is fully open.
    - c. Gas Fired Heater: Operate when the supply and return fans are on.
    - d. Direct Expansion Cooling: Off.
  
  2. Unoccupied Cooling Mode:
    - a. Supply Fan: Cycle supply fan to maintain space temperature at the unoccupied cooling set point (adj.).
    - b. Economizer Dampers: Economizer dampers shall be enabled to provide free cooling when the outside air temperature is below the dry bulb economizer set point.
    - c. Economizer Available: Outside air and exhaust air dampers are fully open and return air damper is fully closed when the supply and return fans are on.
    - d. Economizer Not Available: Outside air and exhaust dampers are fully closed and return air damper is fully open.
    - e. Gas Fired Heater: Off.
    - f. Direct Expansion Cooling: Allow to operate when the supply fan and return fans are on to maintain space temperature set point.
  
  3. Warm-up Mode:
    - a. Supply Fan: Supply fan shall start and run continuously.
    - b. Economizer Dampers: Outside air and exhaust dampers are fully closed and return air damper is fully open.
    - c. Gas Fired Heater: Enabled and modulated to maintain the space temperature at set point as reset by space temperature.
    - d. Direct Expansion Cooling: Off.
  
  4. Cool-down Mode:
    - a. Supply Fan: Supply and return fans shall start and run continuously.
    - b. Economizer Dampers: Economizer dampers shall be enabled to provide free cooling when the outside air temperature is below the dry bulb economizer set point (adj.).
    - c. Economizer Available: Economizer dampers shall modulate subject to a mixed air low limit of 40 degrees F. (adj.).
    - d. Economizer Not Available: Outside air and exhaust dampers are fully closed and return air damper is fully open.
    - e. Gas Fired Heater: Off.
    - f. Direct Expansion Cooling: Stage cooling in sequence with the economizer dampers to maintain the discharge air temperature at set point as reset by space temperature.
  
  5. Occupied Mode:
    - a. Supply and Power Exhaust Fans: Supply fan shall run continuously. Power exhaust shall cycle to maintain space pressure.
    - b. Outside Air Damper: Damper shall open to provide code required minimum outside air.

- c. Economizer Dampers: Economizer dampers shall be enabled to provide free cooling when the outside air temperature is below the dry bulb economizer set point.
    - 1) Economizer Available: Economizer dampers shall modulate subject to a mixed air low limit of 40 degrees F. (adj.).
    - 2) If the CO2 levels are below the recommended ASHRAE Standards while the dampers are at minimum positions, the outside air dampers shall modulate **below** the schedule minimum position to save operational costs while maintain acceptable CO2 levels.
    - 3) At no time shall the outside air dampers go above the minimum setting unless the outside air conditions are appropriate for economizer operation.
  - d. Gas Fired Heater: Enabled and modulated to maintain the discharge air temperature at set point as reset by space temperature.
  - e. Direct Expansion Cooling: Stage cooling in sequence with the economizer dampers to maintain the discharge air temperature at set point as reset by the space temperature.
- K. System Stop:
- 1. When the rooftop unit is indexed to shut down, the supply fan shall stop.
  - 2. Dampers and control valve shall be indexed to their “System Off” conditions.
- L. Safeties and Alarms:
- 1. Smoke Control:
    - a. Duct smoke detector(s) shall stop the supply fan and annunciate alarm when products of combustion are detected in the air stream. Dampers and control valves shall be indexed to their “System Off” conditions.
    - b. The supply fan shall be interlocked to shut down upon a command from the building fire alarm system.
    - c. Upon a return to normal, the supply fan shall start after an adjustable delay to provide a staggered start of all building loads.
  - 2. Annunciate off normal alarms whenever supply or return fan status does not equal alarm.
  - 3. All alarms shall be reported to the operator workstation from the BAS.
  - 4. Points List.
    - a. Discharge Air Temperature.
    - b. Discharge Air Temperature Set Point.
    - c. Supply Fan Command.
    - d. Supply Fan Status.
    - e. Supply Fan VFD Command.
    - f. Supply Fan Alarm.
    - g. Power Exhaust Fan Command.
    - h. Power Exhaust Fan Status.
    - i. Power Exhaust Fan VFD Command.
    - j. Power Exhaust Fan Alarm.
    - k. Heating Command.
    - l. Cooling Command.
    - m. Mixed Air Temperature.
    - n. Low Limit Alarm.
    - o. Filter Alarm.
    - p. Smoke Alarm.
    - q. Return Air Temperature.
    - r. Outside Air Damper Command.
    - s. Outside Air Damper Command Minimum Set Point.
    - t. Economizer Set Point.
    - u. Occupied Command.
    - v. Static Pressure.
    - w. Static Pressure Set Point.

- x. Building Pressure.
- y. Building Pressure Set Point.
- z. Room Temperature.
- aa. Room Temperature Set Point.
- bb. System CO2.
- cc. System CO2 Set Point.

M. Failure Modes:

1. Fan Failure: If the supply fan fails to operate, fan shall shut down and alarm be annunciated. Dampers and control valves shall be indexed to their “System Off” conditions.
2. Sensor Failure: Upon the failure of an analog sensor, associated dampers shall remain at their last position and alarm shall be annunciated.
3. Power Failure:
  - a. Fans: Upon restoration of power, the supply fan and power exhaust fan shall start after an adjustable delay to provide a staggered start of all building loads.
  - b. Dampers: Economizer dampers shall be provided with spring return actuators to fail to their “System Off” positions.
  - c. Gas Fired Heater: Upon restoration of power, the heater shall start.
4. Direct Expansion Cooling: Upon restoration of power, the direct expansion cooling shall start after an adjustable delay to provide a staggered start of all building loads.

