

## 33 0900 | Utility Metering

The University of Kentucky has established the requirement to measure and report the distribution of utilities across the University of Kentucky Campus. This standard is intended to ensure that design teams provide clear guidance for the selection and installation of metering devices for consistent accuracy, integration, and data collection. The University of Kentucky has identified preferred meter measurement technologies by utility, providing options to address specific challenges with a multi-generational campus and facility infrastructure.

Electricity shall be metered to the facility and major sub-load level, along with centrally produced steam and chilled water. These utilities are metering priorities with the goal of 100% accountability for UK distributed utilities. Additionally, condensate flow metering has been established for Central Plant condensate return percentage, and as a proxy for steam flow measurement at the facility level. All related utilities including domestic water, irrigation, natural gas, shall also be metered as part of a facility renovation or new construction.

In new construction and major renovations, design teams must ensure that metering is specifically addressed. Steam, Chilled Water and Natural gas meter locations must be specified in the design documents, establishing a minimum of 10 upstream and 5 downstream pipe diameters with appropriate clearance for installation and maintenance of the preferred metering selection. Meter installations must be done in accordance with the selected meter manufacturer's instructions. The design documents shall include details indicating piping arrangements and piping accessories required for each specified meter. A formal request must be made and approved by the UK Project Manager and UEM Engineering Team to deviate from these instructions.

New or replacement meter installations in existing facilities must be evaluated in accordance with the matrix provided by the UK Utilities & Energy Management (UEM) Engineering team, to identify the meter that best serves UK metering priorities for accuracy, serviceability, reliability, communication, data collection, and cost effectiveness.

Design teams shall include the meters and their integration in the Instrumentation and Control (IC) drawings, **ensuring compliance with the UK Integrated Automation**. Meters shall be shown on the system architecture plans which should include IP or MSTP connections and any required power. Required control points shall be shown on a points list. Meters shall also be shown on the mechanical piping/plumbing plans. All required power and data drops shall also be shown on their respective plans.

While UK Metering Standards have been established to meet performance expectations, special or extenuating circumstances may exist that warrant further evaluation. Design teams and contractors are responsible for adherence to the established UK Standards unless specifically evaluated and approved by the UK Project Manager and UEM Engineering.

### Meter Installation, Communication and Validation

With all new construction/renovation projects, the Prime Contractor (PC) will be responsible for new meter installation in accordance with the design team and meter manufacturer's requirements specific to the installation. The PC will be responsible for coordinating mechanical/electrical installation, including connection and communication to UK BAS infrastructure. Meter communication will be either BACnet IP or BACnet MSTP. When IP data connections are required, the PC will be responsible for the formal IP requests to the UK Project Manager.

The PC will coordinate with the design and controls teams to validate meter data collected and establish BAS trending per UK standards for each meter type and application. When commissioning services are

included in a project, the commissioning team will be required to confirm data validation, communication and BAS trends established.

**Trending Requirements** - all utility trend data to be captured by the UK BAS system with a minimum of 18 months of data accessible for analysis from the BAS system. Historical trend database must also be established to maintain all utility meter data to a minimum of 5 years contiguous data by utility.

## Steam and Condensate Flow Measurement

Any facility or significant process load connected to the UK Central Steam System must be metered for steam consumption with the flow and consumption data reported to the university BAS systems infrastructure for trending and historical reference.

Steam consumption should be directly metered with an application specific meter selected in accordance with the “Steam Flow Meter Selection Matrix” (Appendix A) and the approved meter manufacturers list (*fig a*).

