

HVAC Flow and Energy Measurement

MASTER

About ONICON

- Founded 1987 in Clearwater, Florida
- Shifted focus to HVAC building controls market in early 1990's
- Recognized throughout the HVAC controls industry for innovation and outstanding service
- Became a part of TASI Flow Group in April 2019
- Manufactures flow instruments for:
 - Liquid Flow
 - Steam Flow
 - Natural Gas Flow
 - Thermal Energy Measurement



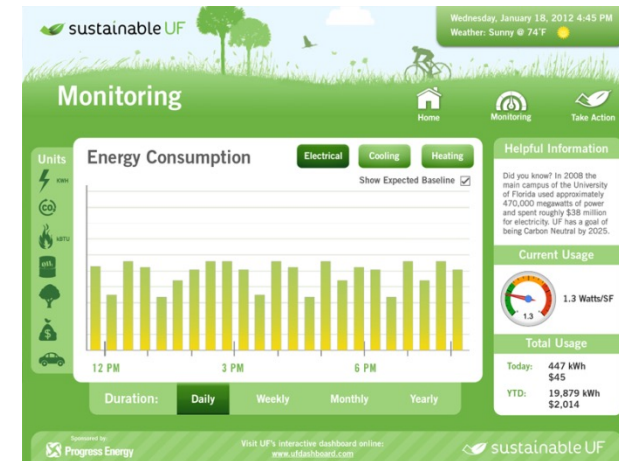
Why Measure Flow?

*To control something, you must first
measure it...*

Lord Kelvin

Why Measure Flow?

What's Driving the Need to Measure Flow in Today's HVAC Applications?



What Makes ONICON Different?

The ONICON Difference is

















- Engineered solutions configured to your specifications, individually wet-calibrated to NIST traceable standards
- Highly trained, applications and technical support engineers
- Unparalleled customer service
- Global independent rep network
- Industry leading warranty
- Repair and calibration services



MANUFACTURED WITH **PRIDE** AND **PRECISION**

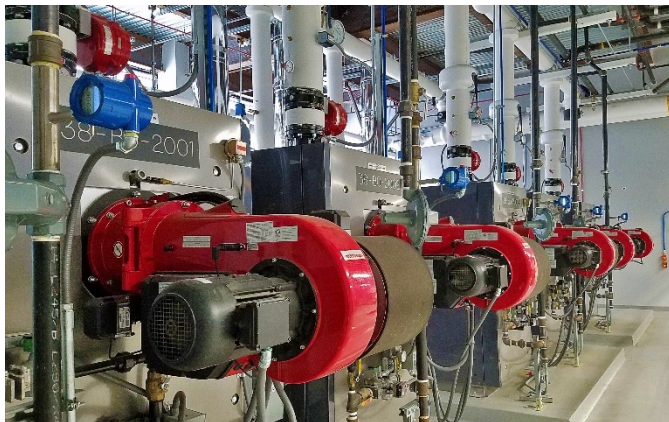


ONICON Family of Products

TURBINE FLOW METERS (LIQUID)		ELECTROMAGNETIC FLOW METER (LIQUID)			DISPLAY MODULE
F-1000 Series  Bluetooth® Single / Dual Turbine Insertion Flow Meter		FT-3000 Series  Inline Electromagnetic Flow Meter	F-3500  Insertion Electromagnetic Flow Meter	FSM-3 Series SuperMag  Insertion Electromagnetic Flow Meter	D-100 Network Display  Flow Display with Network Interface
FLOW METERS (STEAM)			ULTRASONIC (LIQUID)		
F-1500  Insertion Turbine Flow Meter	F-2000 Series  Inline Vortex Flow Meter		 Insertion Vortex Flow Meter	F-4300  Clamp-on Ultrasonic Flow Meter	F-4400  Portable Clamp-on Ultrasonic Flow Meter
				F-4600  Inline Wetted Ultrasonic Flow Meter	
THERMAL MASS FLOW METERS (GAS)			BTU METERING SYSTEM (LIQUID)		
F-5000 Series  Threaded Inline Thermal Mass Flow Meter			 Insertion Thermal Mass Flow Meter		
			System-10 BTU Meter 	System-20 BTU Meter 	System-40 BTU Measurement System 

ONICON Has the Products to Meet Your HVAC Flow Measurement Applications

- Chilled Water
- Hot Water
- Condenser water
- Steam
- Natural Gas
- Compressed Air
- Domestic Water
- Make-up
- Blowdown
- Steam Condensate
- HTHW
- And More!



Applications

Campus Environments & Mixed Use Buildings

Accurate Flow & Energy Measurement Provides:

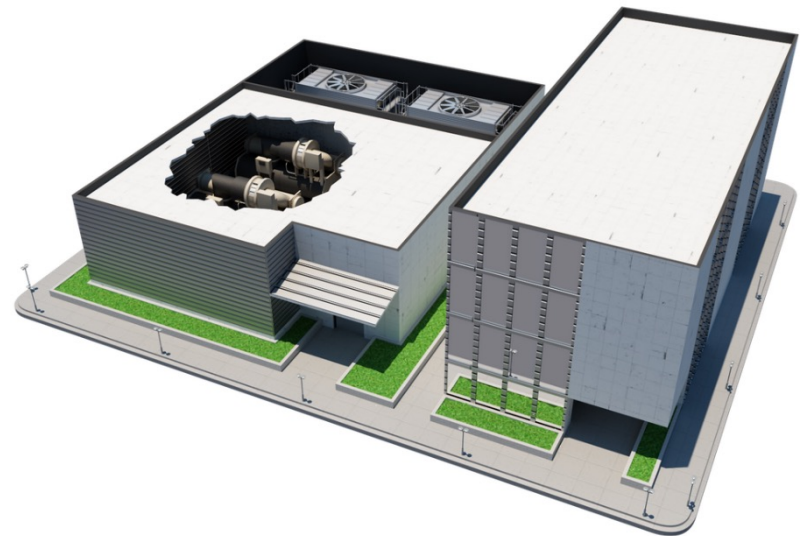
- Basis for cost allocation
- Growth planning
- Real-time commissioning and balancing data
- Basis for LEED® points
- Promotes conservation



Applications CEP/Utility

Accurate Flow & Energy Measurement Provides:

- Information required for complex CEP optimization sequences
- Base-line operational information - required for growth planning
- Real-time commissioning and balancing data
- Basis for LEED® points

