



# Hydronic Flow and Energy Metering: Best Practices for Selecting and Installing the **RIGHT** Metering Technology

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# Today's Agenda

- Why Measure Flow?
- Flow Measurement Basics
- Flow Meter Technologies
- Installation Best Practices
- Questions

# Why Measure Flow?

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

- ASHRAE Standards
- Serves as the Basis for LEED Advanced Metering Credits
- Required for the Implementation of Complex Control -Strategies and Plant Optimization
- Provides the Basis for Billing and Cost Allocation in Multi-Tenant Buildings

# Why Do We Need a Flow Meter?

**How does buying a flow meter save energy?**

## **Consider the scale....**

The act of purchasing a scale won't reduce your weight, but....

Would you begin a weight loss program without first establishing a baseline and having the ability to measure progress?



# Flow Meter Basics

## What is actually being measured by the meter?

- Volume (gallons, cubic feet, etc.)
- Velocity (feet/sec, feet/min, meters/sec.)
- Mass (lb/hr, kg/hr)

**Volumetric Flow Rate = Average Velocity x Internal Area**

$$\text{GPM (gal / min)} = V \text{ (ft/s)} \times A \text{ (in}^2\text{)} \times (60 \text{ s/min}) \times (12 \text{ in/ft}) \times (\text{gal}/231 \text{ in}^3)$$

$$\text{GPM} = V \text{ (ft/s)} \times A \text{ (in}^2\text{)} \times (3.12)$$

# Hydronic Cooling/Heating System

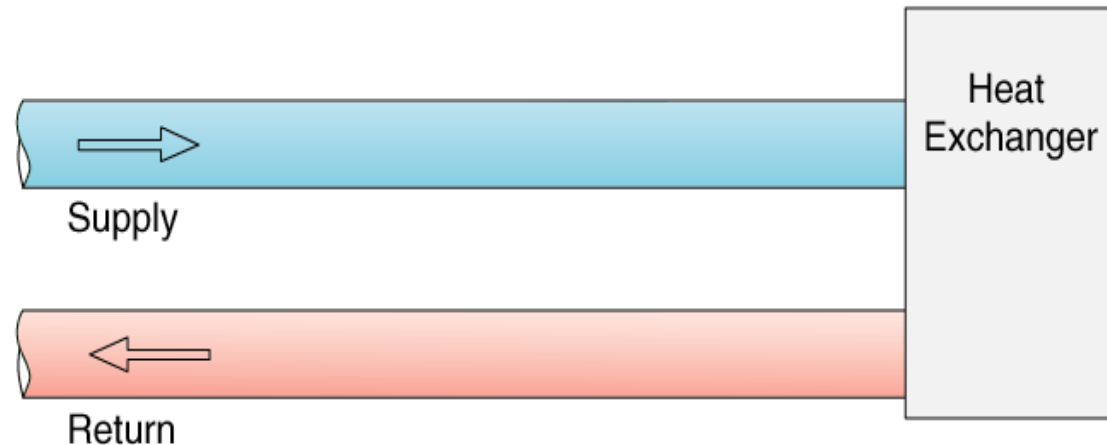
## Hydronic Heat Load Calculation:

**Energy (BTU) Rate =**

**Flow Rate x Density x Specific Heat x Delta-T (Sup. – Ret. Temp)**

*For most HVAC Applications, the equation simplifies to:*

**Energy Rate in BTU/Hr = GPM X Delta-T X 500**



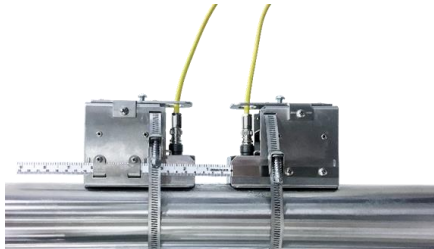
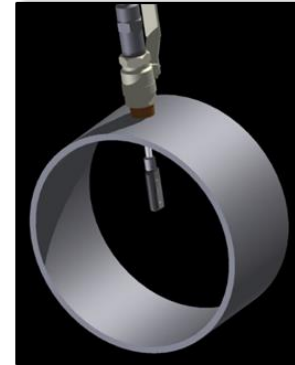
# Typical Flow Meter Configurations

## Full Bore (Inline) Flow Meter (Velocity)



A “full bore” or “inline” type flow meter occupies an entire section of pipe. All flow must go through it.

