SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

1. GENERAL
   * + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section Includes:

Bimetallic-actuated thermometers.

Filled-system thermometers.

Liquid-in-glass thermometers.

Light-activated thermometers.

Duct-thermometer mounting brackets.

Thermowells.

Dial-type pressure gages.

Gage attachments.

Test plugs.

Test-plug kits.

Sight flow indicators.

Flowmeters.

Thermal-energy meters.

* + - 1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Product Data: For each type of product.
         5. Shop Drawings:

Include diagrams for power, signal, and control wiring.

Retain "Product Certificates" paragraph below to require submittal of product certificates from manufacturers.

* + - * 1. Product Certificates: For each type of meter and gage.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. BIMETALLIC-ACTUATED THERMOMETERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3033) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123457060876).

[Marsh Bellofram](http://www.specagent.com/Lookup?uid=123457060865).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457060872).

Approved equivalent.

* + - * 1. Standard: ASME B40.200.

Case in first paragraph below will typically be the sealed (dry) type. Hermetically sealed cases are available.

* + - * 1. Case: [**Liquid-filled**] [**and**] [**sealed**] type(s); stainless steel with [**3-inch**] [**5-inch**] <**Insert dimension**> nominal diameter.
        2. Dial: [**Nonreflective aluminum**] <**Insert material**> with permanently etched scale markings and scales in [**deg F**] [**deg F and deg C**].
        3. Connector Type(s): Union joint, [**adjustable angle**] [**rigid, back**] [**and**] [**rigid, bottom**] <**Insert type**>, with unified-inch screw threads.
        4. Connector Size: [**1/2 inch**] <**Insert dimension**>, with ASME B1.1 screw threads.
        5. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
        6. Window: [**Plain glass**] [**or**] [**plastic**] <**Insert material**>.
        7. Ring: Stainless steel.
        8. Element: Bimetal coil.
        9. Pointer: Dark-colored metal.
        10. Accuracy: Plus or minus [**1**] [**1.5**] <**Insert number**> percent of scale range.
      1. FILLED-SYSTEM THERMOMETERS
         1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3034) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123457061012).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457061018).

[Weiss Instruments, Inc](http://www.specagent.com/Lookup?uid=123457061014).

Approved equivalent.

Standard: ASME B40.200.

Case: Sealed type, [**cast aluminum or drawn steel**] <**Insert material**>; [**4-1/2-inch**] [**5-inch**] [**6-inch**] <**Insert dimension**> nominal diameter.

Element: Bourdon tube or other type of pressure element.

Movement: Mechanical,[**dampening type,**] with link to pressure element and connection to pointer.

Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F**] [**deg F and deg C**].

Pointer: Dark-colored metal.

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Ring: [**Metal**] [**Stainless steel**] <**Insert material**>.

Connector Type(s): Union joint, [**adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device**] [**rigid, back**] [**and**] [**rigid, bottom**]; with ASME B1.1 screw threads.

Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

Design for Air-Duct Installation: With ventilated shroud.

Design for Thermowell Installation: Bare stem.

Accuracy: Plus or minus [**1**] <**Insert number**> percent of scale range.

* + - * 1. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3037) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123457061022).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457061027).

[Weiss Instruments, Inc](http://www.specagent.com/Lookup?uid=123457061028).

Approved equivalent.

Standard: ASME B40.200.

Case: Sealed type, [**cast aluminum or drawn steel**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter with [**back**] [**front**] flange and holes for panel mounting.

Element: Bourdon tube or other type of pressure element.

Movement: Mechanical, with link to pressure element and connection to pointer.

Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F**] [**deg F**].

Pointer: Dark-colored metal.

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Ring: [**Metal**] [**Stainless steel**] <**Insert material**>.

Connector Type(s): Union joint, [**back**] [**bottom**]; with ASME B1.1 screw threads.

Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

Design for Air-Duct Installation: With ventilated shroud.

Design for Thermowell Installation: Bare stem.

Accuracy: Plus or minus [**1**] <**Insert number**> percent of scale range.

* + - 1. LIQUID-IN-GLASS THERMOMETERS
         1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3040) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457061036).

Approved equivalent.