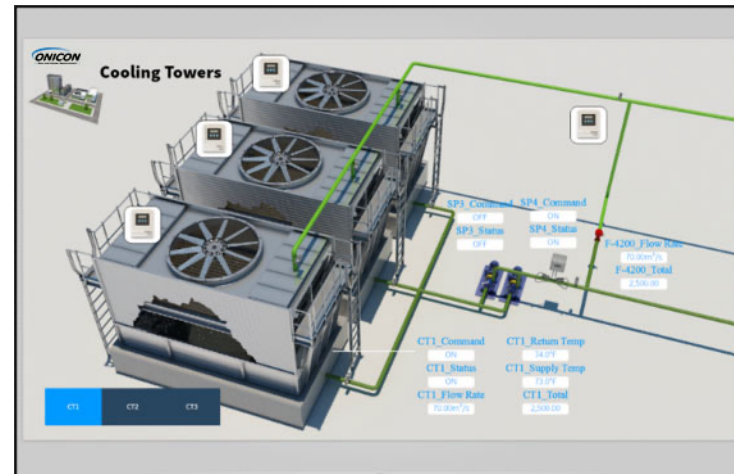
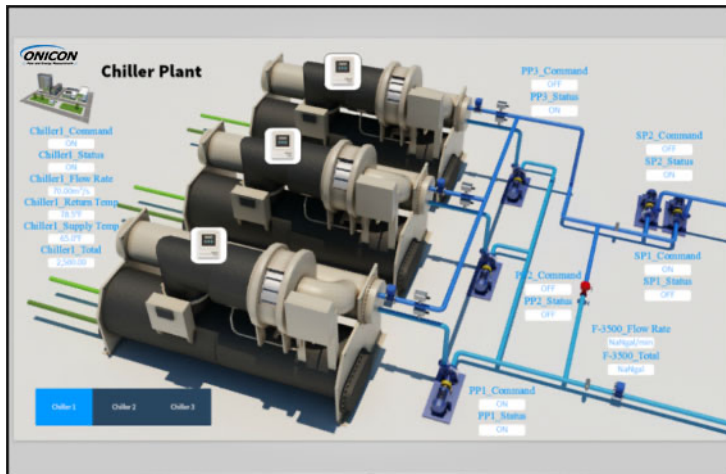


Applications

CEP/Utility Building

Accurate Flow & Energy Measurement Provides:

- Accurate kW/TON monitoring
- Accurate in-service boiler efficiency monitoring
- Chiller/boiler staging



Natural Gas HVAC Applications



- Continuous boiler monitoring for maintenance and in-service efficiency calculations
- Sub-metering/cost allocation
- Real-time commissioning and balancing data
- Basis for LEED[®] points

Wet-Calibration



- Wet calibration - the flow meter was placed in and calibrated for the actual conditions under which it will operate
- All ONICON intrusive flow meters are wet-calibrated

Definitions and Relationships

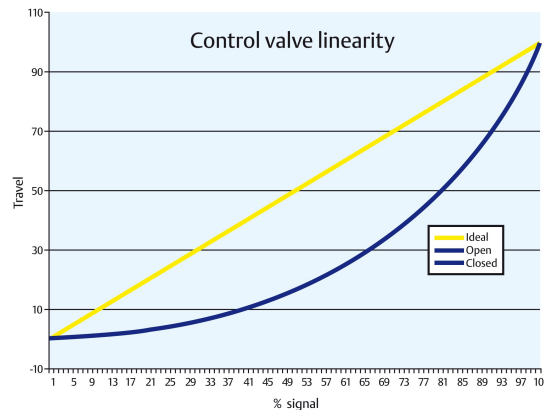
Accuracy



Repeatability



Linearity



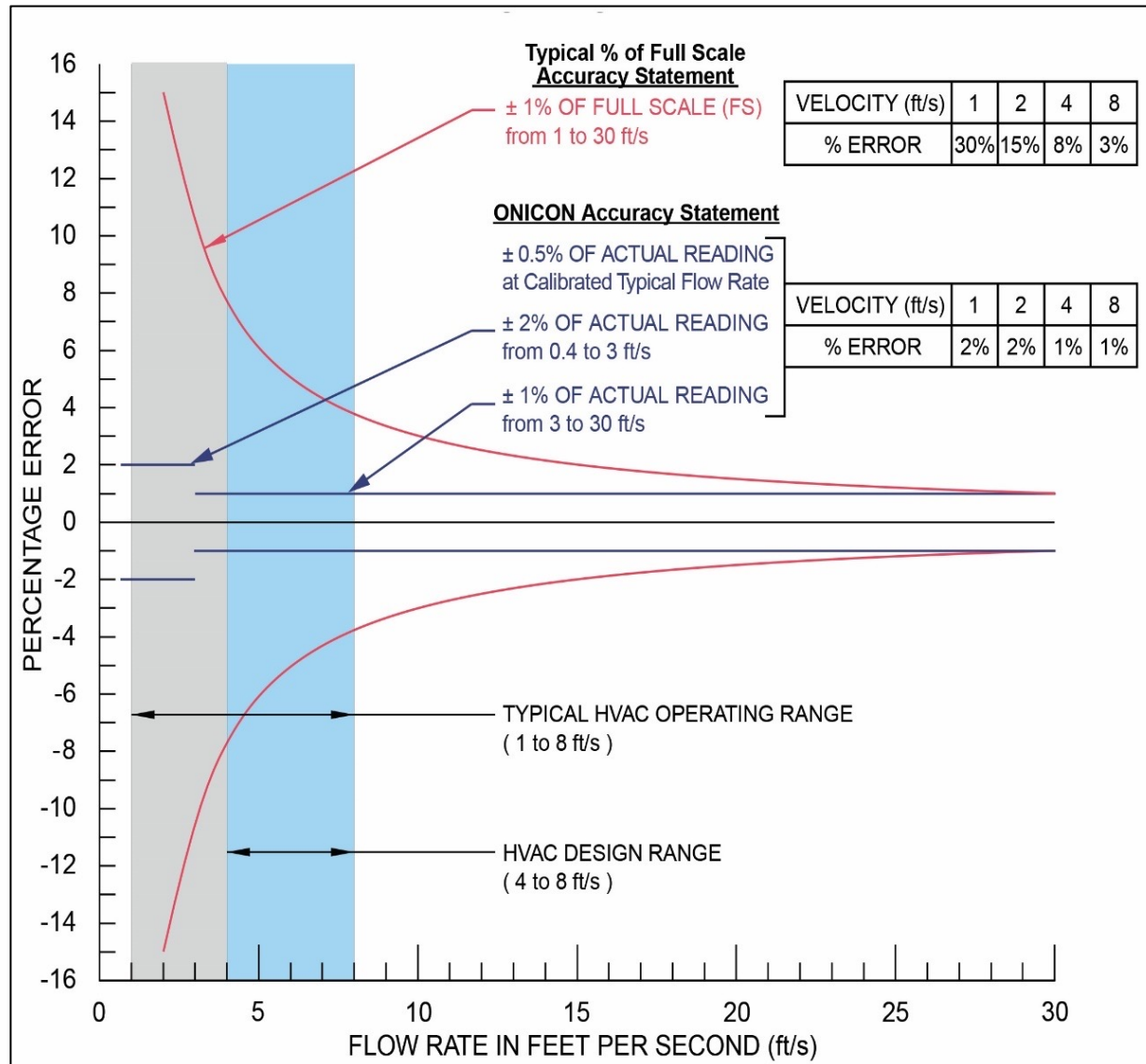
Definitions and Relationships

Turndown – the instrument range specified as a ratio of high measured value to low measured value

Effective Turndown – the instrument range as related to the maximum flow of the specific application

(i.e.; 1-30 ft/s = 30:1 turndown flow at 4 ft/s max yields a 4:1 effective turndown)