An “insertion” type flow meter measures flow velocity at a specific point or several points inside the pipe.



A “clamp-on” style flow meter is non-invasive and measures flow velocity inside the pipe via ultrasonic sound waves.

# Definitions and Relationships

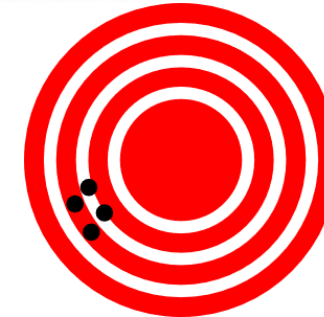
## Accuracy

The ability of an instrument to make the measurement as referenced to a standard



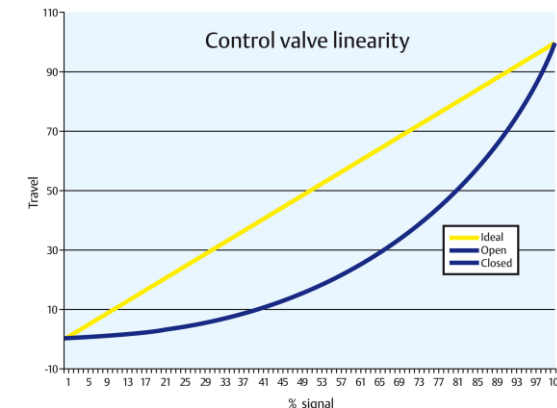
## Repeatability

The deviation of multiple measurements of the same quantity under the same conditions -  
Not a measure of absolute accuracy



## Linearity

The amount of departure of the calibration curve from a straight line - Not a measure of absolute accuracy.





# Definitions and Relationships

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

**Effective Turndown** – This is where the money is!  
The instrument range as related to the maximum flow of the specific application

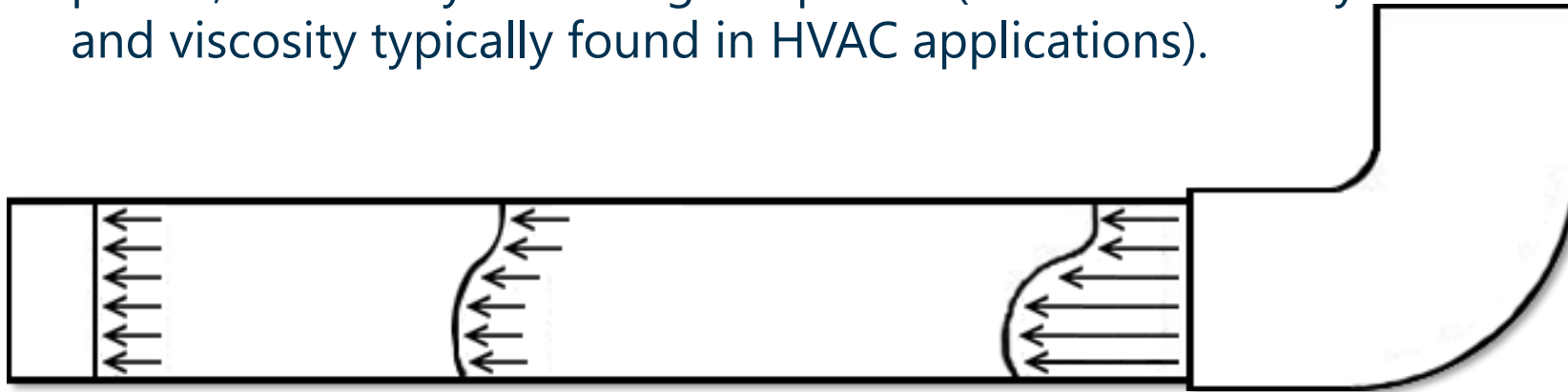
*Example: 1-30 ft/s range = 30:1 turndown (as published)*

*Application max flow at 4 ft/s = 4:1 effective turndown*

# Accuracy and Installation

## *How much Straight Pipe Run do I need??*

- Velocity profile is distorted by pipe obstructions and flow 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).