### UK Approved Steam and Condensate Meters (*fig. A*)

<b>Steam Flow Measurement</b>			
<b>Meter Manufacturer</b>	<b>Measurement Technology</b>	<b>Model</b>	<b>Required Auxiliaries</b>
Armstrong	Differential Pressure	Veris – Accelabar <b>(no straight run required)</b>	HART-BacNet Gateway
Armstrong	Differential Pressure	Veris - Verabar	HART-BacNet Gateway
Armstrong	Vortex Shedding	AVF – V3 Multivariable (In-line)	
Armstrong	Vortex Shedding	AVI – V3 Multivariable (Insertion)	
Vortek	Vortex Shedding	Vortek Pro-V M22-VTP Multivariable (In-line)	
Vortek	Vortex Shedding	Vortek Pro-V M23-VTP Multivariable (Insertion)	
Onicon	Vortex Shedding	F-2600 (In-line) (Applicable for line size $\geq 1/2$ " Saturated Steam Only	
Onicon	Vortex Shedding	F-2700 (Insertion) (Applicable for line size $\geq 3$ " Saturated Steam Only	
<b>Condensate Flow Measurement</b>			
Flexim	Ultrasonic	Fluxus 532	
Vortek	Ultrasonic	SonoPro Model S36	
Onicon	Electromagnetic	FT-3000 (PTFE Liner and Remote electronics required)	

### Steam and Steam Condensate Meter Sizing, Selection and Installation

Each of the recommended meter manufacturers support sizing selection for their respective meters based on the designed and/or anticipated flow range for each meter application. The Design Team must provide a design flow range for each meter application to include maximum, minimum, and median anticipated steam flows. Design flows will be used to identify the best fit metering technology and sizing for each meter installation.

## Condensate Meter Applications

**Main Condensate Return** - Condensate metering shall be required for strategic points in the UK Central System Condensate Return. Meter locations are selected to establish condensate return from main distribution branches to coincide with steam flow measurement in corresponding locations. Main Condensate Return trends shall be established for each branch of the steam system distribution main in gallons per hour and steam equivalent pounds per hour (lbs/hour) for direct comparison to the corresponding branch line steam flow.

**Building Level Condensate Metering** - condensate metering may be established as a proxy measurement for steam flow in existing facilities. Smaller facilities with minimal steam loads may be most effectively metered by measuring and totalizing condensate by the hour. The UK UEM Engineering Team may determine this to be an adequate representation of minimal consumption and a cost-effective metering application.

Building level condensate metering is also currently specified for larger facilities where steam is measured directly. In these applications the condensate return trend will be compared to the steam consumption trend for measurement validation and as an indicator of condensate return percentage. The UK approved condensate meter options are all capable of bi-directional flow measurement and must be configured to indicate and trend negative flow in the connected UK BAS system.

## Steam Flow Trends

To be established in 5-minute intervals where minimum flow remains consistently at or above 10% of the meter selected minimum flow. Where steam flow is inconsistent due to extreme summer/winter load diversity or where steam load is cyclic by nature, totalizing trends should be established. Accumulating steam flow should be totalized hourly and written to the database as pounds per hour (lbs/hr) steam flow.

**Building Condensate flow** is cyclic by nature, condensate flow measured in gallons per minute (gpm) should be established as an accumulating trend with an hourly totalized flow in gallons written to the database. A parallel trend should be established converting hourly accumulated gallons of condensate to the steam equivalent in pounds mass steam per hour (lbs/hr) steam flow. Condensate meters installed on **plant main branch return lines** that measure consistent flow at or above 5 gpm (adj) should record 5-minute flow trend data. Inconsistent condensate flow at any location should default to accumulating, hourly totalized trends.

UK approved condensate meters read bidirectional flow. Negative condensate flow should be established as a secondary trend accumulating total negative flow hourly in gallons. An alarm should be established in the BAS system when negative flow exceeds 2 gallons (adj) in one hour. Negative flow is indicative of failed or failing condensate discharge check valves.

## Chilled Water Flow and BTU Measurement

Any facility or significant process load connected to the UK Central Chilled Water Distribution System must be metered for chilled water flow. Each meter installation must be connected and report 5-min interval instantaneous flow data to the university BAS system's infrastructure for trending and historical reference.

Temperature sensors shall be bath-calibrated and matched (NIST\* traceable) for the specific temperature range of each application. Sensors will be inserted into flow stream via thermo-well. The calculated differential temperature used in the energy calculation shall be accurate to within +0.15°F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations). Surface clamp-on temperature probes shall not be permitted.

BTU calculations will be made in the field at the metering device and passed on to the BAS, along with flow and temperature readings, for trending. Calculated BTU, flow, supply and return temperatures shall be communicated via BACnet and captured in individual 5-minute trends by the UK BAS system.