Comparison of Accuracy Statements

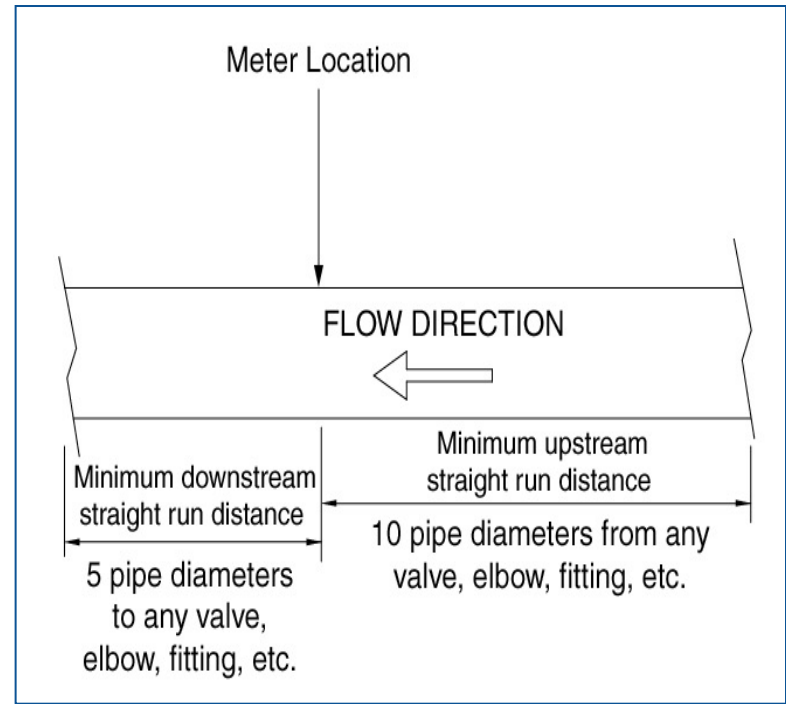


Straight Pipe Run Requirements



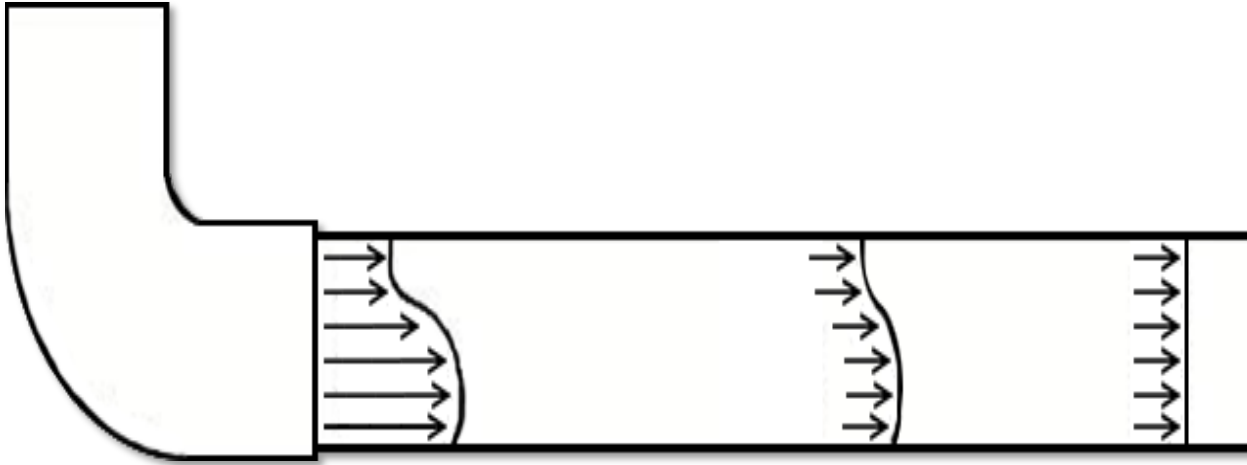
Straight Pipe Run Requirements

Most flow meters require minimum lengths of straight pipe before and after the meter location to maintain accuracy



Example of a straight pipe run recommendation statement

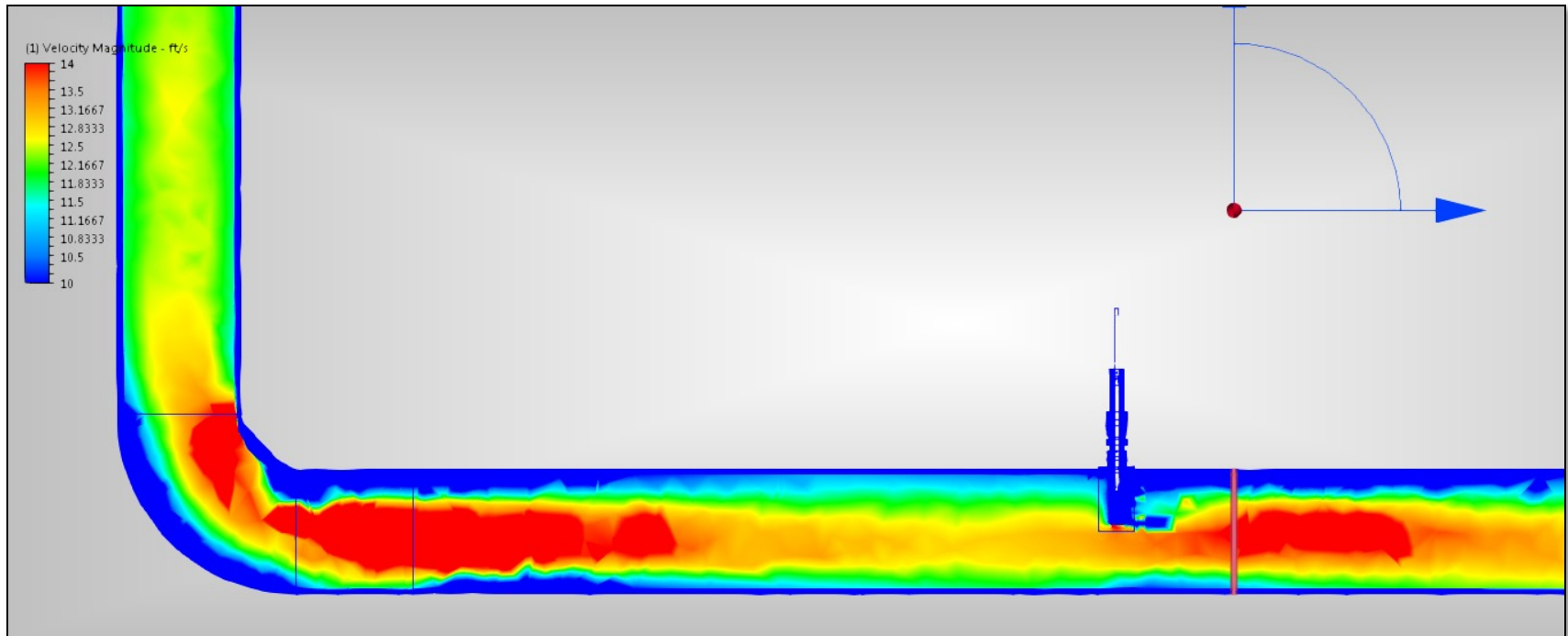
Velocity Profile of Water in Pipes



- Velocity profile is distorted by pipe obstructions and direction changes
- Friction from the pipe wall “conditions” the velocity profile, eventually flattening the profile (based on velocity and viscosity typically found in HVAC applications)

Velocity Profile of Water in Pipes

10" Single Bend 7D High Contrast



Straight Pipe Run Requirements

Minimum upstream dimensions depend on the type of pipe obstruction

AVOID THESE:

- ❖ Control Valve
- ❖ Inflowing Tees
- ❖ Multiple Bends Out of Plane
- ❖ Multiple Bends In Plane