Standard: ASME B40.200.

Case: [**Cast aluminum**] <**Insert material**>; 6-inch nominal size.

Case Form: [**Back angle**] [**Straight**] unless otherwise indicated.

Tube: Glass with magnifying lens and blue[**or red**] organic liquid.

Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F**] [**deg F and deg C**].

Window: Glass or plastic.

Stem: Aluminum or brass and of length to suit installation.

Design for Air-Duct Installation: With ventilated shroud.

Design for Thermowell Installation: Bare stem.

Connector: 3/4 inch, with ASME B1.1 screw threads.

Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

* + - * 1. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

Standard: ASME B40.200.

Case: [**Cast aluminum**] <**Insert material**>; [**7-inch (178-mm)**] [**9-inch (229-mm)**] nominal size unless otherwise indicated.

Case Form: [**Adjustable angle**] [**Back angle**] [**Straight**] <**Insert form**> unless otherwise indicated.

Tube: Glass with magnifying lens and blue[**or red**] organic liquid.

Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in [**deg F (deg C)**] [**deg F and deg C**].

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Stem: [**Aluminum**] <**Insert material**> and of length to suit installation.

Design for Air-Duct Installation: With ventilated shroud.

Design for Thermowell Installation: Bare stem.

Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.

Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

* + - 1. DUCT-THERMOMETER MOUNTING BRACKETS
         1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.
      2. THERMOWELLS

ASME B40.200 uses the following symbols for thermowell materials: "CNR" for copper nickel (90-10), "CUNI" for copper nickel (70-30), "CRES" for corrosion-resistant steel, "NICU" for nickel copper, "ALBR" for aluminum bronze, and "CSA" for steel. Other materials are allowed.

* + - * 1. Thermowells:

Standard: ASME B40.200.

Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.

Material for Use with Copper Tubing: [**CNR**] [**or**] [**CUNI**] <**Insert material**>.

Material for Use with Steel Piping: [**CRES**] [**CSA**] <**Insert material**>.

Type: Stepped shank unless straight or tapered shank is indicated.

External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.

Bore: Diameter required to match thermometer bulb or stem.

Insertion Length: Length required to match thermometer bulb or stem.

Lagging Extension: Include on thermowells for insulated piping and tubing.

Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

* + - * 1. Heat-Transfer Medium: [**Mixture of graphite and glycerin**] <**Insert material**>.
      1. DIAL-TYPE PRESSURE GAGES
         1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3048) Subject to compliance with requirements, provide products by one of the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123457060917).

[Marsh Bellofram](http://www.specagent.com/Lookup?uid=123457060913).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457060922).

Approved equivalent.

Standard: ASME B40.100.

Case: [**Liquid-filled**] [**Sealed**] [**Open-front, pressure relief**] [**Solid-front, pressure relief**] <**Insert type**> type(s); [**cast aluminum or drawn steel**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter.

Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

Match pressure connection size in first subparagraph below with gage attachment size.

Pressure Connection: Brass, with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

Movement: Mechanical, with link to pressure element and connection to pointer.

Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**psi**] [**psi**].

Pointer: Dark-colored metal.

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Ring: [**Metal**] [**Brass**] [**Stainless steel**].

Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] scale range.

* + - * 1. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3050) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ashcroft Inc](http://www.specagent.com/Lookup?uid=123457060945).

[Marsh Bellofram](http://www.specagent.com/Lookup?uid=123457060948).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457060954).

Approved equivalent.

Standard: ASME B40.100.

Case: [**Liquid-filled**] [**Sealed**] <**Insert type**> type; [**cast aluminum or drawn steel**] [**metal**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter with [**back**] [**front**] flange and holes for panel mounting.

Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

Match pressure connection size in first subparagraph below with gage attachment size.

Pressure Connection: Brass, with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

Movement: Mechanical, with link to pressure element and connection to pointer.

Dial: Nonreflective aluminum with permanently etched scale markings graduated in [**psi**] [**psi**].

Pointer: Dark-colored metal.

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Ring: [**Metal**] [**Stainless steel**] <**Insert material**>.

Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] scale range.

Window: [**Glass**] [**or**] [**plastic**] <**Insert material**>.

