SECTION 23 0519

METERS AND GAGES FOR HVAC PIPING AND UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flow meters.

B. Pressure gages and pressure gage taps.

C. Test Plugs.

1.02 RELATED REQUIREMENTS

A. Section 23 0923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

B. Section 23 2113 - HYDRONIC PIPING.

1.03 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.

B. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

C. KSU Metering Standard - 2016.

1.04 SUBMITTALS

A. Refer to Section 230510 - General HVAC Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.05 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 LIQUID FLOW METERS

A. Annular element flow stations (FM):
   1. Manufacturers: Ellison Annubar, Barco, Mid-West, Preso.
   2. Measuring Station: Type 316 stainless steel pitot type flow element inserted through welded threaded couplet, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.
   3. Pressure rating: 275 psi.
   4. Maximum temperature: 400 degrees F.
   5. Accuracy: Plus 0.55 percent to minus 2.30 percent.

2.02 Electrical Metering

A. General
   1. Power meter shall measure at minimum electrical energy consumption (kWh) and peak real power demand (kW).
   2. Power meter shall utilize the acceptable communications protocols identified above to transfer data to the Data Acquisition Device for data capture and transfer to the BAS server (if required) and Dashboard Server.
   3. Power meter shall capture total building electrical consumption for the building. This meter shall be referred to as Meter 1.
   4. If additional power sub-metering is required, for specified areas of the building or to measure specific equipment or loads such as HVAC, lighting, plug load, etc., the metering shall be done using a multi-point meter. This meter, or meters if necessary, shall be referred to as Meter 2, 3, 4, etc.

B. Type

1. The power meter shall be installed to capture total building electric data.
2. The power meter shall be fully electronic with a multi-line backlit display showing measured parameters on a local display.

C. Measurements and Accuracy
1. The power meter shall perform, at minimum, the electrical measurements defined in Appendix A.
2. The power meter shall perform to the accuracy standards provided by the original equipment manufacturer.
3. If utilizing BACnet IP or Modbus TCP (Ethernet) communications, the power meter shall have data logging capability to protect the data in the event of a communications or power failure. The meter shall have a real-time clock that allows for time stamping of all the data collected in the meter when log events are created.

D. Communications
1. The power meter shall communicate to the Data Acquisition Device via one of the following protocols:
   a. Serial & Ethernet (preferred):
      1) BACnet IP and/or MSTP
      2) Modbus TCP and/or RTU
   b. Analog & Digital:
      1) 4-20 mA
      2) 0 to 10 VDC
      3) Scaled pulse

E. Location and Install Requirements
1. The meter shall be located in a readable location, three to five feet off finished floor if possible. Mounting position shall be horizontal.
2. The meter shall be installed to the manufacturer's guidelines, accounting for size, amperage and voltage of the measured line.

F. Acceptable manufacturer and model for power meter products are any of the following:
1. Shark 200 Series (or above) Energy Meter
2. Emon-Dmon Class 3200 or 5000 Smart Meter
3. Veris H81XX Series Energy Meter or Veris E50 Series Power and Energy Meter
4. Measurlogic DTS SMX Surface Mount Three Phase Energy Sub-meter

G. Instrument Transformers
1. Power supply to the meter shall be no greater than 120 volts.
2. Appropriately sized and NEMA rated instrument transformers shall be used to step down voltage to 120 volts for power supply for the meter if necessary.

H. Current Transformers (CTs)
1. The CTs shall be standard 5A secondary and conform to the ANSI Standard accuracy class for metering service of 0.3 or better (revenue metering) with burden B-0.1 to B-2.0 (with burden equal to or greater than that of the installed meter and any other connected equipment).
2. CTs secondary wiring length shall be minimized. The contractor/engineer shall calculate the additional burden of CT wiring and ensure that the total burden of the meter and associated wiring is within the rating of the CTs at the intended accuracy class of 0.3 or better.
3. CT accuracy class shall be sufficient for use in revenue metering with burden equal to or greater than that of the installed meter and any other connected equipment. Split core and solid core CTs are permitted but must confirm to the accuracy specifications.

I. Potential Transformers (PTs)
1. Where system voltages are below 480/277, no potential transformers are required.
2. Where potential transformers are used, they shall be protected by fuses on the primary and secondary sides.

3. Potential transformers shall be instrument transformers of suitable accuracy for revenue metering and shall supply only meters and protective relays. Control power transformers shall not be used as the metering potential source.
4. Fuses shall be class CC or as recommended by the meter manufacturer.