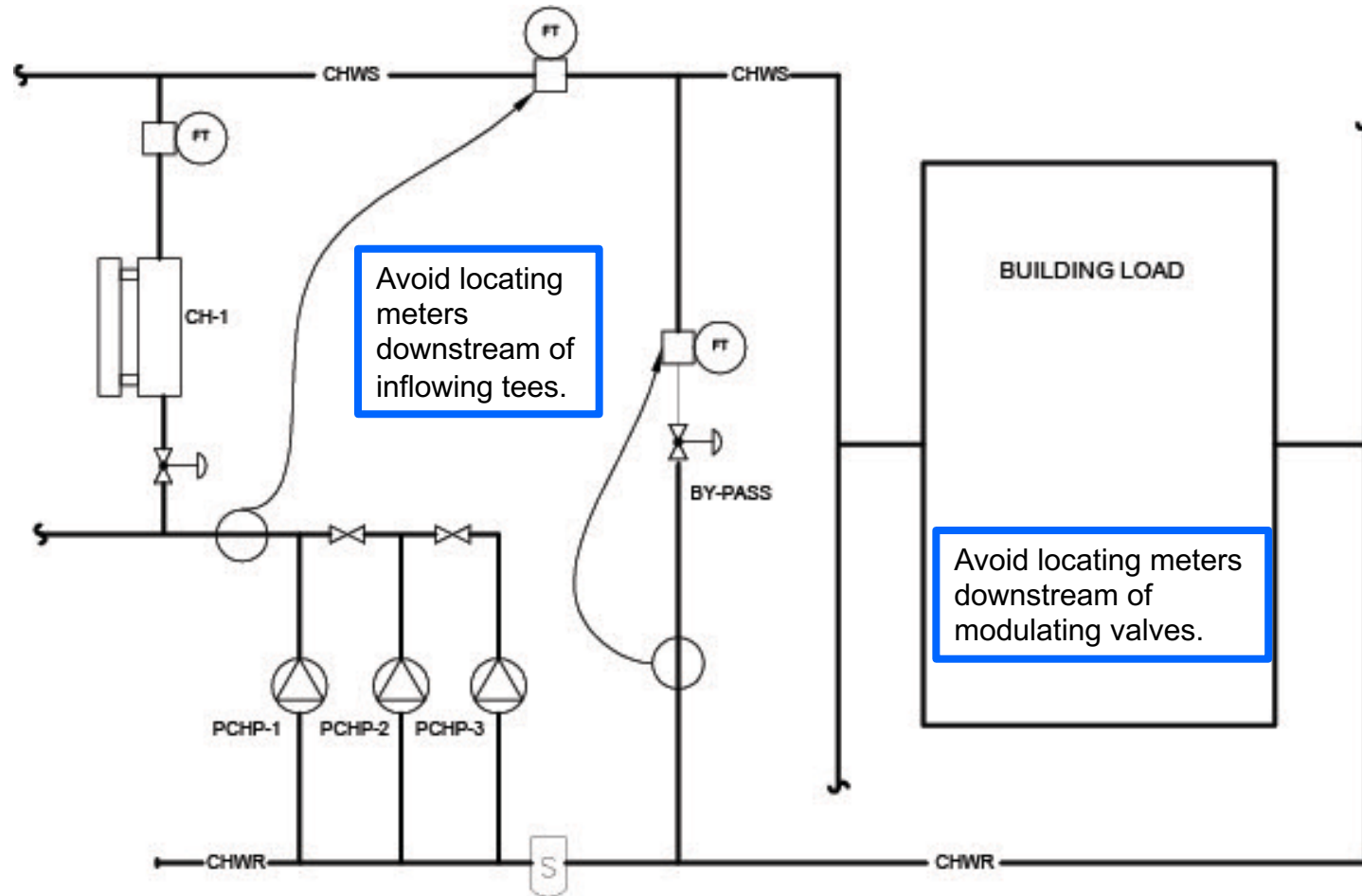
THESE ARE WORKABLE:

- ❖ Outflowing Tees
- ❖ Pipe Reduction or Enlargement
- ❖ Single Bend

IDEAL:

- ❖ Straight Pipe

Locating Meters



Engineered Solutions



READY TO GO...

ONICON meters are wet-calibrated and configured to your specifications, right out of the box.

- Every meter is custom-built to the customer's application
- Typical Outputs
 - Instantaneous flow rate (GPM) requires analog signal, 4-20mA, 0-10 or 0-5 VDC typical
 - Totalization of flow (gallons) requires pulse output; dry contact is typical
 - Serial communications, multi-variable outputs

BACnet® LONWORKS® MODBUS® Apogee® Metasys®

ONICON Family of Products

TURBINE FLOW METERS (LIQUID)

F-1000 Series



ELECTROMAGNETIC FLOW METER (LIQUID)

FT-3000 Series



F-3500



FSM-3 Series SuperMag



DISPLAY MODULE

D-100 Network Display



Flow Display with
Network Interface

FLOW METERS (STEAM)

F-1500



F-2000 Series



ULTRASONIC (LIQUID)

F-4300



F-4400



F-4600



THERMAL MASS FLOW METERS (GAS)

F-5000 Series



BTU METERING SYSTEM (LIQUID)

System-10 BTU Meter



System-20 BTU Meter



System-40 BTU Measurement System



Measuring Energy (BTUs)

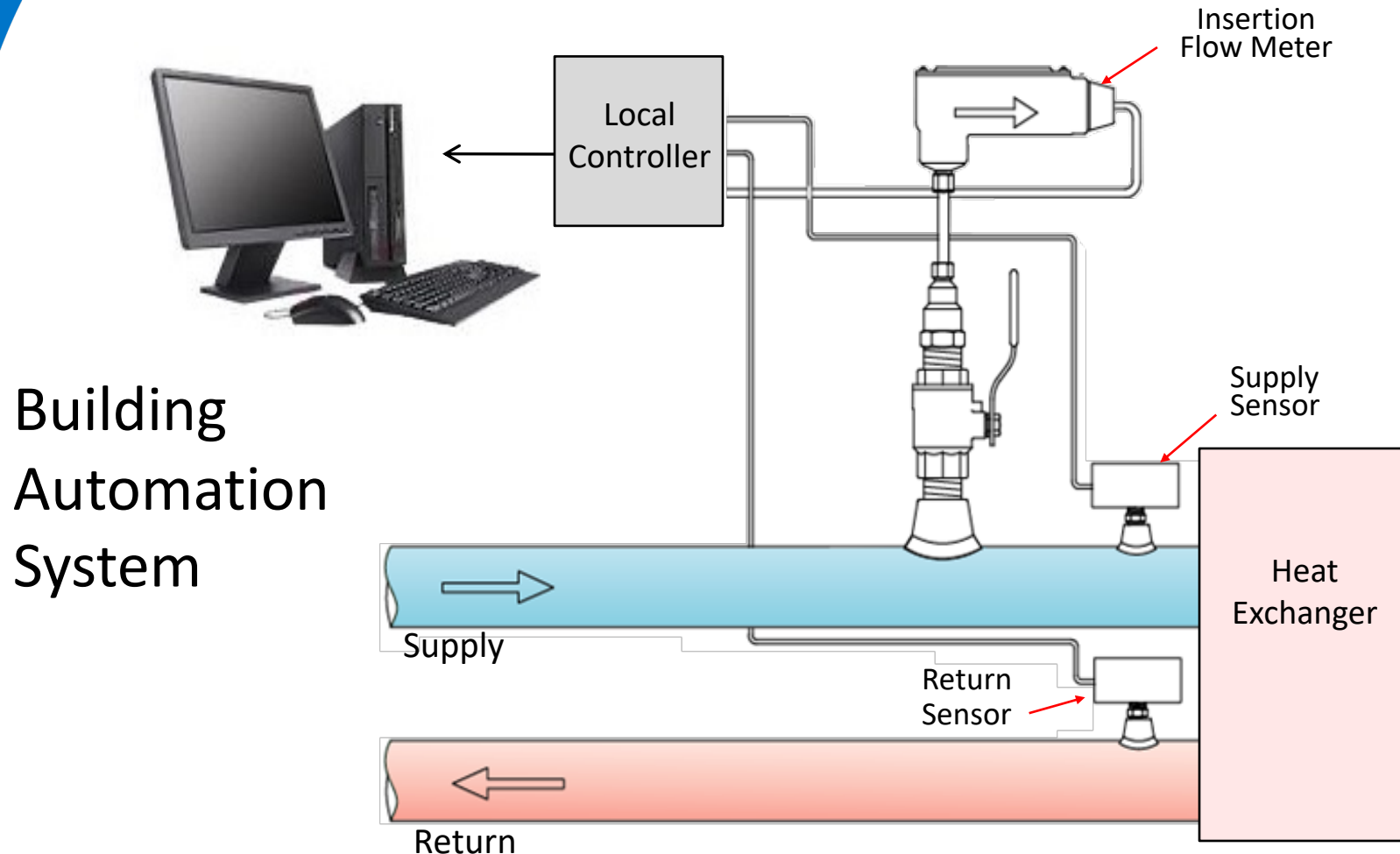
Energy Rate = Specific Heat x Mass Flow Rate x Delta-T