Ring: [**Metal**] [**Stainless steel**] <**Insert material**>.

Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] scale range.

* + - 1. GAGE ATTACHMENTS

Match attachment size in this article with pressure-gage-connection size.

* + - * 1. Snubbers: ASME B40.100, brass; with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and [**piston**] [**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
        2. Siphons: Loop-shaped section of [**brass**] [**stainless-steel**] [**steel**] pipe with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**] pipe threads.
        3. Valves: [**Brass ball**] [**Brass or stainless-steel needle**], with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads.
      1. TEST PLUGS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3052) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Peterson Equipment Co., Inc](http://www.specagent.com/Lookup?uid=123457060977).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457060979).

[Weiss Instruments, Inc](http://www.specagent.com/Lookup?uid=123457060976).

Approved equivalent.

* + - * 1. Description: Test-station fitting made for insertion in piping tee fitting.
        2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
        3. Thread Size: [**NPS 1/4**] [**or**] [**NPS 1/2**], ASME B1.20.1 pipe thread.
        4. Minimum Pressure and Temperature Rating: [**500 psig at 200 deg F**] <**Insert ratings**>.
        5. Core Inserts: [**Chlorosulfonated polyethylene synthetic**] [**and**] [**EPDM**] self-sealing rubber.
      1. TEST-PLUG KITS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3053) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Peterson Equipment Co., Inc](http://www.specagent.com/Lookup?uid=123457060985).

[Trerice, H. O. Co](http://www.specagent.com/Lookup?uid=123457060986).

[Weiss Instruments, Inc](http://www.specagent.com/Lookup?uid=123457060989).

Approved equivalent.

* + - * 1. Furnish [**one**] <**Insert number**> test-plug kit(s) containing [**one**] [**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.

Retain "Low-Range Thermometer" or "High-Range Thermometer" Paragraphparagraph below. If retaining both, indicate location of each on Drawings.

* + - * 1. Low-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch-**] <**Insert dimension**> diameter dial and tapered-end sensing element. Dial range shall be at least [**25 to 125 deg F**] <**Insert temperature range**>.
        2. High-Range Thermometer: Small, bimetallic insertion type with [**1- to 2-inch-**] <**Insert dimension**> diameter dial and tapered-end sensing element. Dial range shall be at least [**0 to 220 deg F**] <**Insert temperature range**>.
        3. Pressure Gage: Small, Bourdon-tube insertion type with [**2- to 3-inch-**] <**Insert dimension**> diameter dial and probe. Dial range shall be at least [**0 to 200 psig**] <**Insert range**>.
        4. Carrying Case: Metal or plastic, with formed instrument padding.
      1. SIGHT FLOW INDICATORS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3054) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ARCHON Industries, Inc](http://www.specagent.com/Lookup?uid=123457061042).

[Dwyer Instruments, Inc](http://www.specagent.com/Lookup?uid=123457061043).

[Emerson Process Management; Rosemount Division](http://www.specagent.com/Lookup?uid=123457061044).

Approved equivalent.

* + - * 1. Description: Piping inline-installation device for visual verification of flow.
        2. Construction: Bronze or stainless-steel body, with sight glass and [**ball, flapper, or paddle wheel**] <**Insert device**> indicator, and threaded or flanged ends.
        3. Minimum Pressure Rating: [**125 psig**] [**150 psig**] <**Insert value**>.
        4. Minimum Temperature Rating: [**200 deg F**] <**Insert temperature**>.
        5. End Connections for NPS 2 and Smaller: Threaded.
        6. End Connections for NPS 2-1/2 and Larger: Flanged.
      1. FLOWMETERS

Indicate flowmeter capacity and operating conditions on Drawings.

* + - * 1. Orifice Flowmeters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3055) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ABB (Industrial Automation Division)](http://www.specagent.com/Lookup?uid=123457061052).

[Bell & Gossett; a Xylem brand](http://www.specagent.com/Lookup?uid=123457061050).

[Meriam Process Technologies](http://www.specagent.com/Lookup?uid=123457061051).

Approved equivalent.

Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.

Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.

Design: Differential-pressure-type measurement for [**gas**] [**oil**] [**steam**] [**water**] <**Insert fluid**>.

Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.

Minimum Pressure Rating: [**300 psig**] <**Insert value**>.

Minimum Temperature Rating: [**250 deg F**] <**Insert temperature**>.

Retain "Permanent Indicators" or "Portable Indicators" Subparagraph below.

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.

Scale: Gallons per minute.

Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**] <**Insert accuracy**>.

Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.

Scale: Gallons per minute.

Accuracy: Plus or minus [**2 percent between 20 and 80 percent of scale range**] <**Insert accuracy**>.

Display: Shows rate of flow[**, with register to indicate total volume in gallons**].

Conversion Chart: Flow rate data compatible with sensor and indicator.

Operating Instructions: Include complete instructions with each flowmeter.

* + - * 1. Pitot-Tube Flowmeters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3056) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ABB (Industrial Automation Division)](http://www.specagent.com/Lookup?uid=123457060850).

[Meriam Process Technologies](http://www.specagent.com/Lookup?uid=123457060848).

[TACO Comfort Solutions, Inc](http://www.specagent.com/Lookup?uid=123457060849).

Approved equivalent.

Description: Flowmeter with sensor and indicator.

Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

Sensor: Insertion type; for inserting probe in piping and measuring flow directly in gallons per minute.

Design: Differential-pressure-type measurement for [**oil**] [**water**] <**Insert fluid**>.

Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.

Minimum Pressure Rating: [**150 psig**] <**Insert value**>.

Minimum Temperature Rating: [**250 deg F**] <**Insert temperature**>.

Indicator: Hand-held meter; either an integral part of sensor or a separate meter.

Integral Transformer: For low-voltage power connection.

Accuracy: Plus or minus [**3**] <**Insert number**> percent.

Display: Shows rate of flow[**, with register to indicate total volume in gallons**].

Operating Instructions: Include complete instructions with each flowmeter.

* + - * 1. Turbine Flowmeters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3057) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ABB (Industrial Automation Division)](http://www.specagent.com/Lookup?uid=123457060999).

[McCrometer, Inc](http://www.specagent.com/Lookup?uid=123457060994).

[ONICON Incorporated](http://www.specagent.com/Lookup?uid=123457060997).

Approved equivalent.

Description: Flowmeter with sensor and indicator.

Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.

Design: Device or pipe fitting with inline turbine and integral direct-reading scale for [**gas**] [**oil**] [**steam**] [**water**] <**Insert fluid**>.

Construction: Bronze or stainless-steel body, with plastic turbine or impeller.

Minimum Pressure Rating: [**150 psig**] <**Insert value**>.

Minimum Temperature Rating: [**180 deg F**] <**Insert temperature**>.

Indicator: Hand-held meter; either an integral part of sensor or a separate meter.

Accuracy: Plus or minus [**1-1/2**] <**Insert number**> percent.

Display: Shows rate of flow[**, with register to indicate total volume in gallons**].

Operating Instructions: Include complete instructions with each flowmeter.

* + - * 1. Venturi Flowmeters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3058) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ABB (Industrial Automation Division)](http://www.specagent.com/Lookup?uid=123457061007).

[Hyspan Precision Products, Inc](http://www.specagent.com/Lookup?uid=123457061005).

[Victaulic Company](http://www.specagent.com/Lookup?uid=123457061006).

Approved equivalent.

Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.

Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

Design: Differential-pressure-type measurement for [**gas**] [**oil**] [**steam**] [**water**] <**Insert fluid**>.

Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.

Minimum Pressure Rating: [**250 psig**] <**Insert value**>.

Minimum Temperature Rating: [**250 deg F**] <**Insert temperature**>.

End Connections for NPS 2 and Smaller: Threaded.

End Connections for NPS 2-1/2 and Larger: Flanged or welded.

Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

Retain "Permanent Indicators" or "Portable Indicators" Subparagraph below.

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.

Scale: Gallons per minute.

Accuracy: Plus or minus [**1 percent between 20 and 80 percent of scale range**] <**Insert accuracy**>.

Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.

Scale: Gallons per minute.

Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

Display: Shows rate of flow[**, with register to indicate total volume in gallons**].

Conversion Chart: Flow rate data compatible with sensor.