N. Each rooftop shall be provided with a sensor that has an after hours override button. The occupant shall be able to override any scheduled night setback/setup period for two hours of after hours comfort by depressing the button for a period of 2-5 seconds. The override shall also be cancelable from the sensor at any time during the override with the use of a Cancel button.

### 3.4 FIRE SHUT DOWN FOR AIR SUPPLY UNIT OVER 2000 CFM

A. The Electrical Contractor shall furnish and install smoke and/or heat detectors in air supply system over 2000 CFM. An addressable fire alarm relay shall be furnished and installed by the Electrical Contractor and mounted by the supply fan starter/variable speed drive. BAS Contractor shall pick up signal from relay and provide a program to stop all supply and return/exhaust fans interlocked with the system sensing fire or smoke. DDC program shall also show fire in unit alarm at time of shut down.

### 3.5 MISCELLANEOUS EXHAUST FAN CONTROL

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

3.6 EXISTING FINNED TUBE RADIATION AND CONVECTORS

A. All existing finned tube radiation shall be controlled by new DDC control valves (see plans) to be controlled by a BAS room sensor which shall modulate the normally open control valve to maintain room setpoint.

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

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

3.7 POWER/PHASE MONITORING

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

1. Pumps
2. Boilers
3. Variable frequency drives

END OF SECTION 230993



SECTION 231123 - FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 REFERENCES

A. American National Standards Institute:

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

B. American Society of Mechanical Engineers:

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

C. ASTM International:

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

D. American Welding Society:

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

E. American Water Works Association:

1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

- F. National Fire Protection Association:
  - 1. NFPA 54 - National Fuel Gas Code.
- G. Underwriters Laboratories Inc.:
  - 1. UL 842 - Valves for Flammable Fluids.

### 1.3 SYSTEM DESCRIPTION

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

### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
  - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
  - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
  - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
  - 4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
    - a. Strainers.
    - b. Natural gas pressure regulators.
    - c. Natural gas pressure relief valves.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

### 1.5 CLOSEOUT SUBMITTALS

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

### 1.6 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform work in accordance with applicable code and local gas company requirements.
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

- D. Perform Work in accordance with authority having jurisdiction and AWS D1.1 for welding hanger and support attachments to building structure.
- E. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

#### 1.7 QUALIFICATIONS

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

#### 1.8 DELIVERY, STORAGE, AND HANDLING

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

#### 1.9 ENVIRONMENTAL REQUIREMENTS

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

#### 1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.11 COORDINATION

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

#### 1.12 WARRANTY

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

#### 1.13 EXTRA MATERIALS

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

#### 1.14 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)

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

## PART 2 - PRODUCTS

### 2.1 NATURAL GAS PIPING, ABOVE GRADE

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

### 2.2 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
  - 1. Ferrous Piping: Class 150, malleable iron, threaded.
  - 2. Copper Piping: Class 150, bronze unions with brazed joints.
  - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
  - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
  - 2. Copper Piping: Class 150, slip-on bronze flanges.
  - 3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

### 2.3 PIPE HANGERS AND SUPPORTS

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

- H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- I. Sheet Lead: ASTM B749, 2.5 lb/sq ft inch thick.

#### 2.4 EXTERIOR REGULATOR COVERS

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

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 PREPARATION

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

#### 3.3 INSTALLATION - INSERTS

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

#### 3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

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

- I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

### 3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access where valves and fittings are not exposed.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- L. Provide support for utility meters in accordance with requirements of utility company.
- M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 90 00.
- O. Install identification on piping systems including underground piping. Refer to Section 23 05 53.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- R. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- S. Install gas pressure regulator with tee fitting not less than 10 pipe diameters downstream of regulator. Cap or plug one opening of tee fitting.
- T. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- U. Provide new gas service complete with gas meter and regulators. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.
- V. All gas piping within walls shall be welded, not screwed.

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

### 3.6 FIELD QUALITY CONTROL

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

END OF SECTION 231123

## SECTION 232113 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

#### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

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

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.



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

C. American Welding Society:

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

### 1.3 SYSTEM DESCRIPTION

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

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

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Shop Drawings: Submit pipe fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
  - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
  - 2. Piping layout.
  - 3. Penetrations through fire rated and other walls.
  - 4. Terminal unit and coil installations.
  - 5. Hangers and supports, including methods for building attachment, and vibration isolation.
- C. Product Data:
  - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
  - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
  - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.

#### 1.5 CLOSEOUT SUBMITTALS

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

#### 1.6 QUALITY ASSURANCE

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

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

#### 1.7 QUALIFICATIONS

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

#### 1.8 DELIVERY, STORAGE, AND HANDLING

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

#### 1.9 ENVIRONMENTAL REQUIREMENTS

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

#### 1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.11 COORDINATION

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

#### 1.12 EXTRA MATERIALS

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

#### 1.13 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.
  - 1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
  - 2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black, rolled grooved ends.
  - 1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, grooved ends.
  - 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
    - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, compatible with steel piping sizes, rigid or flexible type.
    - b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
    - c. Accessories: Steel bolts, nuts, and washers.
- C. Copper Tubing: ASTM B88, Type L, hard drawn.
  - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
- D. Copper Tubing: ASTM B88, Type L, hard drawn, rolled grooved ends.
  - 1. Fittings: ASME B16.18 cast copper alloy, grooved ends.
  - 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
    - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
    - b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
    - c. Accessories: Steel bolts, nuts, and washers.
- E. Copper Tubing: ASTM B88, Type L, hard drawn.
  - 1. Acceptable Manufacturers: Viega and Ridged-Progress.
  - 2. Press Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought.
  - 3. Joints: Pressed by crimping tool.