Energy Rate = Specific Heat x Volume Flow Rate x Density x Delta-T

$$\dot{Q} \left(\frac{BTU}{Hr} \right) = C_p \left(\frac{BTU}{Lb^{\circ}F} \right) * \dot{v} \left(\frac{Gal}{Min} \right) * \rho \left(\frac{Lb}{Ft^3} \right) * \left(\frac{.1337 Ft^3}{Gal} \right) * \left(\frac{60 Min}{Hr} \right) * (T_2 - T_1)(^{\circ}F)$$

Energy Measurement in Hydronic Systems

Traditional Approach



Energy Measurement in Hydronic Systems

Traditional Approach

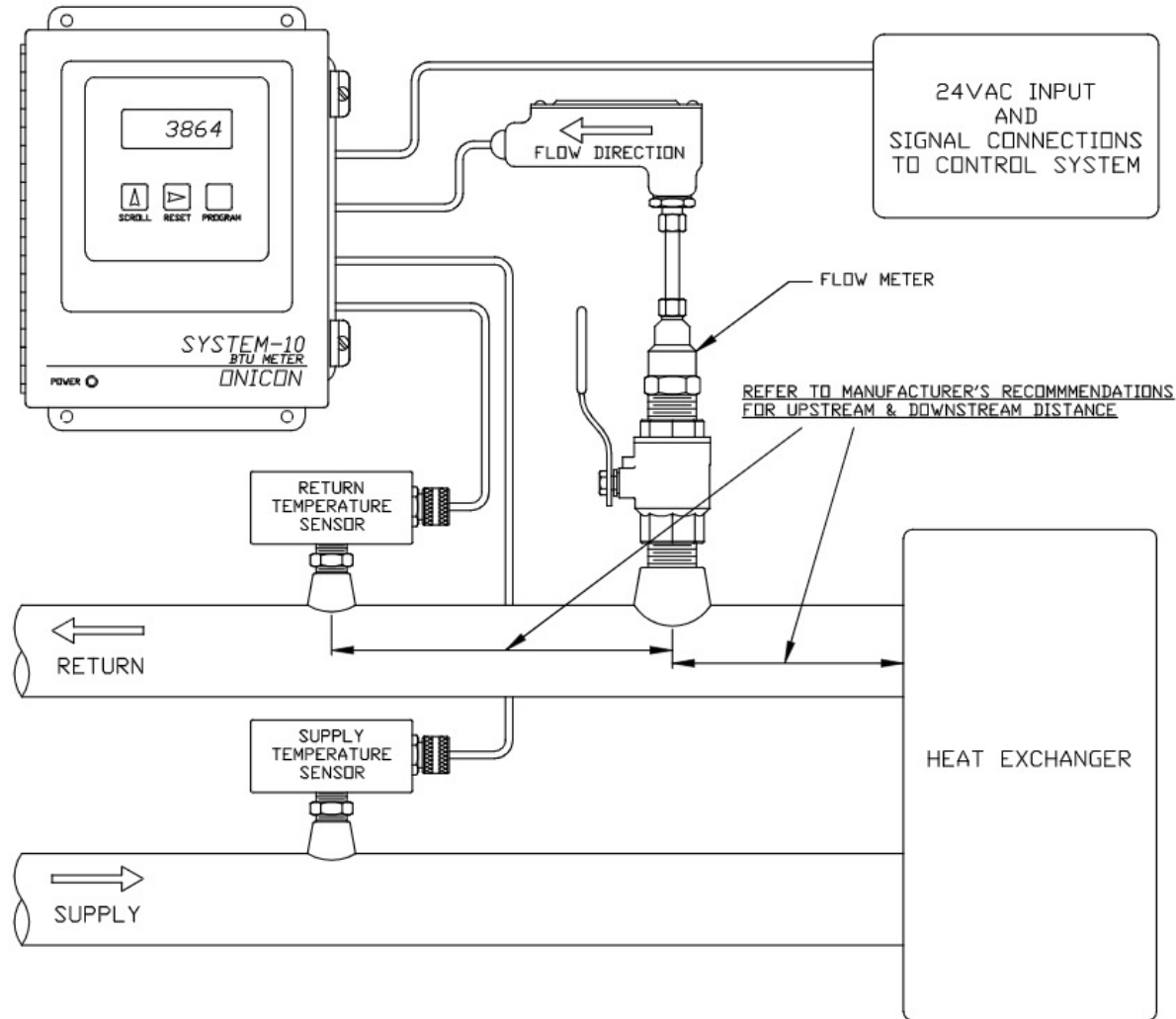
Typical Error

Example: 4" Pipe, 300 GPM, 10°F delta-T

- Flow Measurement Error
Combined Error = 1.6% of reading
- Temperature (RTD's)
Combined Error = 0.5°F to over 1°F

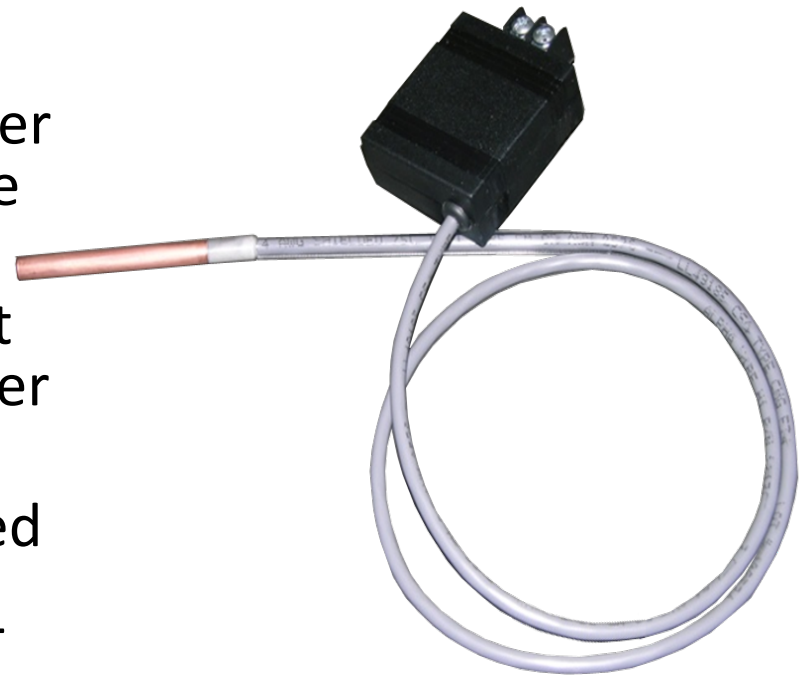
Total Energy Error = >5% to 10% of rate

System-10 BTU Meter with Insertion Turbine Flow Meter



ONICON Matched Temperature Sensors

- Each sensor is bath-calibrated to within 0.01°F and characterized over an application specific temperature range
- Signal conditioner provides current based output signal for stability over long wire runs
- Data for each sensor is programmed into the BTU meter, providing the basis for better than 0.15°F delta-T accuracy