Operating Instructions: Include complete instructions with each flowmeter.

* + - * 1. Vortex-Shedding Flowmeters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3059) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

[ABB (Industrial Automation Division)](http://www.specagent.com/Lookup?uid=123457061056).

[EMCO Flow Systems](http://www.specagent.com/Lookup?uid=123457061057).

[Emerson Process Management; Rosemount Division](http://www.specagent.com/Lookup?uid=123457061058).

Approved equivalent.

Description: Flowmeter with sensor and indicator.

Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute.

Design: Flow obstruction device, vortex-measurement type for [**gas**] [**steam**] [**and**] [**liquids**].

Construction: Stainless-steel body, with integral transmitter and direct-reading scale.

Minimum Pressure Rating: [**1000 psig**] <**Insert value**>.

Minimum Temperature Rating: [**500 deg F**] <**Insert temperature**>.

Integral Transformer: For low-voltage power operation.

Indicator: Hand-held meter; either an integral part of sensor or a separate meter.

Accuracy: Plus or minus [**0.25**] <**Insert number**> percent for liquids and [**0.75**] <**Insert number**> percent for gases.

Display: Shows rate of flow[**, with register to indicate total volume in gallons**].

Operating Instructions: Include complete instructions with each flowmeter.

* + - 1. THERMAL-ENERGY METERS

Indicate capacity and operating conditions of thermal-energy meters on Drawings.

* + - * 1. Impeller-Turbine, Thermal-Energy Meters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3060) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Hoffer Flow Controls, Inc](http://www.specagent.com/Lookup?uid=123457060856).

[ISTEC Corporation](http://www.specagent.com/Lookup?uid=123457060857).

[ONICON Incorporated](http://www.specagent.com/Lookup?uid=123457060858).

Approved equivalent.

Description: System with[**strainer,**] flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.

Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.

Design: Total thermal-energy measurement.

Minimum Pressure Rating: [**150 psig**] <**Insert value**>.

Minimum Temperature Range: [**40 to 250 deg F**] <**Insert temperature range**>.

Temperature Sensors: Insertion-type transducer.

Indicator: Solid-state, integrating-type meter[**with integral battery pack**]; for wall mounting.

Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.

Battery Pack: Five-year lithium battery.

Accuracy: Plus or minus [**1**] <**Insert number**> percent.

Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.

Strainer: Full size of main line piping.

Operating Instructions: Include complete instructions with each thermal-energy meter system.

* + - * 1. Ultrasonic, Thermal-Energy Meters:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3061) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[EMCO Flow Systems](http://www.specagent.com/Lookup?uid=123457060862).

[ONICON Incorporated](http://www.specagent.com/Lookup?uid=123457064253).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457060861).

Approved equivalent.

Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.

Flow Sensor: Transit-time ultrasonic type with transmitter.

Temperature Sensors: Insertion-type or strap-on transducer.

Indicator: Solid-state, integrating-type meter[**with integral battery pack**].

Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.

Battery Pack: Five-year lithium battery.

Accuracy: Plus or minus [**1**] <**Insert number**> percent.

Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.

Operating Instructions: Include complete instructions with each thermal-energy meter system.

1. EXECUTION
   * + 1. INSTALLATION
          1. Install thermowells with socket extending [**a minimum of 2 inches into fluid**] [**one-third of pipe diameter**] [**to center of pipe**] and in vertical position in piping tees.
          2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
          3. Install thermowells with extension on insulated piping.
          4. Fill thermowells with heat-transfer medium.
          5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
          6. 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.
          7. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
          8. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
          9. Install remote-mounted pressure gages on panel.
          10. Install valve and snubber in piping for each pressure gage for fluids (except steam).
          11. Install valve and syphon fitting in piping for each pressure gage for steam.
          12. Install test plugs in piping tees.
          13. Install flow indicators in piping systems in accessible positions for easy viewing.
          14. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
          15. Install flowmeter elements in accessible positions in piping systems.
          16. Install wafer-orifice flowmeter elements between pipe flanges.
          17. 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.
          18. Install permanent indicators on walls or brackets in accessible and readable positions.
          19. Install connection fittings in accessible locations for attachment to portable indicators.
          20. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
          21. Install thermometers in the following locations:

Inlet and outlet of each hydronic zone.

