

SECTION 23 05 19**METERS AND GAGES FOR HVAC EQUIPMENT****PART 1 - DESIGN DIRECTIVES****1.1 QUALITY ASSURANCE**

- A. Comply with applicable UL standards pertaining to meters and gauges and with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

1.2 DESIGN CRITERIA

- A. The designer shall indicate on the drawing details and flow schematics the locations of all gauges.
- B. At hydronic pumps, a single pressure gauge shall be installed with isolated taps before the strainer, between the strainer and the pump inlet, and after the pump discharge. This is not required at domestic hot water recirculation pumps.
- C. Temperature and pressure gauges shall be installed in hydronic systems as required to facilitate troubleshooting. This shall include locations such as building service entrances, supply and return piping mains prior to leaving the mechanical room, and wherever an electronic temperature or pressure sensor is installed for reporting to the Building Management System.
- D. Provide temperature and pressure gauges on both the inlet and discharge piping connections of all equipment whose function is to add or remove heat from the fluid, or to change its pressure.
- E. Provide a low pressure drop flow measuring device as specified herein on the return piping main of all hydronic systems.
- F. All water meters and sub-meters shall communicate in an open protocol or shall terminate into a BAS controller, gateway device, accumulator, or pulse counter that outputs into BACnet IP (preferred) or Modbus TCP/IP.
- G. Water metering and sub-metering systems may communicate in a serial bus using BACnet MSTP to an approved IP-gateway device. All water meters and submeters operating on a serial bus must be physically separated from VFD wiring operating over serial communications.
- H. Proprietary communication protocols, mapping, data encoding, or socket types are prohibited. If multiple disparate systems require access to the meter data, the contractor shall provision for multiple communication outputs when ordering meters, prior to construction submittals.
- I. All water meters for potable water shall meet the NSF requirements for lead-free drinking water system components.

- J. The guidelines of this section define requirements for hydronic metering the usage of non-utility fluid flows. Refer to section 23 05 20 of this guideline for requirements related to thermal utility (building hot water, building chilled water, energy transfer station condensate) energy metering. Refer to the Electrical division section 26 10 00 of these Guidelines for requirements related to metering of electrical usage.

PART 2 - PRODUCTS

2.1 THERMOMETERS, GENERAL

- A. Accuracy shall be 1% of range span, grade A.
- B. Temperature ranges for services listed as follows (center of range shall be the scheduled fluid temperature):
 - 1. Domestic Hot Water: 0° to 200°F with 2° scale divisions.
 - 2. Domestic Cold Water: 30° to 130°F with 2° scale divisions.
 - 3. Hot Water: 0° to 250°F with 2° scale divisions.
 - 4. Condenser Water: 0° to 200°F with 2° scale divisions.
 - 5. Chilled Water: 30° to 130°F with 2° scale divisions.
 - 6. Steam and Condensate: 50° to 300°F with 2° scale divisions.

2.2 BIMETAL DIAL THERMOMETERS

- A. Direct mounted, bimetal type with adjustable angle feature for 360° rotation and 180° angle adjustment. Hermetically sealed, 5" diameter case of welded stainless-steel construction with external adjustment. Thermometer shall have a bimetal coil, plastic window, white dial with black markings. Stem Length of 6", or adjust length to be minimum 3" from insulation, 1/2" NPT stem connection.
- B. Manufacturers:
 - 1. Ashcroft, Dresser Industries, Instrument Div. #50EL60E series.
 - 2. Trerice #B85600 series

2.3 THERMOMETER WELLS

- A. Brass threaded thermometer wells for all piping systems, pressure rated to match piping system design pressure; with 2" extension for insulated piping and threaded cap nut with chain permanently (material to match well material) fastened to well and cap.

2.4 PRESSURE GAUGES - HYDRONICS SYSTEMS

- A. General use, ASME B40.1, Grade 2A, phosphor bronze bourdon tube type, bottom connection. Phenolic case, 4-1/2" diameter, with 1/2" NPS brass connector. White coated aluminum background, with permanently etched black markings. Accuracy shall be $\pm 1/2\%$ of range span. The scale range for all gages shall be 2 times the operating pressure. All gages in liquid systems shall be vibration resistant (Plus performance or silicone filled).
- B. Manufacturers:

1. Ashcroft, Dresser Industries, Instrument Div.
 - a. Steam systems: #45-1279-04L
 - b. Liquid systems: #45-1279-04L-XLL
2. Trerice
 - a. Steam systems: #450B45TRL500PSI series
 - b. Liquid systems: #450BG45TRL500PSI series

2.5 PRESSURE GAUGES – AIR SYSTEMS (Air Systems and Compressed Gases)

2.6 GAS REGULATORS

2.7 MAGNEHELIC GAUGES

2.8 TEST PLUGS

- A. Test Plugs shall be nickel plated brass body, with ¼" or ½" NPS fitting and two self-sealing valve type core inserts, suitable for inserting a probe assembly from a dial type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.
- B. Core Material: Conform to the following for fluid and temperature range:
 1. -30°F to 275°F: EPDM.
- C. Manufacturers:
 1. MG Piping Products Co.
 2. Peterson Equipment Co., Inc.
 3. Sisco, A Spedco, Inc. Co.
 4. Trerice (H.O.) Co.
 5. Watts Regulator Co.