BTU Meters



System-10 BTU Meter

- Dedicated hydronic energy (BTU) measurement system
- Easily interfaced with common building automation protocols
- Best choice for accurate hydronic energy measurement, provided:
 - Temperature sensors are matched over range
 - Flow meter is wet-calibrated
 - Provides serial communication

BACnet® LONWORKS® MODBUS® Apogee® Metasys®

BTU Measurement System Accuracy

Example: 4" pipe, 300 GPM, 10°F delta-T

- Flow Meter Accuracy:
± 0.5% to 1% of reading over a wide flow range
- Temperature Differential Accuracy
± 0.15°F
- Calculation Accuracy
± 0.05%

Total Energy Error = 1.58% to 1.8% of rate

System-40 BTU Meter



- Integral inline flow meter, 1000 Ω matched pair of platinum RTD sensors – Complete BTU meter in a single compact package
- BACnet MSTP, Modbus RTU serial communication, configurable pulse input/outputs
- Integral LCD and operator interface – remote mountable
- Available in line sizes from ½" - 2½"
- NIST traceable calibration with certificate

System-20 BTU Meter



- Native BACnet & Modbus serial communication, plus pulse and analog outputs
- 3 auxiliary pulse inputs
- Accepts 4-wire RTDs and ONICON solid state temp sensors
- Lightweight NEMA 4 enclosure is half the size of System-10 BTU Meter
- Designed to meet EN1434/CSA C900 standard for heat meters
- Conduit ready



BTU Meters with Dual Serial Network Communications

System-10-Dualnet BTU Meter

This version of the System-10 is specifically designed to communicate with multiple BACnet and MODBUS networks simultaneously.

- The System-10-Dualnet is ideal for those campus environments where utility billing and building control are two separate networks.
- It allows for easy connection to the local RS485 building network and remote access via the IP interface.

The System-10-Dualnet BTU Meter is provided with one Ethernet connection and one RS485 connection.

- The Ethernet connection can be used for BACnet/IP and MODBUS TCP/IP, and, if necessary, it can communicate with both at the same time.
- The RS485 interface can be used for either BACnet MS/TP or MODBUS RTU RS482.
- Simple dip-switch settings control the network configuration options and determine which network is allowed to reset totals.



Choosing the Right Flow Meter

**Reliability /
Water Quality**

**Owner/Engineer
Preference**

**Required System
Shut-down?**

**Temperature /
Pressure**

**Straight
Pipe Run**

**Required Accuracy /
Turndown**

Cost

Pipe Size

**Buy American /
ARRA**

Applications Flow Measurement

Applications	Turbine Meters	Electromagnetic Meters			
Chilled Water	✓	✓	✓	✓	✓
Heating Hot Water <280°F	✓	≤ 250°F	≤ 250°F	≤ 250°F	≤ 250°F
Heating Hot Water >280°F					
Condenser Water - Closed Loop	✓	✓	✓	✓	✓
Condenser Water - Open Loop		✓	✓	✓	✓
Domestic (Potable) Water	✓	✓	✓	✓	✓
Gray Water / Surface Water		✓	✓	✓	✓
Well Water		✓	✓	✓	✓
Seawater		✓	✓	✓	✓
Process Liquids				✓	✓
Steam Condensate (Pumped)	✓	✓	✓	✓	✓
Steam					
Process Gases					
Compressed Air					
Natural Gas					

F-1000 Series Insertion Turbine Flow Meters



- Simple to install, one-piece design
 - Hot-tappable into a live and pressurized system
 - Easily removed for service & recalibration
- Adjustable Depth Gauge & Utility Software
 - Flexibility in the field
 - Change pipe size, outputs and other unique details instantly
- Communicate wirelessly via Bluetooth
 - Real time diagnostic data directly to your PC
 - 50 ft connectivity range
 - Retro-fit Kit
- Best overall value in clean, closed loop systems



ONICON F-1000 Series

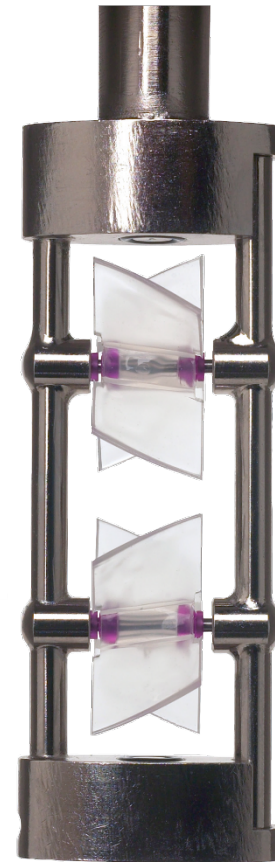
NOW AVAILABLE WITH  **Bluetooth®**


Flow and Energy Measurement

Dual Turbine Flow Meter

Patented - Dual Turbine Meter

- Contra-rotating turbines
- Provides improved accuracy in short pipe runs by canceling the effects of swirl



F-3500

Insertion Electromagnetic Flow Meters



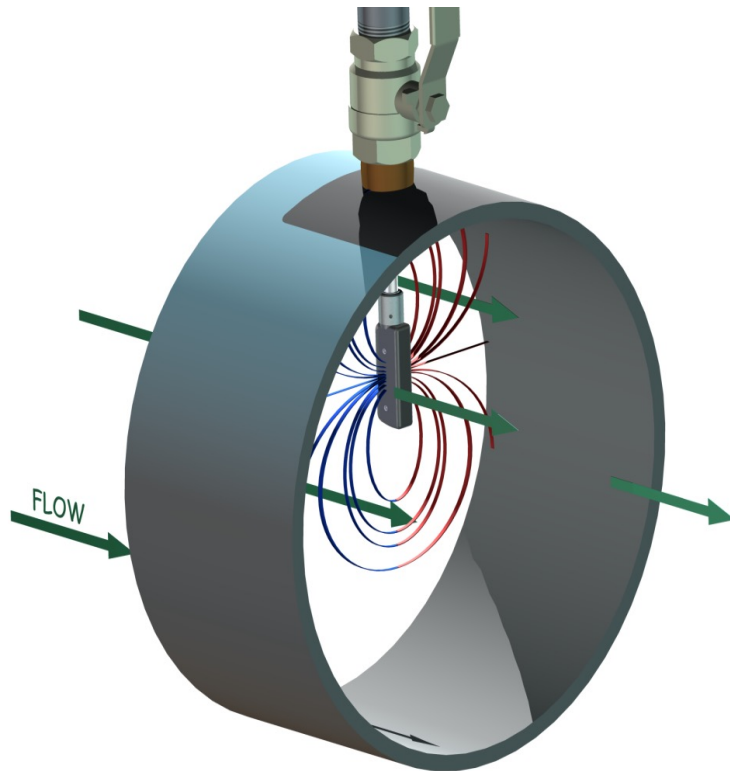
- Simple to install, one-piece design
- Can be hot-tapped into a live and pressurized system
- No moving parts, no wear and tear overtime
- Offers magnetic technology at a reasonable price in large pipes
- Best overall value in challenging open loop systems



Small pipe configuration
down to 1¼"!