### 2.2 EQUIPMENT DRAINS AND OVERFLOWS

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

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

## 2.3 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
  - 1. Ferrous Piping: Class 150, malleable iron, threaded.
  - 2. Copper Piping: Class 150, bronze unions with soldered.
  - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
  - 4. PVC Piping: PVC.
  
- B. Flanges for Pipe 2-1/2 inches and Larger:
  - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
  - 2. Copper Piping: Class 150, slip-on bronze flanges.
  - 3. PVC Piping: PVC flanges.
  - 4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.4 GATE VALVES

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

## 2.5 GLOBE VALVES

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

## 2.6 BALL VALVES

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

## 2.7 BUTTERFLY VALVES

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

## 2.8 CHECK VALVES

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

## 2.9 PIPE HANGERS AND SUPPORTS

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

- M. Floor Support for Hot Pipe 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- N. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- O. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- P. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- Q. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 PREPARATION

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

#### 3.3 INSTALLATION - INSERTS

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

#### 3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9.
- B. Support horizontal piping as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

- F. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping or sheet lead packing between hangers or support and piping.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- J. Install pipe hangers and supports in accordance with Section 23 05 29.

### 3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

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

END OF SECTION 232113



## SECTION 232116 - HYDRONIC PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

#### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

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

B. ASTM International:

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

C. Underwriters Laboratories Inc.:

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

#### 1.3 PERFORMANCE REQUIREMENTS

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

#### 1.4 SUBMITTALS

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

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

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

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

#### 1.5 CLOSEOUT SUBMITTALS

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

#### 1.6 QUALIFICATIONS

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

#### 1.7 DELIVERY, STORAGE, AND HANDLING

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

#### 1.8 ENVIRONMENTAL REQUIREMENTS

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

#### 1.9 FIELD MEASUREMENTS

- A. Verify field measurements before fabrication.

#### 1.10 WARRANTY

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

## 1.11 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 HYDRONIC INDICATORS

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

### 2.2 PRESSURE GAGES

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

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

B. Pressure Gage:

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

C. Pressure Gage Tappings:

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

### 2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

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

B. Thermometer

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

### 2.4 THERMOMETER SUPPORTS

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

### 2.5 TEST PLUGS

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

## 2.6 AIR VENTS

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

## 2.7 STRAINERS

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

## 2.8 PUMP SUCTION FITTINGS

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

## 2.9 COMBINATION PUMP DISCHARGE VALVES

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

## 2.10 CIRCUIT BALANCING VALVES

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

## 2.11 RELIEF VALVES

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

## 2.12 AIR SEPARATORS

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

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

## 2.13 EXPANSION TANKS AND ACCESSORIES

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION - THERMOMETERS AND GAGES

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

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

### 3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

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

### 3.3 PROTECTION OF INSTALLED CONSTRUCTION

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

END OF SECTION 232116



## SECTION 232123 - HYDRONIC PUMPS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

#### 1.2 REFERENCES

A. National Electrical Manufacturers Association:

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

B. Underwriters Laboratories Inc.:

1. UL 778 - Motor Operated Water Pumps.

#### 1.3 PERFORMANCE REQUIREMENTS

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

#### 1.4 SUBMITTALS

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

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

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

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

#### 1.5 CLOSEOUT SUBMITTALS

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

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

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

## 1.6 QUALIFICATIONS

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

## 1.7 DELIVERY, STORAGE, AND HANDLING

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

## 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.9 WARRANTY

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

## 1.10 EXTRA MATERIALS

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

## 1.11 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 IN-LINE CIRCULATORS

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

### 2.2 BASE MOUNTED PUMPS

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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

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

### 3.2 FIELD QUALITY CONTROL

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

END OF SECTION 232123

## SECTION 232500 - HVAC WATER TREATMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

#### 1.2 REFERENCES

A. National Electrical Manufacturers Association:

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

#### 1.3 SUBMITTALS

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

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

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

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

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

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

#### 1.4 CLOSEOUT SUBMITTALS

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

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

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

#### 1.5 QUALITY ASSURANCE

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

B. Maintain one copy of each document on site.

## 1.6 QUALIFICATIONS

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

## 1.7 MAINTENANCE MATERIALS

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

## 1.8 OPERATION AND MAINTENANCE DATA

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

## 1.9 MAINTENANCE SERVICE

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

## 1.10 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURES

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

### 2.2 WATER TREATMENT EQUIPMENT

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

### 2.3 CHEMICALS

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

## PART 3 - EXECUTION

### 3.1 WATER ANALYSIS

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

### 3.2 INSTALLATION

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

### 3.3 CONNECTIONS

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

### 3.4 FIELD QUALITY CONTROL

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



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

### 3.5 DEMONSTRATION

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

END OF SECTION 232500

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 REFERENCES

A. ASTM International:

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

B. National Fire Protection Association:

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

C. Sheet Metal and Air Conditioning Contractors:

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

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

### 1.3 PERFORMANCE REQUIREMENTS

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

### 1.4 SUBMITTALS

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

### 1.5 CLOSEOUT SUBMITTALS

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

### 1.6 QUALITY ASSURANCE

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

### 1.7 ENVIRONMENTAL REQUIREMENTS

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

### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.9 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 MATERIALS