# Straight Pipe Run Requirements

Minimum upstream straight run depends 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



# Choosing the Right Flow Meter

**Reliability /  
Water Quality**

**Straight  
Pipe Run**

**Required System  
Shut-down?**

**Cost**

**Temperature /  
Pressure**

**Required Accuracy /  
Turndown**

**Pipe Size**

# Electromagnetic Flow Meter

*No moving parts*



## Insertion

- Easy to install, immersion style sensor
- Can be hot tapped into a live and pressurized system
- Now suitable for line sizes from 1.25" to 72"
- High accuracy over wide turndown
- Best overall value in **open loop**, conductive fluid systems

## Inline

- **Highest accuracy** & reliability
- Shortest straight pipe run requirements
- Installation requires shutdown and drain
- Suitable for use in most hydronic HVAC systems



# Axial Turbine Insertion Style Flow Meter

- Simple to install, one-piece design
- Can be hot tapped into a live, pressurized system
- Easily removed for service and recalibration
- Wet calibrated versions have a high accuracy over a wide turndown
- Best overall value in **clean closed loop** systems



FLOW →

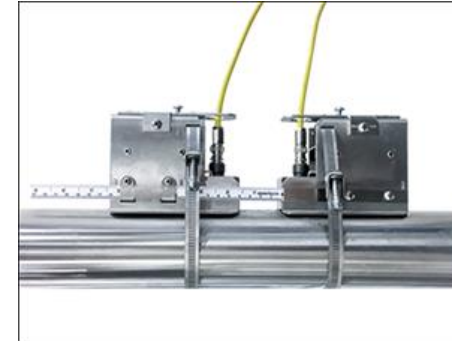


Dual Insertion Turbine  
Flow Meter

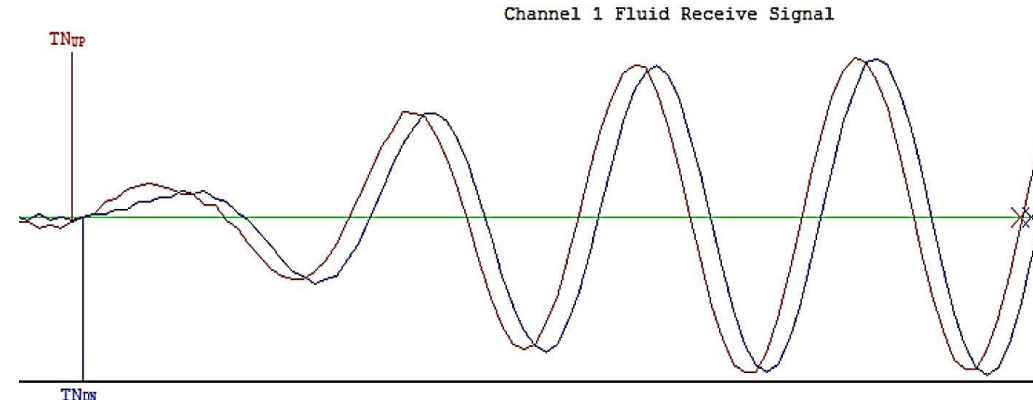
True Axial Turbine – Shaft is  
parallel with flow direction

# Clamp-on Style Ultrasonic Flow Meter

- High accuracy & turndown
- Measures bi-directional flow
- **Non-invasive design** - can be installed without shutting down or tapping the line



Transit Time Transducers



By measuring the difference between transit times of ultrasonic waves traveling between two transducers, the flow velocity of the fluid in the pipe can be accurately determined.

# Inline Wetted Ultrasonic Style Flow Meter

- High accuracy & turndown
- **Non-moving parts** construction provides long service life
- Ultrasonic technology is **impervious to water quality issues**
- Inline body conditions the flow, **eliminating straight run requirements** for most of the common piping configurations



Two direct beam, wetted ultrasonic transducers are utilized to determine the flow velocity in an inline body by measuring the difference in transit time between the ultrasonic signals.