The BAS system will manage and display Chilled Water Data in multiple formats:

- The input variables for each BTU calculation (measured flow, supply and return temperatures) must be independently displayed with trends established.
- Chiller plant data will be calculated and displayed in "Tons" such that total plant and individual chiller capacity are displayed with trend established.
- Individual chiller efficiency in KW/Ton will be calculated and trends established.
- Facility or process level loads should have calculated BTU displayed.

### UK Approved Chilled Water/Hot Water Meters (*fig. B*)

<b>Chilled Water/Hot Water Flow Measurement</b>			
<b>Meter Manufacturer</b>	<b>Measurement Technology</b>	<b>Model</b>	<b>Required Auxiliaries</b>
Flexim	Ultrasonic-time transit	Fluxus 532 BTU Meter	BACnet comm specified IP or MSTP
Flexim	Ultrasonic-time transit	Fluxus 721 BTU Meter (Dual Channel Option)	BACnet comm specified IP or MSTP
Vortek	Ultrasonic-time transit	Vortek S36 BTU Meter	BACnet comm specified IP or MSTP
Onicon	Magnetic	FT-3000 In-line Magnetic BTU Meter	BACnet comm specified IP or MSTP
Onicon	Magnetic	FT-3500 Insertion Magnetic BTU Meter	BACnet comm specified IP or MSTP

## Natural Gas Flow and BTU Measurement

Natural gas flow and total consumption shall be metered across the University of Kentucky Central Plant and Facilities infrastructure.

Each of the recommended meter manufacturers listed in the UK Approved Natural Gas Meter list (*fig. C*) supports sizing selection for their respective meters based on the designed and/or anticipated flow range for each meter application. The Design Team must provide a design flow range for each meter application to include maximum, minimum and median anticipated gas flows. Design flows will be used to identify the best fit metering technology and sizing for each meter installation.

Meter installations must be done in accordance with the selected meter manufacturer's instructions. A formal request must be made and approved by the UK Project Manager and UEM Engineering to deviate from these instructions.

**Natural gas flow trends in cubic feet per minute** to be established in 5-minute intervals where minimum flow remains consistently at or above 10% of the selected meter minimum flow. Where gas flow is inconsistent, cyclic by nature, or where **Pulse technology meters** are selected, totalizing trends should be established. Accumulating gas flow should be totalized hourly and written to the database as cubic feet per hour.

### UK Approved Natural Gas Meters (*fig. C*)

Natural Gas Flow Measurement			
Meter Manufacturer	Measurement Technology	Model	Required Auxiliaries
Emerson Micro Motion	Coriolis	Micro Motion F Series Coriolis <b>(no straight run required)</b>	HART-BacNet Gateway
Armstrong	Differential Pressure	Veris – Accelabar <b>(no straight run required)</b>	HART-BacNet Gateway
Armstrong	Differential Pressure	Veris - Verabar	HART-BacNet Gateway
Armstrong	Vortex Shedding	AVF – V3 Multivariable (In-line)	
Armstrong	Vortex Shedding	AVI – V3 Multivariable (Insertion)	
Vortek	Vortex Shedding	Vortek Pro-V M22-VTP Multivariable (In-line)	
Vortek	Vortex Shedding	Vortek Pro-V M23-VTP Multivariable (Insertion)	
Honeywell	Rotary	Honeywell - Elster RABO (Pulse output included)	
Honeywell – American Meter	Diaphragm	AL-425	IMAC Pulser Type 1 & Type 1A

## Domestic, Irrigation, and Make-up Water Flow and Totalization

Domestic water taken from the utility to include potable water, irrigation, and plant make-up must be metered with representative trends established in the UK BAS system.

In select applications, UK UEM Engineering may request a shared signal output from a utility owned meter. With approval and support from the utility provider a pulse output may be established for integration with the UK BAS system.

When independent metering is required or preferred, UK metering options include time-transit ultrasonic meters as approved for chilled and hot water applications but also include utility grade turbine meters. The turbine meters listed in the UK standard have available pulse output configurations for integration with the UK BAS system.

