SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Light-activated thermometers.
 - 5. Duct-thermometer mounting brackets.
 - 6. Thermowells.
 - 7. Dial-type pressure gages.
 - 8. Gage attachments.
 - 9. Test plugs.
 - 10. Test-plug kits.
 - 11. Sight flow indicators.
 - 12. Flowmeters.
 - 13. Thermal-energy meters.
- B. Related Requirements:
 - 1. Section 231123 "Facility Natural-Gas Piping" for gas meters.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Standard: ASME B40.200.
- B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.
- C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- E. Connector Size: 1/2 inch with ASME B1.1 screw threads.
- F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- G. Window: Plain glass or plastic
- H. Ring: Stainless steel.
- I. Element: Bimetal coil.
- J. Pointer: Dark-colored metal.
- K. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Standard: ASME B40.200.
 - 2. Case: Sealed type, cast aluminum or drawn steel 5-inchnominal diameter.
 - 3. Element: Bourdon tube or other type of pressure element.
 - 4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F
 - 6. Pointer: Dark-colored metal.
 - 7. Window: Glass or plastic
 - 8. Ring: Stainless steel
 - 9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device and rigid, bottom; with ASME B1.1 screw threads.
 - 10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 11. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Standard: ASME B40.200.
 - 2. Case: Cast aluminum 6-inch nominal size.
 - 3. Case Form: Back angle unless otherwise indicated.
 - 4. Tube: Glass with magnifying lens and blue organic liquid.
 - 5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 6. Window: Glass or plastic.
 - 7. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 8. Connector: 3/4 inch, with ASME B1.1 screw threads.
 - 9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
- C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Standard: ASME B40.200.
 - 2. Case: Cast aluminum 9-inch nominal size unless otherwise indicated.
 - 3. Case Form: Adjustable angle unless otherwise indicated.
 - 4. Tube: Glass with magnifying lens and blue organic liquid.
 - 5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F
 - 6. Window: Glass or plastic
 - 7. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 LIGHT-ACTIVATED THERMOMETERS

- A. Direct-Mounted, Light-Activated Thermometers:
 - 1. Case: Metal 9-inch nominal size unless otherwise indicated.
 - 2. Scale(s): Deg F
 - 3. Case Form: Adjustable angle
 - 4. Connector: 1-1/4 inches with ASME B1.1 screw threads.
 - 5. Stem: Aluminum and of length to suit installation.

- a. Design for Air-Duct Installation: With ventilated shroud.
- b. Design for Thermowell Installation: Bare stem.
- 6. Display: Digital.
- 7. Accuracy: Plus or minus 2 deg F.
- B. Remote-Mounted, Light-Activated Thermometers:
 - 1. Case: Plastic, for wall mounting.
 - 2. Scale(s): Deg F
 - 3. Sensor: Bulb and thermister wire.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 4. Display: Digital.
 - 5. Accuracy: Plus or minus 2 deg F.

2.5 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.6 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR
 - 4. Material for Use with Steel Piping: CRES
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - 8. Bore: Diameter required to match thermometer bulb or stem.
 - 9. Insertion Length: Length required to match thermometer bulb or stem.
 - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin

2.7 DIAL-TYPE PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - 1. Standard: ASME B40.100.
 - 2. Case: Liquid-filled, Sealed type(s); cast aluminum or drawn steel 4-6-inchnominal diameter.

- 3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- 4. Pressure Connection: Brass, with NPS 1/2ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- 5. Movement: Mechanical, with link to pressure element and connection to pointer.
- 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
- 7. Pointer: Dark-colored metal.
- 8. Window: Glass or plastic
- 9. Ring: Stainless steel.
- 10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.8 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass or steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball with NPS 1/4 or NPS ½ASME B1.20.1 pipe threads.

2.9 TEST PLUGS

- A. Description: Test-station fitting made for insertion in piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.10 TEST-PLUG KITS

- A. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig
- E. Carrying Case: Metal or plastic, with formed instrument padding.

2.11 SIGHT FLOW INDICATORS

- A. Description: Piping inline-installation device for visual verification of flow.
- B. Construction: Bronze or stainless-steel body, with sight glass and ball indicator, and threaded or flanged ends.
- C. Minimum Pressure Rating: 150 psig
- D. Minimum Temperature Rating: 200 deg F
- E. End Connections for NPS 2 and Smaller: Threaded.
- F. End Connections for NPS 2-1/2 and Larger: Flanged.