Principle of Operation

Faraday's Law of Induction



Electromagnetic flow meters are based on **Faraday's Law**, which states:

"A conductor moving perpendicular through a magnetic field induces a voltage across the conductor that is proportional to its velocity."

F-3500 Applications



- Condenser water (towers & chillers)
- Domestic water mains
- Well water & irrigation
- Chilled water
- Heating water (up to 250°F)
- Ideal for open loop applications and closed loops with poor water quality

F-3500 Calibration & Accuracy



Calibration:

- Individually wet-calibrated against a NIST traceable volumetric standard
- Certificate of calibration provided with every meter

Accuracy:

- Better than $\pm 1\%$ of rate from 2 - 20 ft/s (10:1 turndown)
- ± 0.02 ft/s for velocities below 2 ft/s (low flow cut-off at 0.1 ft/s)

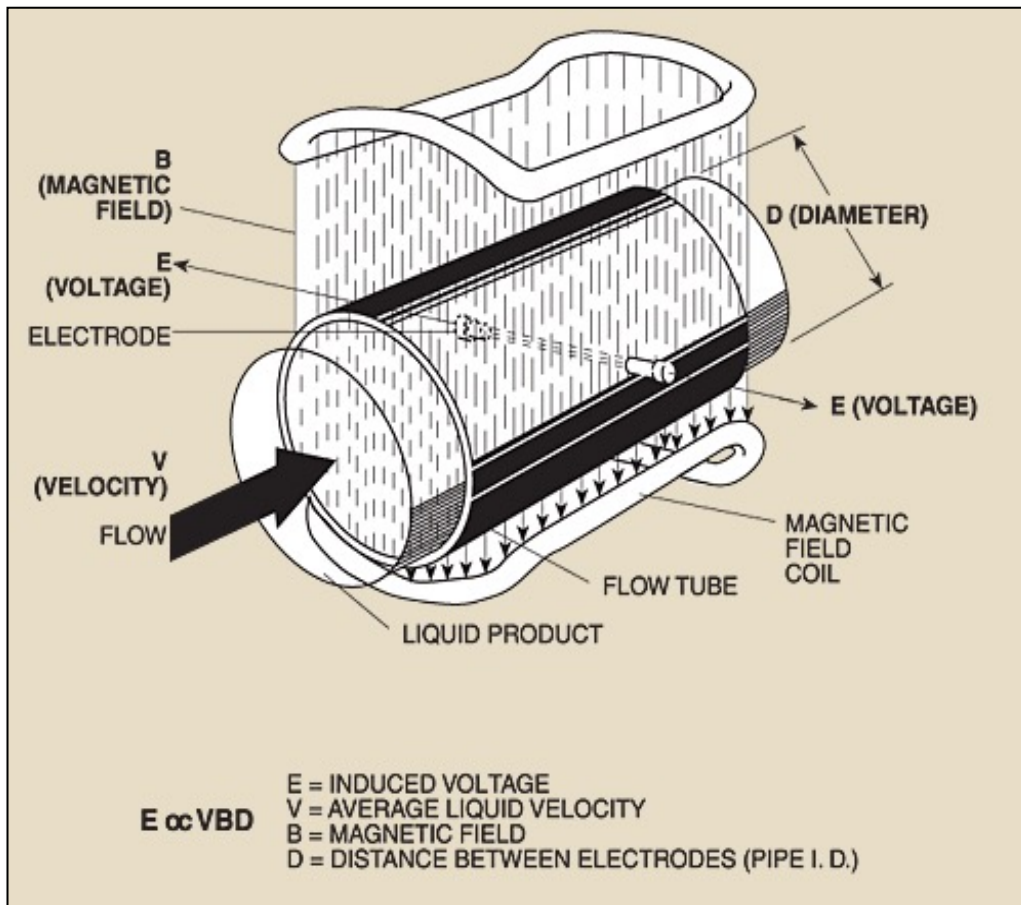
FT-3000

Series Inline Electromagnetic Flow Meters



- Highest accuracy & reliability
- Best short straight pipe run performance
- Typically highest cost
- Installation, service, or calibration requires shutdown and drain
- Best choice for high dollar custody transfer or to satisfy owner/engineer technology preference

Principle of Operation



Accurate measurement depends on the generation of a uniform magnetic field

FT-3000 Performance Features



- Highest accuracy available
 $\pm 0.2\%$ of reading (3 to 33 ft/s)
- Minimal straight run requirements;
Only three diameters upstream, two
diameters downstream
- Bi-directional flow measurement
- Factory programmed – ready for use
upon delivery

FT-3000 Applications



- Chilled water
- Heating water
- Condenser water
- Make-up water
- Boiler feed (to 250°F)
- Pumped condensate (to 250°F)
- Domestic (city) water
- Well/pond/reservoir water
- Gray water/rain water

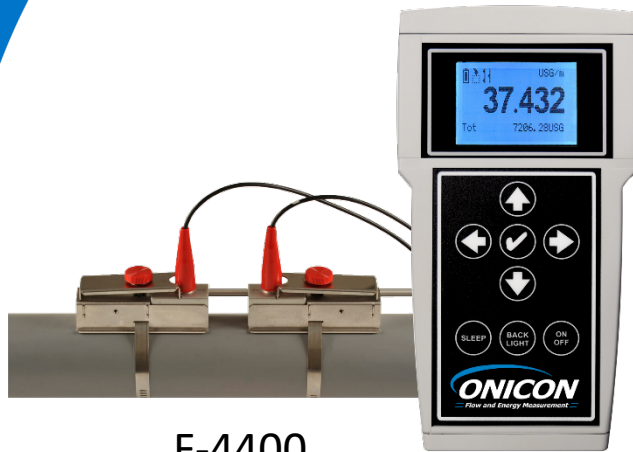
FSM-3 Series Supermag Insertion Electromagnetic Flow Meter



High Performance Electromagnetic Platform

- Full Profile Traverse design – 6" through 24" line
- Utilizes Monolithic Coil – Creates a continuous and highly stable electromagnetic field across the entire pipe
- High Accuracy – Reduced Straight Run!
 - $\pm 1.0\%$ of reading from 1 to 20 ft/s
 - $\pm 0.5\%$ of reading at the calibrated velocity
 - ± 0.01 ft/s at flow rates less than 1 ft/s
- Hand-insertable up to 400 PSI (6" through 12")

Ultrasonic Flow Meters



F-4400



F-4600



F-4300

F-4300

Clamp-on Ultrasonic Flow Meter



- High accuracy & turndown
 - $\pm 1.0\%$ of reading from 1 to 20 ft/s
 - ± 0.01 ft/s for velocities below 1 ft/s
- Non-invasive design can be installed with no shutdown & no tapping the line
- Preconfigured in factory. Comes with spacing bar and mounting hardware for easy installation
- BACnet MS/TP and MODBUS RTU native to the device
- New expanded pipe size range!