2.9 PRESSURE GAUGE ACCESSORIES

- A. Connectors:
 1. Steam systems: Provide 1/2" NPS iron pig tail siphons.
 2. Water systems: 1/2" NPS steel (for steel pipe) or brass (for copper pipe) nipple, length to allow minimum 3" beyond insulation cover.
- B. Snubber
 1. 1/2" stainless steel, Ashcroft #112S (for steel piping systems), or 1/2" brass, Ashcroft #112B (for copper piping systems).
 2. Provide a 1/2" ball or needle valve, carbon steel for steel piping systems or bronze for copper piping systems.

2.10 HYDRONIC FLOW AND ENERGY METERS

- A. GENERAL –The guidelines of this section define requirements for metering the usage of non-thermal utility steam condensate, hot water, chilled water, condenser water, and domestic water. See section 23 05 20: Thermal Utility Meters for revenue-grade metering requirements.
- B. FLOW METERS – INLINE ELECTROMAGNETIC
1. Product: Magnetic, In-Line Flow Meter shall be Cadillac EMAG or CMAG Series as manufactured by Central Station Steam Co., Tigard, OR; or equivalent
 2. Description: Flow meter with sensor and indicator, capable of bi-directional flow measurement.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Inline type; flanged, for installing between pipe flanges and measuring flow directly in gallons per minute.
 - a. Design: Electromagnetic flowmeter with operation based on Faraday's Law, utilizing pulsed DC coil excitation.
 - b. Construction: Stainless-steel body, with integral transmitter and direct-reading scale. Full bore flow tube with magnetic field traversing the entire section.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 180 deg F. or higher as required by application
 - e. Service: Suitable for liquids with a minimum conductivity of 5 micros/cm.
 5. Indicator: Remote or local mount for indication of flow.
 6. Accuracy: Plus or minus +/- 0.5% f or velocities of 1 to 30 ft./sec.
 7. Display: Shows rate of flow in gallons per minute and total gallons
 8. Interface with BMS: Provide 4 to 20 mA signal, proportional to volumetric flow rate in gallons per minute
 9. Operating Instructions: Include complete instructions with each flowmeter.
 10. Factory calibrated and furnished with NIST calibration certificate.
 11. Factory Mutual Approved.
- C. FLOW METERS – INLINE TURBINE
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Data Industrial Corp.
 - c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - d. ONICON Incorporated.
 - e. ISTECH Corporation.
 2. Description: Flowmeter with sensor and indicator.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

4. Sensor: Impeller turbine; for inserting into 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 steam, water.
 - 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. or higher as required by application
5. Indicator: Remote or local mount for indication of flow.
6. Accuracy: Plus or minus 1-1/2 percent.
7. Display: Shows rate of flow in gallons per minute, with register to indicate total volume in gallons.
8. Interface with BMS: Provide 4 to 20 mA signal, proportional to volumetric flow rate in gallons per minute
9. Operating Instructions: Include complete instructions with each flowmeter.

D. FLOW METERS – ULTRASONIC (Use for Controls)

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Flexim Fluxus F501
 - b. Baker Hughes Panametrics DF868
 - c. Endress and Hauser Prosonic 91W
2. Description: Flowmeter with ultrasonic transducers and integral electronics.
3. Flow Range: Transducers and integral calculator shall be sized to cover operating range of equipment or system served.
4. Transducers: Clamp on transducers must be provided with mounting hardware, preferably with a mounting track. Transducer must be as specified by the flow meter manufacturer for the application and installed as per manufacturer's instructions.
5. Design: Device with clamp on transducers and integral electronic display for measuring hydronic flows. Clamp-on transducers with automatic transducer spacing utilizing a mounting track (ruler scales not acceptable), precluding the requirement of penetrating into the pipe.
 - a. Indicator: Remote or local mount for indication of flow.
 - b. Minimum Temperature Rating: 180 deg F. or higher as required by application
6. Indicator: Remote or local mount for indication of flow.
7. ACCURACY: +/-1% of flow over a +/-40 fps flow range with 10 diameters upstream and 5 diameters downstream straight run of piping.
8. Display: Shows rate of flow in gallons per minute, with register to indicate total volume in gallons.
9. Interface with BMS: Provide 4 to 20 mA signal, proportional to volumetric flow rate in gallons per minute

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

E. FLOW-ENERGY (BTU) METERS

1. Non-revenue flow-energy meters may utilize BAS sensors for non-utility energy monitoring. Refer to Section 23 05 20, Thermal Utility Meters, for all utility meters.

F. WATER METERS

1. Acceptable Manufacturers:

- a. Neptune
- b. Badger

Note: Manufacturer and model of main domestic water must be approved by Town of Hanover Water & Sewer department. Purchase meter from Water & Sewer Department if required by Town.