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

### 2.2 MANUFACTURED DUCTWORK

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

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

### 2.3 DUCTWORK FABRICATION

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

### 2.4 SINGLE WALL SPIRAL DUCTWORK

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

## 2.5 DOUBLE WALL INSULATED ACOUSTICAL SPIRAL DUCTWORK

### A. General:

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

### B. Materials:

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

### C. Construction:

#### 1. Fittings:

- a. All double wall fitting ends shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
- b. Double wall duct and fittings shall consist of a perforated or solid inner liner, a 1 inch, 1.50 lb/ft<sup>3</sup> (unless otherwise specified) layer of fiber glass insulation and a solid outer pressure shell. When a perforated inner liner is specified, a retaining fabric shall be wrapped between the perforated inner and the fiber glass insulation. The fabrics provide fiber glass tear retention while maintaining the desired acoustical properties. For 1-inch thick insulation, the outer pressure shell diameter shall be 2 inches larger than the inner liner.
- c. All fittings shall be furnished with gasket on the outer shell. The inner shell on all double wall fittings shall extend a minimum of 1" past the outer shell.
- d. All fittings ends shall be calibrated to manufacturer's published dimensional tolerance standard.
- e. All fitting ends O.D. shall have rolled over edges for added strength and rigidity during installation and shipping.
- f. Double wall to single wall transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.
- g. When contract documents require divided flow fittings, only full body fittings will be accepted. Double wall saddle taps are unacceptable.
- h. All double wall duct and fittings shall be furnished with both an inner liner and a outer pressure shell coupling. The inner liners shall not be fastened together to allow for expansion and contraction.

#### 2. Spiral Duct:

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 SCHEDULES

A. Ductwork Material Schedule

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

END OF SECTION 233100

---

## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

#### 1.2 REFERENCES

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

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

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

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

D. Sheet Metal and Air Conditioning Contractors:

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

E. Underwriters Laboratories Inc.:

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

#### 1.3 SUBMITTALS

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

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

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



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

#### 1.4 CLOSEOUT SUBMITTALS

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

#### 1.5 QUALITY ASSURANCE

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

#### 1.6 QUALIFICATIONS

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

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

#### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.9 EXTRA MATERIALS

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

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

#### 1.10 REGULATORY REQUIREMENTS

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

### PART 2 - PRODUCTS

#### 2.1 AIR TURNING DEVICES

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

#### 2.2 BACKDRAFT DAMPERS

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

## 2.3 DUCT ACCESS DOORS

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

## 2.4 FLEXIBLE DUCT CONNECTIONS

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

## 2.5 DUCT TEST HOLES

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

## 2.6 VOLUME CONTROL DAMPERS

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

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

## 2.7 DYNAMIC FIRE DAMPERS

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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

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

END OF SECTION 233300

## SECTION 233700 - AIR OUTLET AND INLETS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.

B. Related Sections:

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

#### 1.2 REFERENCES

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

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

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

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

C. Sheet Metal and Air Conditioning Contractors:

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

#### 1.3 SUBMITTALS

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

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

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

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

#### 1.4 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of air outlets and inlets.

#### 1.5 QUALITY ASSURANCE

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

#### 1.6 REGULATORY REQUIREMENTS

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

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

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

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

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

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

### 2.3 HEAVY DUTY RETURN REGISTERS/GRILLES (TYPE B)

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

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

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

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

### 3.3 INTERFACE WITH OTHER PRODUCTS

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

END OF SECTION 233700



---

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 REFERENCES

A. American National Standards Institute:

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

B. ASTM International:

1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.
6. ASTM A 959 – Type AL29-4C Vent

C. National Fire Protection Association:

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

D. Sheet Metal and Air Conditioning Contractors:

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

E. Underwriters Laboratories Inc.:

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

### 1.3 DEFINITIONS

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

### 1.4 SUBMITTALS

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

### 1.5 QUALIFICATIONS

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

### 1.6 ENVIRONMENTAL REQUIREMENTS

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

### 1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

### 1.8 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 DOUBLE WALL METAL STACK

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

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTALLATION

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

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

END OF SECTION 235100

---

SECTION 235236 - FLEXIBLE WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Boilers.

B. Related Sections:

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

1.2 REFERENCES

A. American Gas Association:

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

B. American Society of Mechanical Engineers:

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

C. Hydronics Institute:

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

D. National Electrical Manufacturers Association:

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

E. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.

### 1.3 SUBMITTALS FOR REVIEW

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

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 QUALIFICATIONS

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

### 1.6 REGULATORY REQUIREMENTS

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

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

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

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

#### 1.8 WARRANTY

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

### PART 2 - PRODUCTS

#### 2.1 BOILERS

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

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

D. Hot Water Boiler Trim:

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

E. Fuel Burning System:

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

F. Burner Controls:

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



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

G. Burner Control Panel:

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

H. Manufacturer’s Field Services:

1. The boiler manufacturer’s representative, upon completion and start-up of the system shall submit to the Owner a written certified report that the installation of the complete system is in accordance with the specifications and the system is in proper operating condition. The report shall include at least the following:
  - a. Stack temperature - high, medium and low fire.
  - b. CO<sub>2</sub> reading of the flue gas - high, medium, and low fire with combustion efficiency being a minimum of 85%.
  - c. Draft read.
  - d. Voltage output of flame scanner.
  - e. Operationally check for safety low water cutoff and all operating and limit controls as specified on boiler.
  - f. Operationally simulate pilot and main flame failure to check electronic flame safeguard control.

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

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

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

#### 3.2 MANUFACTURER'S FIELD SERVICES

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

END OF SECTION 235236

---

SECTION 238103 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - SMALL CAPACITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged rooftop unit.
2. Roof curb.