**Domestic, Irrigation, and Make-up Water flow trends** shall be established as accumulating water flow in gallons, totalized hourly and written to the database as gallons per hour.

### UK Approved Domestic Water Meters (*fig. D*)

<b>Domestic, Irrigation and Make-up Water Flow and Totalization</b>			
<b>Meter Manufacturer</b>	<b>Measurement Technology</b>	<b>Model</b>	<b>Required Auxiliaries</b>
Flexim	Ultrasonic-time transit	Fluxus 532	BACnet comm specified IP or MSTP
Flexim	Ultrasonic-time transit	Fluxus 721 (Dual Channel Option)	BACnet comm specified IP or MSTP
Vortek	Ultrasonic-time transit	Vortek S36	BACnet comm specified IP or MSTP
Sensus	Turbine	Omni+ Turbo (T <sup>2</sup> ) Water Meter	Omni+ Electronic Register
Badger	Turbine	Recordall Turbo Series	XMT Pulse Transmitter

## Electric Metering and Meter Data Collection

University projects vary in size and scope between new construction/major renovation and existing systems upgrade. The University of Kentucky requires 100% accountability for electric utility consumption and data collection. UK Electric Metering is divided into two distinct categories: **Facility and High Voltage Substation**.

**Facility-Level** – to include building main, sub-metering, and select major loads such as chillers.

The UK Utilities and Energy Management Team has provided a list of UK-approved Facility Level electric meter options for new construction, renovation, and digital upgrade opportunities (see *figure E*).

**High Voltage Substation** – defined as 69kV-to 12kV, main campus service entry distribution. High Voltage Substation expansion, new construction, repair, or renovation projects must specify new metering to match existing substation infrastructure. Any additional or replacement substation meters will be **Schneider METSEPM8244** with a dedicated 4-wire RS-485 communication module **METSEPMRS-485W**.

The design team must ensure that design documents outline the electric metering requirements as provided by the UK Utilities and Energy Management Team, and the High Voltage Electrical Manager to include meter installation, set-up, validation and communication.

- **Facility Level** metering will connect and communicate with the UK Tridium BAS.
- **High Voltage Substation** metering will connect and communicate with the existing Schneider PowerLogic infrastructure.

Design documents will require electrical load projections for initial occupancy and (10) year growth to the capacity of the electrical gear. Multi-tap current transformers shall be specified along with fuse and shorting blocks.

Meter upgrade projects in existing facilities will require a shutdown inspection to verify the existing CT/PT ratios for connection to the new digital meter.

The Electrical Contractor must ensure that each meter is installed, adjusted, and calibrated by a trained instrument technician with factory support as required for successful start-up and data collection integration. When commissioning services are included in a project, the commissioning team will be required to confirm data validation, communication, and trends established.

Electrical meters must be connected and report 5-min interval instantaneous consumption data in kilowatt-hours (kWh), and demand in kilowatts (kW), expressed as a per hour rate. Facility Level electrical data reporting to the UK BAS systems, and High Voltage Substation data reporting to the Schneider PowerLogic system for trending and historical reference.

**UK Approved Electric Meters (fig. E)**

<b>Electric Metering and Data Logging</b>			
<b>Facility Level</b>			
<b>Meter Manufacturer</b>	<b>Measurement Technology</b>	<b>Model</b>	<b>Required Auxiliaries</b>
SATEC	Digital Electric	SATEC Pro Series PM335/EM235	ProtoCom Protocol Gateway for BACnet Communication
SATEC	Digital Electric	SATEC EM920 Under Glass Retrofit	ProtoCom Protocol Gateway for BACnet Communication
Electro Industries	Digital Electric	Shark 250	ProtoCom Protocol Gateway for BACnet Communication
Electro Industries	Digital Electric	Shark 270 Under Glass Retrofit	ProtoCom Protocol Gateway for BACnet Communication
Eaton	Digital Electric	PXM	ProtoCom Protocol Gateway for BACnet Communication
Schneider Electric	Digital	PM5563	BACnet/IP
<b>High Voltage Substation</b>			
Schneider	Digital Electric	METSEPM8244	Dedicated 4-Wire Comm Module METSEPMRS4854W

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