Inlet and outlet of each hydronic boiler.

Two inlets and two outlets of each chiller.

Inlet and outlet of each hydronic coil in air-handling units.

Two inlets and two outlets of each hydronic heat exchanger.

Inlet and outlet of each thermal-storage tank.

Outside-, return-, supply-, and mixed-air ducts.

<**Insert location**>.

* + - * 1. Install pressure gages in the following locations:

Discharge of each pressure-reducing valve.

Inlet and outlet of each chiller chilled-water and condenser-water connection.

Suction and discharge of each pump.

<**Insert location**>.

* + - 1. CONNECTIONS
         1. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.
         2. Connect flowmeter-system elements to meters.
         3. Connect flowmeter transmitters to meters.
         4. Connect thermal-energy meter transmitters to meters.
      2. ADJUSTING
         1. After installation, calibrate meters according to manufacturer's written instructions.
         2. Adjust faces of meters and gages to proper angle for best visibility.
      3. THERMOMETER SCHEDULE

Retain this article if more than one type of thermometer is required; delete if all thermometers are the same type.

Retain and revise applicable thermometer applications in this article. Coordinate with materials specified.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlet and outlet of each hydronic zone shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**]-case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlet and outlet of each hydronic boiler shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlets and outlets of each chiller shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlets and outlets of each hydronic heat exchanger shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at inlet and outlet of each thermal-storage tank shall be[**one of**] the following:

Retain one or more of five subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact] [Industrial**]-style, liquid-in-glass type

Retain " one of" option in first paragraph below to allow Contractor to select thermometer materials from those retained.

* + - * 1. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be[**one of**] the following:

Retain one or more of four subparagraphs below. If retaining more than one type of thermometer, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**], bimetallic-actuated type.

[**Direct**] [**Remote**]-mounted, [**metal**] -case, vapor-actuated type.

[**Compact**] [**Industrial**]-style, liquid-in-glass type.

Insert additional paragraphs for thermometer applications here.

* + - * 1. Thermometer stems shall be of length to match thermowell insertion length.
      1. THERMOMETER SCALE-RANGE SCHEDULE

The IP and SI (metric) temperature values for the scale ranges in this article are not mathematical, rounded, conversions from IP to SI (metric); rather, they are the temperature ranges within each specific unit of measure that are available from most manufacturers.

Retain first option in each paragraph below for thermometers with a single scale in either deg F or deg C; retain second option for thermometers with dual scales.

Scale ranges vary among types of thermometers and among manufacturers. Retain a scale range that covers more than service-fluid temperature range. Exact ranges listed are not mandatory.

Retain one or more of first four paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Chilled-Water Piping: [**Minus 40 to plus 160 deg F**] [**Minus 40 to plus 160 deg F**].
        2. Scale Range for Chilled-Water Piping: [**0 to 100 deg F**] [**0 to 100 deg F**].
        3. Scale Range for Chilled-Water Piping: [**0 to 150 deg F**] [**0 to 150 deg F**].
        4. Scale Range for Chilled-Water Piping: [**0 to 250 deg F**] [**0 to 250 deg F**].

Retain one or more of first five paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Condenser-Water Piping: [**0 to 100 deg F**] [**0 to 100 deg F**].
        2. Scale Range for Condenser-Water Piping: [**0 to 150 deg F**] [**0 to 150 deg F**].
        3. Scale Range for Condenser-Water Piping: [**0 to 250 deg F**] [**0 to 250 deg F** ].
        4. Scale Range for Condenser-Water Piping: [**20 to 240 deg F**] [**20 to 240 deg F**].
        5. Scale Range for Condenser-Water Piping: [**30 to 240 deg F**] [**30 to 240 deg F**].

Retain one or more of first five paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Heating, Hot-Water Piping: [**0 to 250 deg F**] [**0 to 250 deg F**].
        2. Scale Range for Heating, Hot-Water Piping: [**20 to 240 deg F**] [**20 to 240 deg F**].
        3. Scale Range for Heating, Hot-Water Piping: [**30 to 240 deg F**] [**30 to 240 deg F**].
        4. Scale Range for Heating, Hot-Water Piping: [**50 to 400 deg F**] [**50 to 400 deg F**].
        5. Scale Range for Heating, Hot-Water Piping: [**50 to 550 deg F**] [**50 to 550 deg F**].