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

- A. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. ARI 360 - Unitary Air-Conditioning Equipment.
- C. ANSI/ASHRAE/IESNA 90.1 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- 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. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)
- F. Conform to Illinois Accessibility Code. (71 IL Adm. Code 400)
- G. Conform to (IECC) International Energy Conservation Code. (2015)
- H. Conform to (IFGC) International Fuel Gas Code. (2015)
- I. Conform to (IPMC) International Property Maintenance Code. (2015)
- J. Conform to Illinois State Fire Marshal's Boiler and Pressure Vessel Safety. (41 IL Adm. Code 120)
- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 QUALITY ASSURANCE

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

## 1.8 WARRANTY

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

## 1.9 SUMMARY

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

## PART 2 - PRODUCTS

### 2.1 ROOFTOP UNIT

A. Acceptable Manufacturers:

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

B. General Description:

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

C. Construction:

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

6. Access to filters, dampers, cooling coils, heaters, exhaust fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
  7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
  8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
  9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
  10. Unit shall include lifting lugs on the top of the unit.
  11. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
- D. Electrical:
1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
  2. Unit shall be provided with a factory installed and field wired 115V, 13 amp GFI outlet disconnect switch in the unit control panel.
- E. Supply Fans:
1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
  2. Blowers and motors shall be dynamically balance and mounted on rubber isolators.
  3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
  4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- F. Exhaust Fans:
1. Exhaust dampers shall be sized for 100% relief.
  2. Fans and motors shall be dynamically balanced.
  3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
  4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
  5. Unit shall include belt driven, unhooded, backward curved, plenum exhaust fans.
  6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
- G. Cooling Coils:
1. Evaporator Coils:
    - a. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
    - b. Coils shall have interlaced circuitry and shall be 6 row high capacity.
    - c. Coils shall be helium leak tested.
    - d. Coils shall be furnished with factory installed thermostatic expansion valves.
- H. Refrigeration System:
1. Unit shall be factory charged with R-410A refrigerant.
  2. Compressors shall be scroll type with thermal overload protection, independently circuited and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

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

I. Condensers:

1. Air-Cooled Condenser:

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

J. Gas Heating:

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

L. Outside Air/Economizer:

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

M. Controls:

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

## 2.2 ROOF CURBS

A. Manufacturers:

1. Thybar.
2. Or approved as equal.

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

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

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

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

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

A. Roof Curb:

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

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

- C. Install components furnished loose for field mounting.



- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between unit and field installed accessories.
- F. Remove from roof and dispose off-site panels removed from units during installation of all accessories.

### 3.3 INSTALLATION - NATURAL GAS HEATING SECTION

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

### 3.4 CLEANING

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

### 3.5 MANUFACTURER'S FIELD SERVICES

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

END OF SECTION 238103

---

## SECTION 239900 - VARIABLE FREQUENCY MOTOR CONTROLLER

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

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

#### 1.5 QUALIFICATIONS

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

## 1.6 DELIVERY, STORAGE, AND HANDLING

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

## 1.7 ENVIRONMENTAL REQUIREMENTS

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

## 1.8 WARRANTY

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

## 1.9 MAINTENANCE MATERIALS

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

## 1.10 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 VARIABLE FREQUENCY MOTOR CONTROLLER

#### A. Manufacturers:

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

#### B. Description:

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

#### C. Ratings:

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

#### D. Design:

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

E. Product Options and Features:

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

F. Fabrication:

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

G. Source Quality Control:

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

---

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

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

3.4 ADJUSTING

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

3.5 CLEANING

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

3.6 WARRANTY

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

3.7 START-UP SERVICE

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

END OF SECTION 239900

---

## SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 CLOSEOUT SUBMITTALS

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

#### 1.4 COORDINATION

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

#### 1.5 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 CORD AND PLUGS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.



- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

### 3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 260503

---

SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

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

1.3 SYSTEM DESCRIPTION

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

1.4 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

### 1.5 SUBMITTALS

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

### 1.6 CLOSEOUT SUBMITTALS

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

### 1.7 QUALITY ASSURANCE

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

### 1.8 QUALIFICATIONS

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

### 1.9 FIELD MEASUREMENTS

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

### 1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- C. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 ft of length shown.

### 1.11 REGULATORY REQUIREMENTS

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

- K. Conform to (ICC) International Code Council Reference Standards. (2015)
- L. Conform to (NFPA) National Fire Protection Association 70 National Electrical Code. (2014)
- M. Products: Listed and classified by Underwriter's Laboratories, Inc. as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 BUILDING WIRE

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

### 2.2 TERMINATIONS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

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

### 3.3 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques - Building Wire in Raceway:
  - 1. Pull conductors into raceway at same time.
  - 2. Install building wire 4 AWG and larger with pulling equipment.
- E. Special Techniques - Cable:
  - 1. Protect exposed cable from damage.
  - 2. Support cables above accessible ceiling, using spring metal clips or plenum rated plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
  - 3. Use suitable cable fittings and connectors.
- F. Special Techniques - Wiring Connections:
  - 1. Clean conductor surfaces before installing lugs and connectors.
  - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
  - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
  - 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
  - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
  - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
  - 7. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- G. Install stranded conductors for branch circuits 10 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
- H. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.
- I. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- J. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

### 3.4 WIRE COLOR

- A. General:
  - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
    - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
    - b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
  - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
  - b. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
  1. For 6 AWG and smaller: Green.
  2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

### 3.5 FIELD QUALITY CONTROL

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

END OF SECTION 260519

---

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 SYSTEM DESCRIPTION

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

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 25 ohms maximum.