2.03 Natural Gas Metering

A. General
1. If available and approved by the local natural gas utility provider, a pulse signal may be captured by the Data Acquisition Device for 15 minute interval gas consumption and flow data from the utility grade meter serving the building.
2. If additional natural gas sub-metering is desired and a pulse option is not available on the utility meter, a natural gas sub-meter shall be installed to capture building natural gas consumption and flow.
3. Building natural gas supply shall be sub-metered to capture at minimum total building gas flow and total consumption.
4. Meter shall have a visual display of measured variables and if not, shall be paired with a network communication device with a backlit visual display along with BACnet or Modbus network communication capabilities.
5. The meter shall be selected based upon the size of the line, operating pressure, temperature, mass and volume requirements of the measured gas line.
6. The required enclosure for the meter shall be rated for the environmental conditions it will be exposed to (interior versus exterior).

B. Type
1. The natural gas meter shall utilize thermal dispersion or Coriolis technology that is temperature and pressure compensated according to the specifics of the line that is being metered.
2. Basis of design for the natural gas meter shall be an insertion thermal mass flow meter, inline thermal mass flow meter, or Coriolis metering technology.

C. Measurements and Accuracy
1. The natural gas meter shall perform, at minimum, the measurements defined in Appendix A.
2. The natural gas meter shall perform to the accuracy standards provided by the original equipment manufacturer.

D. Communications
1. The natural gas meter shall communicate to the Data Acquisition Device via one of the following protocols:
   a. Serial & Ethernet Communications (preferred):
      1) BACnet IP and/or MSTP
      2) Modbus TCP and/or RTU
   b. Analog & Digital:
      1) 4-20 mA
      2) 0 to 10 VDC
      3) Scaled pulse

E. Location and Install Requirements
1. The meter shall be located in a readable location, three to five feet off finished floor if possible. Mounting position shall be horizontal.
2. Local Display
   a. A remote flow display (register) will be provided when the meter location prevents direct reading of the meter register from a standing position on grade or finished floor. Remote register shall be installed at 4’ to 5’ above grade or finished floor. Remote register shall be compatible with the installed meter, shall be from the same manufacturer, and shall have a straight reading odometer or digital type display.
3. The meter shall be installed to the manufacturer’s guidelines, accounting for required straight pipe before and after the meter. A flow conditioner may be required to meet these

conditions. Any questions regarding installation shall be referred to the local meter representative for confirmation prior to installation.

4. Required power and mounting shall conform to the manufacturer's recommendations.

F. Acceptable manufacturer and model for natural gas meter products are any of the following:
   1. Onicon F-5100 Series Thermal Mass Flow Meter (inline or insertion).
      a. May be paired with the Onicon D-100 Flow Display for a local indication of data and network interface for BACnet or Modbus.
   2. TRICOR Coriolis Mass Flow Meter
      a. TCM XXXX - Specific series/meter type dependent upon line size, max volumetric flow rate, and max mass flow rate.
      b. TCE 8000-C Compact Version Transmitter with Modbus output option.
   3. Sage Prime Natural Gas Thermal Mass Flow Meter (inline or insertion)

2.04 Domestic and Makeup Water Metering

A. General
   1. If available and approved by the local utility water provider, a pulse signal may be captured by the Data Acquisition Device for 15 minute interval water consumption and flow data from the utility grade meter serving the building.
   2. If additional domestic and make-up water sub-metering is required, a water sub-meter shall be installed for domestic and make-up water metering.
   3. All water meters will be installed per manufacturer guidelines with sufficient pipe run before and after the flow meter for accurate measurements.
   4. Materials which will be wetted shall be made from non-corrosive materials and shall not contaminate water.
   5. Include particulate strainer, isolation valves, and bypass lines where necessary.
   6. Meters shall have a minimum warranty of 2 years.
   7. Meters shall utilize standard 24 VDC power supply. Required power and mounting shall conform to the original equipment manufacturer's recommendations.

B. Type
   1. Basis for design shall be Seametrics MJ-Series Pulse Meter
   2. The water meter shall utilize electromagnetic or ultrasonic (for Onicon), turbine (for Neptune), Seametrics MJ-Series Pulse Meters or Water Signal metering technology.

C. Measurement and Accuracy
   1. The water meter shall perform, at minimum, the measurements defined in Appendix A.
      a. If utilizing an approved Water Signal device, Appendix A does not apply and the only metric necessary to capture is hourly consumption in gallons.
   2. The water meter shall perform to the accuracy standards provided by the original equipment manufacturer.
   3. The turndown ratio of the meter shall be calculated according to the operational flow range of the water line that is being measured.

D. Communications
   1. The water meter shall communicate to the Data Acquisition Device via one of the following protocols:
      a. Serial & Ethernet Communications (preferred):
         1) BACnet IP and/or MSTP
         2) Modbus TCP and/or RTU
      b. Analog & Digital:
         1) 4-20 mA
         2) 0 to 10 VDC
         3) Scaled pulse
      c. Cellular
         1) Cellular communications are only acceptable when utilizing Water Signal devices.