Retain one or more of first four paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Steam and Steam-Condensate Piping: [**0 to 250 deg F**] [**0 to 250 deg F**].
        2. Scale Range for Steam and Steam-Condensate Piping: [**20 to 240 deg F**] [**20 to 240 deg F**].
        3. Scale Range for Steam and Steam-Condensate Piping: [**30 to 240 deg F**] [**30 to 240 deg F**].
        4. Scale Range for Steam and Steam-Condensate Piping: [**50 to 400 deg F**] [**50 to 400 deg F**].

Retain one or more of eight paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Air Ducts: [**Minus 40 to plus 110 deg F**] [**Minus 40 to plus 110 deg F**].
        2. Scale Range for Air Ducts: [**Minus 40 to plus 160 deg F**] [**Minus 40 to plus 160 deg F**].
        3. Scale Range for Air Ducts: [**0 to 100 deg F**] [**0 to 100 deg F**
        4. Scale Range for Air Ducts: [**0 to 150 deg F**] [**0 to 150 deg F**].
        5. Scale Range for Air Ducts: [**0 to 250 deg F**] [**0 to 250 deg F**].
        6. Scale Range for Air Ducts: [**20 to 240 deg F**] [**20 to 240 deg F**].
        7. Scale Range for Air Ducts: [**30 to 240 deg F**] [**30 to 240 deg F**].
        8. Scale Range for Air Ducts: [**50 to 400 deg F**] [**50 to 400 deg F**].

Insert additional paragraphs for thermometer scale ranges and applications here.

* + - 1. PRESSURE-GAGE SCHEDULE

Retain this article if more than one type of pressure gage is required; delete if all pressure gages are the same type.

Retain and revise applicable pressure-gage applications in this article. Coordinate with materials specified.

Retain " one of" option in first paragraph below to allow Contractor to select pressure-gage materials from those retained.

* + - * 1. Pressure gages at discharge of each pressure-reducing valve shall be[**one of**] the following:

Retain one or more of three subparagraphs below. If retaining more than one type of pressure gage, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**] <**Insert type**>, [**direct**] [**remote**]-mounted, metal case.

Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

Retain " one of" option in first paragraph below to allow Contractor to select pressure-gage materials from those retained.

* + - * 1. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be[**one of**] the following:

Retain one or more of three subparagraphs below. If retaining more than one type of pressure gage, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**] <**Insert type**>, [**direct**] [**remote**]-mounted, metal case.

Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

Retain " one of" option in first paragraph below to allow Contractor to select pressure-gage materials from those retained.

* + - * 1. Pressure gages at suction and discharge of each pump shall be[**one of**] the following:

Retain one or more of three subparagraphs below. If retaining more than one type of pressure gage, indicate location of each on Drawings.

[**Liquid-filled**] [**Sealed**] <**Insert type**>, [**direct**] [**remote**]-mounted, metal case.

Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

Insert additional paragraphs for pressure-gage applications here.

* + - 1. PRESSURE-GAGE SCALE-RANGE SCHEDULE

The IP and SI (metric) pressure values for the scale ranges presented in this article are not mathematical, rounded, conversions from IP to SI (metric); rather they are the pressure ranges within each specific unit of measure that are available from most manufacturers.

Retain first option in each paragraph below for pressure gages with a single scale in either psi or kPa; retain second option for pressure gages with dual scales.

Scale ranges vary among types of pressure gages and among manufacturers. Retain a scale range that covers more than service-fluid pressure range. Exact ranges listed are not mandatory.