#### 1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.6 CLOSEOUT SUBMITTALS

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

### 1.7 QUALITY ASSURANCE

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

### 1.8 QUALIFICATIONS

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

### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

### 1.10 COORDINATION

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

### 1.11 REGULATORY REQUIREMENTS

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



---

## PART 2 - PRODUCTS

### 2.1 WIRE

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

### 2.2 MECHANICAL CONNECTORS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

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

### 3.3 INSTALLATION

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

- H. Bond together reinforcing steel and metal accessories in pool and fountain structures.
- I. Install isolated grounding conductor for circuits supplying network equipment and in accordance with IEEE 1100.
- J. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- K. Bond to lightning protection system.
- L. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- M. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- N. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- O. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.
- P. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- Q. Permanently attach equipment and grounding conductors prior to energizing equipment.

#### 3.4 FIELD QUALITY CONTROL

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

END OF SECTION 260526

---

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.2 REFERENCES

A. ASTM International:

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

B. FM Global:

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

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:

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

E. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.3 DEFINITIONS

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

#### 1.4 SYSTEM DESCRIPTION

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

#### 1.5 PERFORMANCE REQUIREMENTS

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

#### 1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers, where required.
- C. Product Data:
  - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
  - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- F. Manufacturer's Installation Instructions:
  - 1. Hangers and Supports: Submit special procedures and assembly of components.
  - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

#### 1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
  - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
  - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
    - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
  - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
  - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy of each document on site.

#### 1.8 QUALIFICATIONS

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

#### 1.9 DELIVERY, STORAGE, AND HANDLING

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

#### 1.10 ENVIRONMENTAL REQUIREMENTS

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

#### 1.11 REGULATORY REQUIREMENTS

- A. Conform to Health/Life Safety Code for Public Schools.
- B. Conform to (IMC) International Mechanical Code. (2015)
- C. Conform to (IBC) International Building Code. (2015)
- D. Conform to (IFC) International Fire Code, excluding Chapter 4. (2015)
- E. Conform to State of Illinois Plumbing Code. (2014)

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

## PART 2 - PRODUCTS

### 2.1 CONDUIT SUPPORTS

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. Electroline Manufacturing Company.
  - 3. O-Z Gedney Co.
  - 4. Or approved as equal.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

### 2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems.
  - 3. Midland Ross Corporation, Electrical Products Division.
  - 4. Unistrut Corp.
  - 5. Or approved as equal.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

### 2.3 SPRING STEEL CLIPS

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

4. Or approved as equal.

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

#### 2.4 SLEEVES

- A. Sleeves for cabling Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for cabling Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduits or cabling Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Stuffing Type Fire-stopping Insulation: Glass fiber type, non-combustible.

#### 2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  1. Thunderline Link-Seal, Inc.
  2. NMP Corporation.
  3. Wiremold.
  4. Or approved as equal.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

#### 2.6 FIRESTOPPING

- A. Manufacturers:
  1. Dow Corning Corp.
  2. Fire Trak Corp.
  3. Hilti Corp.
  4. International Protective Coating Corp.
  5. 3M fire Protection Products.
  6. Specified Technology, Inc.
  7. Or approved as equal.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
  1. Silicone Firestopping Elastomeric Firestopping: Silicone elastomeric compound and compatible silicone sealant.
  2. Foam Firestopping Compounds: Foam compound.
  3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
  4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
  5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
  6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
  7. Firestop Pillows: Formed mineral fiber pillows.

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

## 2.7 FIRESTOPPING ACCESSORIES

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

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



### 3.3 INSTALLATION - HANGERS AND SUPPORTS

#### A. Anchors and Fasteners:

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

#### B. Inserts:

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

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

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

#### E. Install multiple conduit runs on common hangers.

#### F. Supports:

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

### 3.4 INSTALLATION - FIRESTOPPING

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

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

#### C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

#### D. Compress fibered material to maximum 40 percent of its uncompressed size.

#### E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

#### F. Place intumescent coating in sufficient coats to achieve rating required.

#### G. Remove dam material after firestopping material has cured.

H. Fire Rated Surface:

1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
  - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
  - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
  - c. Pack void with backing material.
  - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
2. Where cable tray, conduit, wireway, trough, and cabling penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

I. Non-Rated Surfaces:

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

### 3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

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

### 3.6 INSTALLATION - SLEEVES

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

- G. Install escutcheons at finished surfaces to match surrounding surfaces.

### 3.7 FIELD QUALITY CONTROL

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

### 3.8 CLEANING

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

### 3.9 PROTECTION OF FINISHED WORK

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

END OF SECTION 260529

---

## SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
  - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
  - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

#### 1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide rigid steel conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Thin-wall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal or nonmetallic boxes.
- D. Under Slab on Grade: Provide rigid steel conduit. Thin-wall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast or nonmetallic metal boxes.
- E. Outdoor Locations, Above Grade: Provide rigid steel and aluminum conduit. Provide cast metal, pull, and junction boxes.