E. Location and Install Requirements
   1. Meters shall be installed to provide easy access for readings, maintenance and repairs.
   2. Meters shall be flanged and valved to permit convenient replacement or calibration of metering device.
   3. Each flow meter shall be equipped with an identification tag indicating the size and location for the specified water line.
   4. Local Flow Display
      a. Flow meters without a digital backlit display for data visualization shall be coupled with a local flow display for viewing captured data metrics and providing additional BACnet and Modbus network communications capabilities.
         1) Local flow display is required only for Onicon meters if applicable.
         2) Local flow display is not required for Water Signal, Seametrics, and Neptune installations.
      b. A remote flow display (register) will be provided when the meter location prevents direct reading of the meter register from a standing position on grade or finished floor. Remote register shall be installed at 4' to 5' above grade or finished floor. Remote register shall be compatible with the installed meter, shall be from the same manufacturer, and shall have a straight reading odometer or digital type display.

F. Acceptable manufacturer and model for domestic and makeup water meter products are any of the following:
   1. Water Signal Device
   2. Onicon - Optional Inline (F-3100 & F-3200 series) and Insertion (F-3500) Electromagnetic Meters, or Clamp-On Ultrasonic (F-4200) Flow Meter
      a. All Onicon meter installations must be approved by KSU Facilities Team.
      b. Onicon F-3200 Inline Electromagnetic Flow Meter - for pipe sizes greater than or equal to 1" in diameter.
         1) F-3200 is the preferred Onicon meter for water (particularly domestic) with low flow parameters. Turndown shall be established at 0.05 feet per second for low end velocity applications.
      c. Onicon F-3100 Inline Electromagnetic Flow Meter - for pipe sizes up to 1" in diameter.
      d. Onicon F-3500 Insertion Electromagnetic Flow Meter - for pipes ranging in size from 3" to 72" in diameter.
         1) May be paired with the Onicon D-100 Flow Display for a local indication of data and network interface for BACnet or Modbus.
      e. Onicon F-4200 Clamp-On Ultrasonic Flow Meter - for pipes ranging in size from ½" to 48" in diameter.
         1) Shall include a visible display of data captured with Modbus RTU communications capabilities.
         2) Appropriate transducers shall be selected based on pipe diameter.
   3. Neptune - Optional TRU/FLO Compound Meter or High Performance Turbine Meter
      a. TRU/FLO Compound Meter - for the following pipe diameter sizes: 2" HP, 3", 4", 6", and 6" X 8"
      b. High Performance Turbine Meter for pipe sizes ranging from 1 ½" to 10" in diameter.
      c. All Neptune meters shall be paired with a Tricon/E3 Transmitter for a digital pulse and analog output to be integrated with the Data Acquisition Device for data capture. A transmitter is required for each register (high and low flow registers for the TRU/FLO Compound Meters).
   4. Seametrics MJ-Series Pulse Meter
      a. Hot or cold water model to be selected based on application.
      b. For the following pipe diameter sizes: ¾", 1", 1 ½", & 2".

2.05 Heating Hot Water (HHW)

A. General

1. A HHW meter shall be installed for heating hot water applications where a boiler is providing hot water for multiple buildings on campus to provide the ability to measure the overall energy consumption of each building.
2. All HHW BTU meters shall be installed per manufacturer guidelines.
3. HHW BTU meters shall have a minimum warranty of 2 years.
4. HHW BTU meters shall utilize standard 24 VDC power supply. Required power and mounting shall conform to the original equipment manufacturer's recommendations.

B. Type
1. Each HHW metering system shall include a flow meter and a BTU energy meter.
2. The HHW BTU meter shall include two temperature sensors, one for supply and one for return, a BTU processor, and BACnet or Modbus network communications capabilities for integration with the Data Acquisition Device.
3. The HHW BTU meter, flow meter, and temperature sensors shall be from the same manufacturer for each installed BTU system.

C. Measurement and Accuracy
1. The HHW BTU meter shall perform, at minimum, the measurements defined in Appendix A.
2. The HHW BTU meter shall measure the total BTUs delivered and used at the building level.
3. The flow meter shall be sized to read at mid-point for the nominal operating system load. The meter shall not be sized for the maximum capacity of the installed system.

D. Communications
1. The HHW BTU meter shall communicate to the Data Acquisition Device via one of the following serial protocols:
    a. Serial Communications:
        1) BACnet MSTP
        2) Modbus RTU

E. Location and Install Requirements
1. HHW BTU and flow meters shall be installed to provide easy access for readings, maintenance and repairs.
2. All HHW BTU meters shall be installed per manufacturer guidelines with sufficient pipe run before and after the flow meter for accurate water measurements.
3. Hot water flow meters shall be flanged and valved to permit convenient replacement or calibration of metering device.
4. Each flow meter shall be equipped with an identification tag indicating the size and location for the specified water line.