Retain one or more of first seven paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Chilled-Water Piping: [**30-in. Hg to 15 psi**] [**30-in. Hg to 15 psi**].
        2. Scale Range for Chilled-Water Piping: [**0 to 30 psi**] [**0 to 30 psi**].
        3. Scale Range for Chilled-Water Piping: [**0 to 100 psi**] [**0 to 100 psi**].
        4. Scale Range for Chilled-Water Piping: [**0 to 160 psi**] [**0 to 160 psi**].
        5. Scale Range for Chilled-Water Piping: [**0 to 200 psi**] [**0 to 200 psi**].
        6. Scale Range for Chilled-Water Piping: [**0 to 300 psi**] [**0 to 300 psi**].
        7. Scale Range for Chilled-Water Piping: [**0 to 600 psi**] [**0 to 600 psi**].

Retain one or more of first seven paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Condenser-Water Piping: [**30-in. Hg to 15 psi**] [**30-in. Hg to 15 psi**].
        2. Scale Range for Condenser-Water Piping: [**0 to 30 psi**] [**0 to 30 psi**].
        3. Scale Range for Condenser-Water Piping: [**0 to 100 psi**] [**0 to 100 psi**].
        4. Scale Range for Condenser-Water Piping: [**0 to 160 psi**] [**0 to 160 psi**].
        5. Scale Range for Condenser-Water Piping: [**0 to 200 psi**] [**0 to 200 psi**].
        6. Scale Range for Condenser-Water Piping: [**0 to 300 psi**] [**0 to 300 psi**].
        7. Scale Range for Condenser-Water Piping: [**0 to 600 psi**] [**0 to 600 psi**].

Retain one or more of first seven paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Heating, Hot-Water Piping: [**30-in. Hg to 15 psi**] [**30-in. Hg to 15 psi**].
        2. Scale Range for Heating, Hot-Water Piping: [**0 to 30 psi**] [**0 to 30 psi**].
        3. Scale Range for Heating, Hot-Water Piping: [**0 to 100 psi**] [**0 to 100 psi**].
        4. Scale Range for Heating, Hot-Water Piping: [**0 to 160 psi**] [**0 to 160 psi**].
        5. Scale Range for Heating, Hot-Water Piping: [**0 to 200 psi**] [**0 to 200 psi**].
        6. Scale Range for Heating, Hot-Water Piping: [**0 to 300 psi**] [**0 to 300 psi**].
        7. Scale Range for Heating, Hot-Water Piping: [**0 to 600 psi**] [**0 to 600 psi**].

Retain one or more of seven paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

* + - * 1. Scale Range for Steam Piping: [**30-in. Hg to 15 psi**] [**30-in. Hg to 15 psi**].
        2. Scale Range for Steam Piping: [**0 to 30 psi**] [**0 to 30 psi**].
        3. Scale Range for Steam Piping: [**0 to 100 psi**] [**0 to 100 psi**].
        4. Scale Range for Steam Piping: [**0 to 160 psi**] [**0 to 160 psi**].
        5. Scale Range for Steam Piping: [**0 to 200 psi**] [**0 to 200 psi**].
        6. Scale Range for Steam Piping: [**0 to 300 psi**] [**0 to 300 psi**].
        7. Scale Range for Steam Piping: [**0 to 600 psi**] [**0 to 600 psi**].

Insert additional paragraphs for pressure-gage scale ranges and applications here.

* + - 1. FLOWMETER SCHEDULE

Retain and revise applicable flowmeter applications in this article. Coordinate with materials specified.

* + - * 1. Flowmeters for Chilled-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.
        2. Flowmeters for Condenser-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.
        3. Flowmeters for Heating, Hot-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.
        4. Flowmeters for Steam and Steam-Condensate Piping: [**Orifice**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.
      1. THERMAL-ENERGY METER SCHEDULE

Retain and revise applicable thermal-energy meter applications in this article. Coordinate with materials specified.

* + - * 1. Thermal-Energy Meters for Chilled-Water Piping: [**Impeller-turbine**] [**Ultrasonic**] type.
        2. Thermal-Energy Meters for Condenser-Water Piping: [**Impeller-turbine**] [**Ultrasonic**] type.
        3. Thermal-Energy Meters for Heating, Hot-Water Piping: [**Impeller-turbine**] [**Ultrasonic**] type.
        4. Thermal-Energy Meters for Steam and Steam-Condensate Piping: [**Impeller-turbine**] [**Ultrasonic**] type.

END OF SECTION 230519