2.12 FLOWMETERS

- A. Orifice Flowmeters:
 - 1. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
 - 2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 3. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
 - a. Design: Differential-pressure-type measurement for water as appropriate for application.
 - b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
 - c. Minimum Pressure Rating: 300 psig
 - d. Minimum Temperature Rating: 250 deg F .
 - 4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range
 - 5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range
 - 6. Display: Shows rate of flow
 - 7. Conversion Chart: Flow rate data compatible with sensor and indicator.
 - 8. Operating Instructions: Include complete instructions with each flowmeter.
- B. Pitot-Tube Flowmeters:

- 1. Description: Flowmeter with sensor and indicator.
- 2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- 3. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig
 - d. Minimum Temperature Rating: 250 deg F
- 4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 5. Integral Transformer: For low-voltage power connection.
- 6. Accuracy: Plus or minus 3 percent.
- 7. Display: Shows rate of flow
- 8. Operating Instructions: Include complete instructions with each flowmeter.
- C. Turbine Flowmeters:
 - 1. Description: Flowmeter with sensor and indicator.
 - 2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 3. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water as appropriate for application
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig
 - d. Minimum Temperature Rating: 180 deg F
 - 4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 - 5. Accuracy: Plus or minus 1-1/2 percent.
 - 6. Display: Shows rate of flow
 - 7. Operating Instructions: Include complete instructions with each flowmeter.
- D. Venturi Flowmeters:
 - 1. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
 - 2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 3. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for water
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig
 - d. Minimum Temperature Rating: 250 deg F
 - e. End Connections for NPS 2 and Smaller: Threaded.

- f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
- g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
- 4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range
- 5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
- 6. Display: Shows rate of flow, with register to indicate total volume in gallons.
- 7. Conversion Chart: Flow rate data compatible with sensor.
- 8. Operating Instructions: Include complete instructions with each flowmeter.

2.13 THERMAL-ENERGY METERS

- A. Impeller-Turbine, Thermal-Energy Meters:
 - 1. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
 - 2. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
 - a. Design: Total thermal-energy measurement.
 - b. Minimum Pressure Rating: 150 psig.
 - c. Minimum Temperature Range: 40 to 250 deg F.
 - 3. Temperature Sensors: Insertion-type transducer.
 - 4. Indicator: Solid-state, integrating-type meter; for wall mounting.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
 - b. Battery Pack: Five-year lithium battery.
 - 5. Accuracy: Plus or minus 1 percent.
 - 6. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
 - 7. Strainer: Full size of main line piping.
 - 8. Operating Instructions: Include complete instructions with each thermal-energy meter system.
- B. Ultrasonic, Thermal-Energy Meters:

- 1. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
- 2. Flow Sensor: Transit-time ultrasonic type with transmitter.
- 3. Temperature Sensors: Insertion-type or strap-on transducer.
- 4. Indicator: Solid-state, integrating-type meter
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
 - b. Battery Pack: Five-year lithium battery.
- 5. Accuracy: Plus or minus 1 percent.
- 6. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
- 7. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.

- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between pipe flanges.
- Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- U. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Inlet and outlet of each thermal-storage tank.
 - 7. Outside-, return-, supply-, and mixed-air ducts.
- V. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone, radiant floor manifolds, hydronic heat exchangers, thermal storage tanks, shall be one of the following:
 - 1. Liquid-filled Sealed, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
 - 3. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlets and outlets of each chiller shall be one of the following:
 - 1. Liquid-filled, Sealed, bimetallic-actuated type.
 - 2. Compact style, liquid-in-glass type.
 - 3. Direct mounted, light-activated type.
 - 4. Test plug with EPDM self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - 1. Liquid-filled, Sealed, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
 - 3. Direct mounted, light-activated type.
 - 4. Test plug with EPDM self-sealing rubber inserts.
- D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
 - 1. Liquid-filled bimetallic-actuated type.
 - 2. Direct metal case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
 - 4. Test plug with EPDM self-sealing rubber inserts.
- E. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Direct mounted, metal case, vapor-actuated type.
- F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F
- C. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

- 1. Liquid-filled Sealed direct mounted, metal case.
- 2. Sealed mounted, plastic case.
- 3. Test plug with EPDM self-sealing rubber inserts.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 - 1. Liquid-filled Sealed direct, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Pressure gages at suction and discharge of each pump shall be one of the following:
 - 1. Liquid-filled Sealed direct mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 160 psi
- B. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Turbine type.
- B. Flowmeters for Heating, Hot-Water Piping: Turbine type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine type.
- B. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.

END OF SECTION 230519