F. Acceptable manufacturer and model for HHW BTU meter products are any of the following:
1. Onicon System-10 BTU Meter
    a. Shall include BACnet MSTP or Modbus RTU output communication capability.
    b. Shall include the required temperature sensors for HHW supply and return temperatures.
    c. Shall be paired with one of the following Onicon flow meters:
        1) F-3200 Inline Electromagnetic Flow Meter - for pipe sizes greater than or equal to 1" in diameter.
        2) F-3100 Inline Electromagnetic Flow Meter - for pipe sizes up to 1" in diameter.
        3) F-3500 Insertion Electromagnetic Flow Meter - for pipes ranging in size from 3" to 72" in diameter.
2. Spire Metering Technology
    a. HHW BTU meter shall be one of the following:
        1) SpireMag Series T-Mag Electromagnetic BTU Meter
        2) ThermoPro Series TP10 Ultrasonic Thermal Energy Meter
    b. Shall include BACnet MSTP or Modbus RTU output communication capability.

c. Shall include the required temperature sensors and for HHW supply and return temperatures and flow meter.

3. Flexim Fluxus BTU Meter (aka F704 Series)
   a. Shall include BACnet MSTP or Modbus RTU output communication capability.
   b. Shall include the appropriate ultrasonic transducer components that are dependent on pipe diameter (refer to OEM for further information).
   c. Shall include the required temperature sensors for HHW supply and return temperatures.

2.06 PRESSURE GAGES

A. Manufacturers:
   1. Trerice Model 500X.
   2. Other acceptable manufacturers offering equivalent products: Duro 102, Marsh 103, Palmer 40SPDLH, Weksler BM1, Weiss *AG-1.

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Cast aluminum with phosphor bronze bourdon tube, Stem(flangeless) mounting.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Hydronic Water Scale: Feet-H2O in 2 ft graduations. Scale range shall be so pump suction pressure is above lower 10% and pump discharge is below upper 10% of scale range.

2.07 PRESSURE GAGE TAPPINGS

A. Ball Valve: 1/4 inch, 400 psig WOG, Bronze two piece body, standard port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip, threaded ends.

B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections, as manufactured by Trerice, Model 872,Duro, Marsh, Weksler, Weiss.

2.08 STEM TYPE THERMOMETERS - DIGITAL - LIGHT POWERED

A. Manufacturers:
   1. Trerice Model SX9.
   2. Weiss Model DVU.
   3. Other acceptable manufacturers offering equivalent products: Ashcroft 200-36E, Moeller 706AW, Palmer 9FLA, Weksler A7.

B. Thermometer: Adjustable angle digital thermometer, stainless steel case, light-powered, with well probe adapter.
   1. Size: 7 inch scale.
   2. Display: 9/16", minimum, LCD digits with min./max. readings with reset & C/F switchable.
   3. Range: -40 to 300° F (-40° to 150° C)
   4. Stem: 6 inch brass.
   5. Accuracy: +/- 1°F , or 25% FS.

2.09 TEST PLUGS

A. Manufacturers:
   1. FDI Model Super Seal.
   2. Other acceptable manufacturers offering equivalent products: MG Piping Products Co., Peterson Equipment Co. "Pete's Plug II, Sisco, Trerice, Texas Fairfax, Universal Lancaster.

B. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F. Provide extra-long shaft when mounted on insulated pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flow meters in pipe lines indicated on Drawings with the manufacturer's required straight length of pipe entering and leaving meter.

C. Install pressure gages on hydronic systems with pulsation dampers. Provide ball valve to isolate each gage connection to system. Extend nipples to allow clearance from insulation.

D. Install pressure tappings on piping where specified or shown on flow diagrams and details. Provide valve to isolate each tapping connection to system. Extend nipples to clear insulation.

E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 0943.

F. Provide instruments with scale ranges selected according to service with appropriate scale.

G. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

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

I. Locate test plugs adjacent to thermometers, temperature wells, pressure gages, coil connections, and where shown on flow diagrams and details. Install in 1/2 inch pipe opening(minimum), with bushing.

J. Install test plugs vertical to horizontal. Do not install pointing down.

3.02 SCHEDULE

A. Flow Meters, Location:
   1. Provide annular flow stations where shown on Drawings and Flow Diagrams.

B. Stem Type Thermometers, Location and Scale Range:
   1. Provide thermometers where shown on flow diagrams and details.
   2. Low Temperature Heating Water, 30 to 230 degrees F in two degree divisions.

END OF SECTION