AVAILABLE
1/2" TO 48" PIPE SIZES

F-4600

Inline Ultrasonic Flow Meter



- Highly Accurate Over a Wide Flow Range
 - F-4600's measurement system is optimized for water and water/ glycol solutions
 - ± 1% of reading over 25:1 turndown
 - ± 2% of reading over a 100:1 turndown
- Simplified Wiring - Conduit Ready NEMA 4 Enclosure (integral enclosure version)
 - The F-4600 is provided with 10' pigtail and ½" conduit ready adapter
- Wet Calibration - Standard!
 - NIST traceable certificate provided with each meter
- Low pressure drop across typical flow range
 - Flow tube design produces a pressure drop of less than 1 psi at 4 ft/sec

F-4600 Applications



- Domestic water
 - Sub-metering of tenant spaces, cold and hot water
 - Make-up water applications
 - Irrigation applications
- Hydronic Systems
 - Chilled water
 - Heating hot water
 - Condenser water
 - Make-up water
- Steam condensate
- Process water applications

F-4400 Portable Clamp-on Ultrasonic Flow Meter



- High Accuracy
 $\pm 1\%$ of reading or ± 0.1 ft/sec
(0.03 m/sec)
- 2" to 48" pipe
- Battery operated
- Data logging features
- 1 set of universal transducers
- User-friendly display
- Great for TAB

Inline Vortex Steam Flow Meters

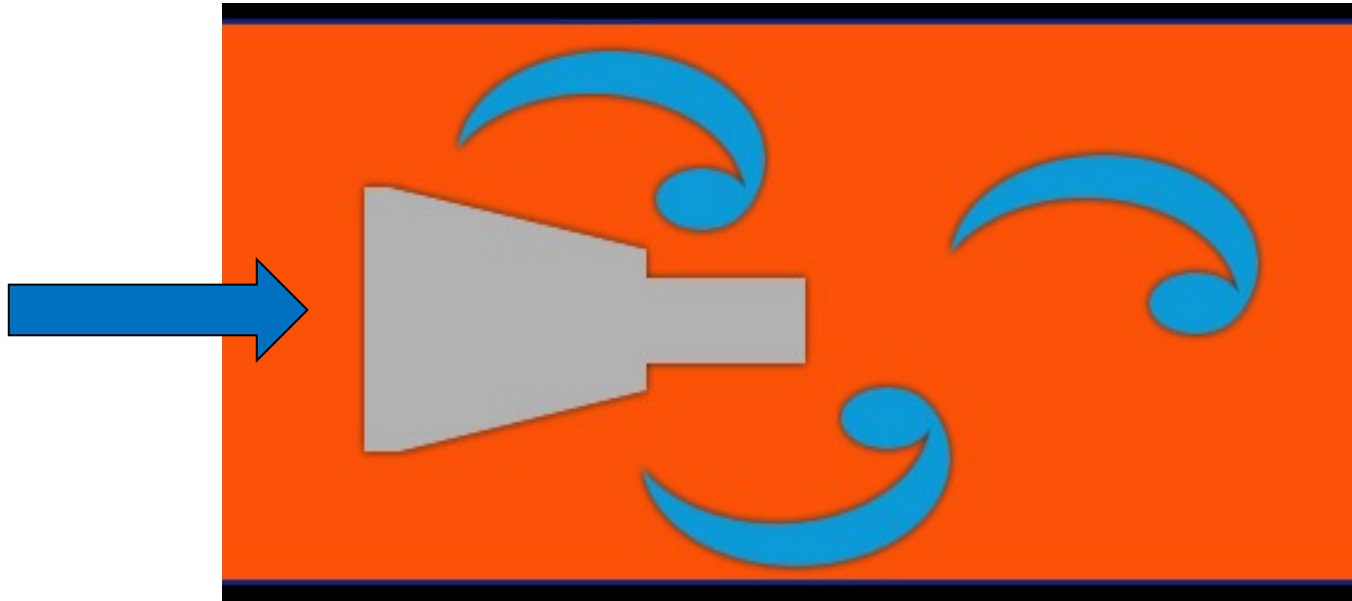


For steam, HTHW over 300°F to 500°F, ultrapure water for process, compressed air, and vacuum

- High accuracy and reliability
- Limited turndown (must be sized correctly)
- No moving parts - no wear and tear
- Installation or service requires shutdown and drain Optional integral temperature and pressure sensor for direct mass flow output

Principle of Vortex Shedding

When any liquid, gas or vapor in motion hits a solid body in its path, it flows around it, shedding vortices alternately on either side of the body.



The frequency of the vortices is directly proportional to the velocity of the flow.

Vortex Shedding is a Natural Phenomenon



Steam Flow Meter

Important Considerations

Determining Application Turndown

- Types of loads
- Summer/winter Loads
- Typical operating conditions vs. design maximum
- Consider “point of use” load values vs. overall capacity when determining maximum steam flow rates



F-2600

Inline Vortex Flow Meter



- Highly accurate
 - $\pm 1\%$ of reading volumetric flow rate
 - $\pm 1.5\%$ of reading mass flow rate
- Durable SS flow tube & ANSI class 150 or 300 flanges
- Rugged NEMA 4X electronics enclosure w/LCD

Insertion Steam Meters



F-1500 Insertion
Turbine Meter



F-2700 Insertion
Vortex Meter

F-5000 Series

Thermal Mass Flow Meters



For natural gas, compressed air, other combustible and industrial gases

- High accuracy and huge turndown; ideal for low flow rates
 - Natural Gas/Propane Gas
 - $\pm 1.0\%$ of reading from 500 – 7,000 SFPM
 - $\pm 2.0\%$ of reading from 100 – 500 SFPM
 - Compressed Air & Other High Velocity Calibrations
 - $\pm 1.0\%$ of reading
 - $\pm 0.5\%$ of full scale over a 100:1 turndown
- No moving parts, no wear and tear
- Hand insertable, hot tap design requires no shutdown for installation
- Zero-calibration check feature is unmatched

F-5000 Series Applications

- Natural Gas
 - Boiler monitoring
 - Campus monitoring
 - Sub-metering (internal)
- Propane gas
- Compressed air
- Medical gases



F-5000 Series Configuration and Features



- Insertion meter pipe size range: 1½" - 24" diameter
- Insertion meter can be wet-tapped, no system shut-down required for installation
- Inline meter pipe size range: ¾" - 3" diameter

D-100 Network Interface Display Module



- Works with virtually any flow meter
- Improves data acquisition accuracy
 - High resolution pulse/analog data totalized every second vs. analog input into BMS with much slower scan rate (10-15 minutes)
 - Eliminates the large input offset errors typical of BMS analog inputs
- Supports a wide variety of communications protocols
 - BACnet/IP and MS/TP
 - LONWORKS FTT10
 - MODBUS RTU-RS485 and RTU-TCP/IP
 - Johnson Controls Metasys N2
 - Siemens Apogee P1
 - Dualnet – Both MODBUS and BACnet

Upcoming Product Releases

- FSM-3 will have new Communications
- Introduction of the next generation of the F-4400 Clamp-on Ultrasonic Turbine Flow Meter

Thank You!

Questions?



- www.ONICON.com



- ONICON Incorporated



- [official.onicon](https://www.facebook.com/official.onicon)



- [@ONICONsolutions](https://twitter.com/ONICONsolutions)



- ONICON Incorporated