SECTION 23 05 20

THERMAL UTILITY METERS

PART 1- DESIGN DIRECTIVE

1.1 GENERAL

- A. The guidelines of this section define requirements for metering campus hot water and chilled water for building utility monitoring purposes and for metering campus steam and hot water for regional energy transfer stations (ETSs).
- B. Each building included in the project shall be furnished with hot water and chilled water utility meters as needed to monitor building utility consumption. In some instances, utility metering may extend to tenant sub-metering. Consult with Dartmouth's Energy Management Program for project-specific metering requirements.
- C. All regional ETSs shall be furnished with utility-grade hot water, steam condensate, and electric utility meters. Consult with Dartmouth's Energy Management Program to determine whether a steam to HW heat exchanger is considered a regional ETS and requires such metering.
- D. These standards apply to all new meter installs. When modifying an existing meter, the contractor shall attempt to follow these standards as closely as possible. If the existing meter cannot be made to fully adhere to these standards the contractor shall come to an agreement with Dartmouth's Energy Management Program about how to handle all discrepancies.

1.2 DESIGN CRITERIA

- A. Thermal Utility Meters
 - 1. Thermal utility meters shall include a single or dual-channel energy calculator, flow meter, and dedicated matched pair temperature sensors.
 - 2. Thermal utility meters installed on systems that allow bi-directional energy flow shall be specified as being capable of measuring and reporting forward and reverse total energy and energy rate to the Campus Energy Management System (CEMS).
 - 3. All utility meter components, connections, and requirements shall be appropriately sized for the application and clearly detailed in project mechanical, electrical, ATC, and telecom drawings and specifications. Contractor shall provide utility meter vendor with expected minimum and maximum temperatures (in degrees F) and water flow rates (in GPM) for the application and shall size the meter accordingly.
 - 4. Thermal utility meters shall be provided by the Mechanical Contractor for all projects and shall be one of the products listed in Part 2 Products of this guideline. The Mechanical Contractor shall coordinate with other contractors as needed to ensure that the requirements of Part 3 Execution of this guideline are met.
 - 5. Thermal utility meters must be operational and be able to be manually read before utility systems are energized and providing service to the facility.
 - 6. Thermal utility flow meter displays and energy calculators must be located in an easily accessible location. All meter displays and buttons must be read-able and

reachable from the ground without using a ladder. Where meters are not readable from the floor, provide a floor level remote display.

- B. Non-Revenue Flow and Energy Meters
 - 1. Monitoring of non-utility energy and flow (i.e. process energy, medium temperature CHW, domestic hot water) may either follow the requirements of this section or utilize the BAS system. In cases where the BAS system is used, the flow meters shall be in compliance with Section 23 05 19.
- C. Electrical Energy Meters
 - 1. Refer to Section 26 10 00 Electric Metering of these Guidelines for requirements related to metering of electrical usage.
- D. Town Water Meters
 - 1. Refer to section 23 05 19 Meters and Gages for HVAC Equipment of these Guidelines for requirements related to metering of town water.

1.3 COMMUNICATIONS

- A. All thermal utility meters shall communicate in an open protocol or shall terminate into a gateway device, accumulator, or pulse counter that outputs into BACnetIP or Modbus TCP/IP and is connected directly to the campus energy management system (CEMS) via a dedicated energy management VLAN-enabled Ethernet jack.
- B. All thermal utility meters operating on a serial bus must be physically separated from VFD wiring operating over serial communications.
- C. 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.

1.4 SUBMITTALS

A. Product data sheets including construction materials, assembly methods, energy calculator cut sheets, flow meter cut sheets, temperature sensor cut sheets, calibration certificates, manuals, wiring details, and communications details.

1.5 QUALITY ASSURANCE

- A. Comply with applicable UL standards pertaining to meters and gages and with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.
- B. Obtain adequate system information to properly size and locate flow meters and temperature sensors.

PART 2- PRODUCTS

2.1 BUILDING HOT WATER AND CHILLED WATER METERING

- A. Building hot water and chilled water energy metering systems shall include energy calculator, flow meter, and dedicated matched pair temperature sensors and shall be one of the following:
 - 1. Manufacturer: Central Station Steam Company
 - a. Energy Calculator: HEATX-2 dual-channel energy calculator (preferred) or Heat-X single channel energy calculator.
 - b. Flow monitoring: EMAG electromagnetic flow meter sized and specified for the application. In critical low flow or lined pipe measurement applications CMAG may be required consult with Dartmouth Energy Management Program in such instances.
 - c. Temperature sensors: Dedicated matched pair RTD100 class A or better immersion temperature sensors. Temperature sensors shall be provided with calibration certificates.