- F. In Slab above Grade: Provide rigid steel conduit and intermediate metal conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide sheet metal boxes.
- G. Wet and Damp Locations: Provide rigid steel and aluminum conduit. Thickwall nonmetallic conduit may be utilized where approved by the authority having jurisdiction. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. Concealed Dry Locations: Provide intermediate metal conduit and electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Exposed Dry Locations: Provide electrical metallic tubing except where subject to damage then provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

#### 1.4 DESIGN REQUIREMENTS

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

#### 1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

#### 1.6 CLOSEOUT SUBMITTALS

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

#### 1.7 DELIVERY, STORAGE, AND HANDLING

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

#### 1.8 COORDINATION

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

#### 1.9 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 METAL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Southwire Company.
  - 3. Wheatland Tube Company.
  - 4. Or approved as equal.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Intermediate Metal Conduit (IMC): Rigid steel.
- E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

### 2.2 FLEXIBLE METAL CONDUIT

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

### 2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

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

### 2.4 ELECTRICAL METALLIC TUBING (EMT)

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

### 2.5 NONMETALLIC CONDUIT

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

### 2.6 SURFACE METAL RACEWAY

- A. Manufacturers:
  - 1. Wiremold Co. Model V700 Series.
  - 2. Hubbell.
  - 3. Or approved as equal.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: 21/32" x 3/4" x length as required.
- D. Finish: Scratch resistant ivory finish.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

## 2.7 WIREWAY

- A. Manufacturers:
  - 1. Circle AW.
  - 2. Hoffman.
  - 3. Square D Company.
  - 4. Or approved as equal.
- B. Product Description: General purpose or as required to match environment installed
- C. Knockouts: Manufacturer's standard.
- D. Size: As indicated on Drawings.
- E. Cover: Hinged cover.
- F. Fittings: Lay-in type with removable side.
- G. Finish: Rust inhibiting primer coating with gray enamel finish.

## 2.8 OUTLET BOXES

- A. Manufacturers:
  - 1. Appleton Electric.
  - 2. OZ Gedney.
  - 3. Raco.
  - 4. Red Dot.
  - 5. Thomas & Betts.
  - 6. Or approved as equal.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
  - 2. Concrete Ceiling Boxes: Concrete type.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

## 2.9 PULL AND JUNCTION BOXES

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



- D. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
  - 1. Material: Galvanized cast iron or Cast aluminum.
  - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
  - 3. Cover Legend: "ELECTRIC".
  
- E. Fiberglass or Concrete composite Handholes: Die-molded, glass-fiber or concrete composite hand holes:
  - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
  - 2. Cover: Glass-fiber or concrete composite, weatherproof cover with nonskid finish.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

#### 3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceway.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maximum Size Conduit in Slab Above Grade: 1 inch. Do not cross conduits in slab.

- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows or hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- X. Close ends and unused openings in wireway.

### 3.4 INSTALLATION - BOXES

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

- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

### 3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
- C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

### 3.6 ADJUSTING

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

### 3.7 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION 260533

---

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

#### 1.2 SUBMITTALS

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

B. Product Data:

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

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

#### 1.3 ENVIRONMENTAL REQUIREMENTS

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

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

#### 1.4 REGULATORY REQUIREMENTS

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

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

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

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

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

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

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

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

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

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

## PART 2 - PRODUCTS

### 2.1 NAMEPLATES

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

### 2.2 LABELS

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

### 2.3 WIRE MARKERS

- A. Furnish materials in accordance with industry standards.
- B. Description: Cloth tape, split sleeve, or tubing type wire markers.
- C. Legend:
  - 1. Power and Lighting Circuits: Actual branch circuit or feeder number.
  - 2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.
- D. Conduit and Raceway Markers:
  - 1. Furnish materials in accordance with industry standards.
- E. Description: Labels fastened with adhesive or stencils.
- F. Color:
  - 1. 480 Volt System: Black lettering on white background.
  - 2. 208 Volt System: Black lettering on white background.
- G. Legend:
  - 1. Medium Voltage System: HIGH VOLTAGE.
  - 2. 480 Volt System: 480 VOLTS. HIGH VOLTAGE.
  - 3. 208 Volt System: 208 VOLTS.

## 2.4 STENCILS

- A. Furnish materials in accordance with industry standards.
- B. Stencils: With clean cut symbols and letters of following size:
  - 1. Up to 2 inches Outside Diameter of Raceway: 1/2 inch high letters.
  - 2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.
- C. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to the following:
  - 1. Black lettering on white background.
  - 2. White lettering on gray background.
  - 3. Red lettering on white background.
  - 4. Blue lettering on white background.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
  - 1. Install nameplate parallel to equipment lines.
  - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
  - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
  - 4. Secure nameplate to equipment front using screws, rivets, or adhesive.
  - 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
  - 6. Install nameplates for the following:
    - a. Switchboards.
    - b. Panelboards.
    - c. Transformers.
    - d. Service Disconnects.
    - e. Motor Starters.
- C. Label Installation:
  - 1. Install label parallel to equipment lines.
  - 2. Install label for identification of individual control device stations.
  - 3. Install labels for permanent adhesion and seal with clear lacquer.
- D. Wire Marker Installation:
  - 1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
  - 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.

3. Install labels at data outlets identifying patch panel and port designation as indicated on Drawings.
- E. Conduit Marker Installation:
1. Install conduit marker for each conduit 1 1/2" and larger longer than 20 feet.
  2. Conduit Marker Spacing: 20 feet on center.
  3. Raceway Painting: Identify conduit using field painting in accordance with Section 09 90 00.
    - a. Paint colored band on each conduit longer than 20 feet.
    - b. Paint bands 20 feet on center.
    - c. Color: Utilize the owners standard color coding. If no standard exists provide;
      - 1) 480 Volt System: Orange.
      - 2) 208 Volt System: Blue.
- F. Stencil Installation:
1. Apply stencil painting in accordance with Section 09 90 00.
- G. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION 260553

## SECTION 262413 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

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



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

#### 1.5 QUALIFICATIONS

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

#### 1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.7 SEQUENCING

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

#### 1.8 REGULATORY REQUIREMENTS

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

#### 1.9 DELIVERY, STORAGE, AND HANDLING

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

### 1.10 FIELD MEASUREMENTS

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

## PART 2 - PRODUCTS

### 2.1 SWITCHBOARDS - EXISTING

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

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

### 3.3 FIELD QUALITY CONTROL

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

### 3.4 ADJUSTING

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

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

### 3.5 CLEANING

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

END OF SECTION 262413

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

### PART 2 - PRODUCTS

#### 2.1 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 26 05 53.

## 2.2 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 262813 - FUSES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes fuses.