2. Main domestic water meter size for peak demand compound type, as approved by the Town of Hanover. Meter shall be provided with readout units as required by the Town, and with remote metering kit. Mount remote metering readout device where directed by the Town.
3. Makeup water meters shall be magnetic rive type with readout in gallons.

2.11 LOW PRESSURE DROP FLOW MEASUREMENT DEVICES

- A. Very low-pressure drop, wafer-type, orifice flow meter or calibrated manual balancing valve; flow proportional to measured differential pressure. Furnish with appropriate flow vs. differential pressure charts.
 1. Orifice Flow Meters: Bell & Gossett Circuit Sensor or approved equal.
 2. Manual Balancing Valves: (Refer to Section 23 05 23, General Duty HVAC Valves & Section 23 09 23, HVAC Instrumentation and Controls.). Manual balancing valves, if used, shall be used for flow verification only during testing and balancing operations. The valve shall be set in the 100% open position under normal operating conditions.
- B. Very low-pressure drop, pitot tube type flow meter, sensing upstream total pressure and downstream static pressure. Furnish with appropriate flow charts.
 1. Taco Sentinel or approved equal.

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

- A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.
- B. Install thermometer wells in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

- C. Install thermowells with socket extending one-third of pipe diameter on pipe 3 inches and under and to center of pipe on pipe over 3 inches, and in vertical position in piping tees.
- D. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- E. Install thermowells with extension on insulated piping.
- F. Fill thermowells with heat-transfer medium.
- G. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- H. 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.
- I. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- J. Install remote-mounted pressure gages on panel.
- K. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- L. Install test plugs in piping tees, on top of pipe.
- M. Install test plugs in stems of all thermometers and pressure gauges.
- 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 the required 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. Provide bypass with isolation valves on all inline magnetic flow meters for service.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

- B. Connect flowmeter-system elements to energy calculator, gateway, or BAS controller.
- C. Connect flowmeter transmitters to energy calculator, gateway, or BAS controller.
- D. Connect thermal-energy meter transmitters to energy calculator, gateway, or BAS controller.
- E. For flanged meter installations, provide valved bypass to allow meter removal for servicing.

3.3 LOW PRESSURE DROP FLOW MEASUREMENT DEVICES

- A. Comply with manufacturer's written recommendations for unrestricted pipe upstream and downstream of the flow device.

3.4 HYDRONIC FLOW METERS

- A. All meters must be able to be read directly without the use of a ladder. Where meters are not readable from the floor provide a floor level remote display.
- B. Condensate meters shall be piped so that there is a column of liquid present in the meter at all times.
- C. Install all meters in conformance with manufacturer's written instructions, with particular attention paid to pipe configuration and minimum straight runs of pipe.

3.5 THERMOMETER SCHEDULE

- A. Thermometers in hydronic piping locations shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Remote-mounted, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each chiller, chilled-water and condenser-water connection, shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Remote-mounted, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
- D. 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. Sealed, bimetallic-actuated type.
 - 2. Remote-mounted, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.

- E. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Industrial style, liquid-in-glass type.
- F. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- G. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
 - 1. Sealed, bimetallic-actuated type.
 - 2. Remote-mounted, metal-case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
- H. Thermometer stems shall be of length to match thermowell insertion length.

3.6 THERMOMETER SCALE-RANGE SCHEDULE

- A. Contractor shall choose manufacturer's standard ranges nearest the values below.
- B. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- C. Scale Range for Ice-Storage Piping: Minus 40 to plus 160 deg F.
- D. Scale Range for Condenser-Water Piping: 0 to 150 deg F.
- E. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.
- F. Scale Range for Steam-Condensate Piping: 30 to 240 deg F.
- G. Scale Range for Steam Piping: 50 to 400 deg F.
- H. Scale Range for Air Ducts: 0 to 150 deg F.

3.7 PRESSURE-GAGE SCHEDULE

- A. Contractor shall choose manufacturer's standard ranges nearest the values below.
- B. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
- C. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection, boiler, heat exchanger, air handling unit coil, shall be the following:
 - 1. Liquid-filled, direct-mounted, metal case.
- D. Pressure gages at each pump shall be the following:

1. Liquid-filled, direct-mounted, metal case.
- E. Pressure gauges at inlet and outlet of each VAV box reheat coil, shall be the following:
 1. Test plug.
- F. Provide magnehelic type air pressure gauge at each coil and filter bank in an air-handling unit. Gauges shall be installed to read differential pressure.

3.8 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 200 psi.
- B. Scale Range for Condenser-Water Piping: 0 to 200 psi.
- C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
- D. Scale Range for Steam Piping: 30 in. Hg to 15 psi.
- E. Scale Range for Steam Piping: 0 to 30 psi.
- F. Scale Range for Air Systems and Compressed Air:
- G. Scale for Gas Regulators:
- H. Scale for Magnehelic Gauges: 0 to 3 psi

END OF SECTION 23 05 19