OR

- 2. Manufacturer: Flexim
 - a. Calculator: Flexim F721 dual-channel energy calculator (preferred) OR Flexim F502TE single-channel energy calculator.
 - b. Flow monitoring: Ultrasonic transducers sized and specified for the application.
 - c. Temperature sensors: Dedicated matched pair RTD100 class A or better immersion temperature sensors. In special circumstances, strap on temperature sensors may be allowed pending review and approval by the Dartmouth College Energy Management Program. Temperature sensors shall be provided with calibration certificates.

2.2 REGIONAL ETS THERMAL UTILITY METERING

- A. Regional ETS steam condensate meters shall include energy calculator, flow meter, and dedicated matched pair temperature sensors and shall be as follows:
 - 1. Manufacturer: Central Station Steam Company
 - a. Calculator: HEATX-2 dual-channel energy calculator
 - b. Flow monitoring: CMag electromagnetic flow meters sized and specified for the application. One CMag shall measure ETS hot water supply flow and the second shall measure the ETS pumped condensate flow.
 - c. Temperature sensors: Dedicated matched pair RTD100 class A or better immersion temperature sensors on ETS hot water supply and return lines and on steam supply and pumped condensate return lines. Temperature sensors shall be provided with calibration certificates.

PART 3- EXECUTION

3.1 GENERAL

- A. Install meters as per manufacturer's requirements and in conformance with the requirements detailed below and the diagrams at the end of this section.
- B. Meter start-up, configuration, and commissioning shall be coordinated by the Mechanical Contractor and done by meter manufacturer or by Dartmouth College Energy Management Program approved manufacturer's representative.
- C. Meter commissioning to be verified by the project commissioning agent and Dartmouth College Energy Management Program prior to building turn over.
- D. The Mechanical Contractor shall provide as-built drawings showing the location of each meter and associated sensors and all O&M documentation for the meters to the Dartmouth College Energy Management System Engineer.

3.2 ENERGY METER OUTPUTS

A. Energy meters shall be factory-programmed to provide the following outputs to the campus energy management system (CEMS):

			Steam
Output	CHW Unit	HW Unit	Condensate
Energy	Ton-hrs	kBtu	kBtu
Power	Tons	kBtu/hr	kBtu/hr
Flow Rate	GPM	GPM	GPM
Total Flow	Gallons	Gallons	Gallons
Delta Temperature	°F	°F	°F
Supply Temperature	°F	°F	°F
Return Temperature	°F	°F	°F

B. Thermal utility meters installed on systems that allow bi-directional energy flow shall output both forward and reverse total energy and energy rate to the CEMS.

3.3 SCOPE OF WORK

A. Unless otherwise specified the Mechanical Contractor (Div 23) shall be responsible for providing the energy or consumption meter and the associated calculator and is responsible for coordinating with other trades to ensure that the meter and associated equipment is installed and working properly, even if another trade will be installing a component of the system.

B. MECHANICAL REQUIREMENTS

- 1. Flow meters and temperature sensors shall be installed by the mechanical contractor in locations detailed on drawings and in conformance with manufacturer's written instructions, with particular attention paid to pipe configuration and minimum straight run requirements for flow meters.
- 2. All in-line flow meters shall include isolation valves upstream and downstream of the meter.

23 05 20 – Thermal Energy Utility Meters

C. ELECTRICAL POWER AND WIRING REQUIREMENTS

- 1. All wiring shall be installed as per meter manufacturer's requirements and shall comply with the Electrical Division of these Guidelines.
- 2. Energy calculator and flow meter shall be provided with 120V power as required by manufacturer's specifications. 120V circuit should be from dedicated breaker and fed from emergency power if available. Alternative power wiring may be considered with prior approval from Dartmouth College Energy Management Program.
- 3. All wiring shall be in conduit.

D. ATC AND LOW VOLTAGE WIRING REQUIREMENTS

- 1. ATC contractor shall provide all low voltage wiring between energy meter system components as per manufacturer's requirements.
- 2. All wiring shall be in conduit.
- 3. Energy metering system shall have one 4-20mA flow output per measurement channel wired to BAS controller and reported on BAS graphics.

E. TELECOM AND COMMUNICATION REQUIREMENTS

- 1. Each energy calculator shall employ Modbus TCP or BACnetIP and be connected directly to the campus energy management system (CEMS) via a dedicated Ethernet jack.
- 2. Each energy meter shall be connected to the campus energy management VLAN. IP address/subnet mask/gateway/Bacnet ID assignment to be coordinated with Dartmouth College BAS shop.
- 3. All meters must be installed and working on site before project can be turned over.



Dartmouth College – Ultrasonic Energy Meter Installation Detail



Dartmouth College - In-Line Magnetic Energy Meter Installation Detail



Dartmouth College – Regional ETS Condensate Meter Installation Detail

END OF SECTION 23 05 20