#### 1.2 REFERENCES

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

#### 1.3 DESIGN REQUIREMENTS

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

#### 1.4 FUSE PERFORMANCE REQUIREMENTS

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

#### 1.5 SUBMITTALS

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

#### 1.6 CLOSEOUT SUBMITTALS

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



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

## 1.7 QUALIFICATIONS

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

## 1.8 MAINTENANCE MATERIALS

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

## 1.9 EXTRA MATERIALS

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

## 1.10 REGULATORY REQUIREMENTS

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

## PART 2 - PRODUCTS

### 2.1 FUSES

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

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

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

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

END OF SECTION 262813

---

## SECTION 262819 - ENCLOSED SWITCHES

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

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

#### 1.5 QUALIFICATIONS

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

#### 1.6 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCH ASSEMBLIES

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

### 2.2 NONFUSIBLE SWITCH ASSEMBLIES

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

### 2.3 SWITCH RATINGS

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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

### 3.2 FIELD QUALITY CONTROL

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

END OF SECTION 262819

## SECTION 262913 - ENCLOSED CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

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

#### 1.2 REFERENCES

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

#### 1.3 SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

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

#### 1.5 QUALIFICATIONS

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

#### 1.6 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 MANUAL CONTROLLERS

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

### 2.3 AUTOMATIC CONTROLLERS

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

### 2.4 PRODUCT FEATURES FOR AUTOMATIC CONTROLLERS

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

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

## 2.5 DISCONNECTS

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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

### 3.2 FIELD QUALITY CONTROL

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

END OF SECTION 262913



## 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 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.

#### 1.3 QUALIFICATIONS

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

#### 1.4 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.5 REGULATORY REQUIREMENTS

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

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

## PART 2 - PRODUCTS

### 2.1 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.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.
- B. Support luminaires independent of ceiling framing.
- C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan drawings.
- D. Install pendant and surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- E. 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.
- F. Install recessed luminaires to permit removal from below.
- G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- H. Install clips to secure recessed grid-supported luminaires in place.
- I. Install wall-mounted luminaires at height as indicated on Drawings or as scheduled.
- J. Install accessories furnished with each luminaire.
- K. Connect grid mounted luminaires to branch circuit outlets provided under Section 26 05 33 using flexible conduit.
- L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- M. Install specified lamps in each luminaire.
- N. Interface with air handling accessories furnished and installed under Section 23 37 00.
- O. 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 283100 - FIRE DETECTION AND ALARM

### 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.

#### 1.2 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Notifier to match existing equipment.

#### 1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, 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 23.
  - 2. Division 26.
- C. The system and all associated operations shall be in accordance with the following:
  - 1. Guidelines of the following Building Code: BOCA, SBCCI, ICBO, UBC, IBC
  - 2. NFPA 72, National Fire Alarm Code
  - 3. NFPA 70, National Electrical Code
  - 4. NFPA 101, Life Safety Code
  - 5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
  - 6. Other applicable NFPA standards
  - 7. Local Jurisdictional Adopted Codes and Standards
  - 8. ADA Accessibility Guidelines

#### 1.4 SYSTEM DESCRIPTION

- A. General: Extend the existing, non-coded, addressable/conventional, 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. 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 while incoming power is present.

5. The system batteries shall be supervised so that a low battery or 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.

## 1.5 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
  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 per 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, 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.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.
- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

## PART 2 - PRODUCTS

### 2.1 FIRE ALARM CONTROL PANEL (FACP)

- A. The existing Notifier NFS-320 fire alarm control panel to be expanded. Contact Local Distributor: ProCom Systems, Inc.; Representative: Steve Peppers 815.986.0355.

## 2.2 REMOTE LCD ANNUNCIATOR

- A. The existing LED annunciator to be programmed to include remodeled areas.

## 2.3 EMERGENCY POWER SUPPLY

- A. Existing batteries to be evaluated and upgraded as required to provide code required size.
- B. Battery: Sealed lead-acid. 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 indicating devices in alarm or supervisory mode for a period of 15 minutes.

## 2.4 SMOKE AND CARBON MONOXIDE 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. Photoelectric sensor and electronics in a single piece construction which shall twist-lock onto a mounting base that attaches to a standard electrical box.
  - 5. 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.
  - 6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
  - 7. 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.
  - 8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
  - 9. 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.
  - 10. 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. Where acceptable per manufacturer specifications, ionization type sensors may be used.
- 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 were 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 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. Compact 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 sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated a NEMA 4X weatherproof duct housing enclosure 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.

## 2.5 ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and 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 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 multiplexing 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.

### 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, 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. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

#### 3.3 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 (AHJ) 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.

### 3.4 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 or damaged items with new and retest until satisfactory performance and conditions are achieved.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- 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.
- H. Final Test, Certificate of Completion, and Certificate of Occupancy: Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

### 3.5 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 levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

### 3.6 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system.
- B. Schedule training with the Owner at least seven days in advance.

END OF SECTION 283100