# Dedicated BTU Measurement System



- 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

## FACTORY INSTALLED SUB-METERS

RESIDENTIAL PROJECT IN QUEENS, NY UTILIZES CHW/HW SUB-METERS  
THAT WERE FACTORY INSTALLED BY THE FAN COIL MANUFACTURER

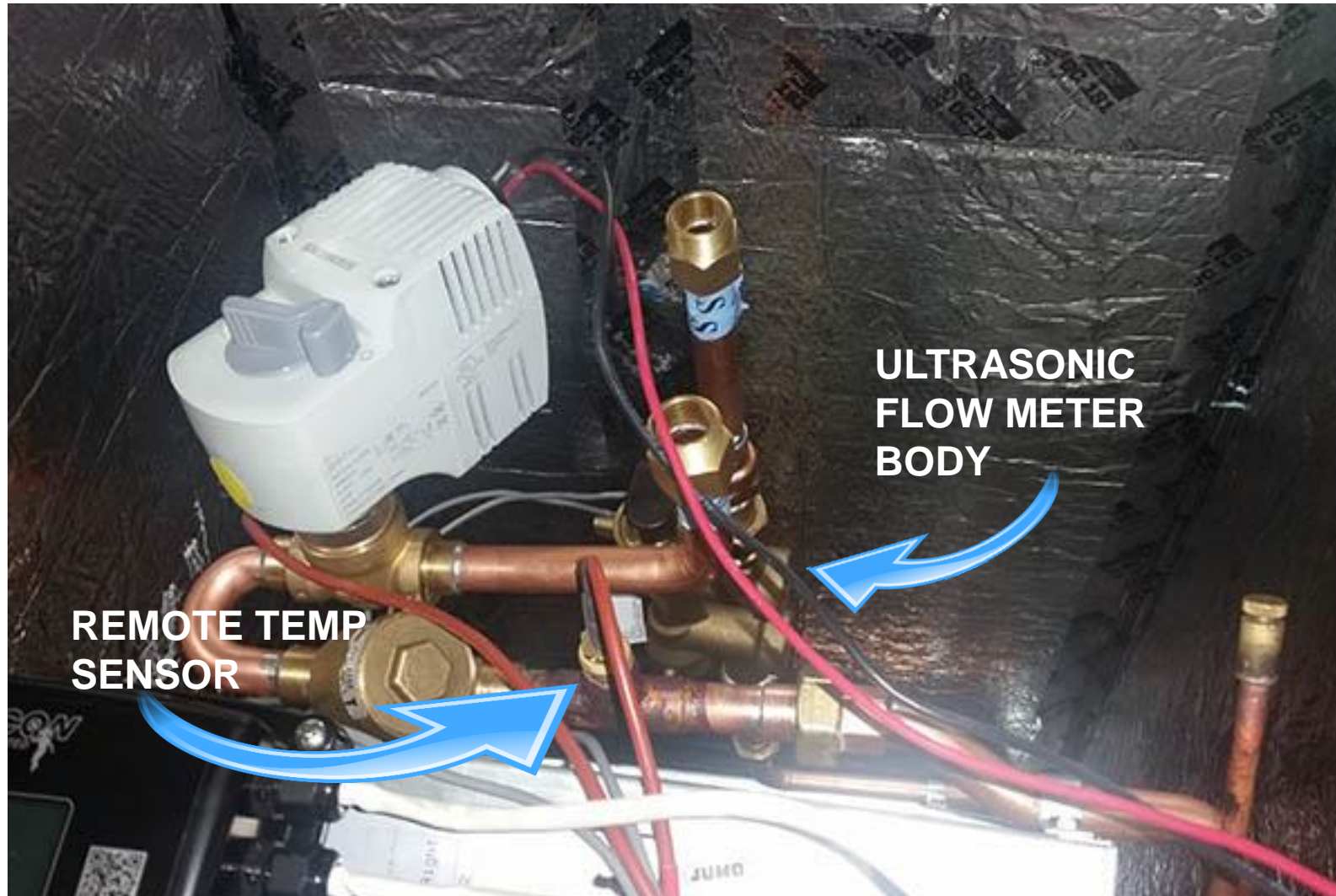


# Factory Installed Sub-Meters

Dedicated BTU sub-meters

- Reduce the owners risk associated with cost allocation
- Provide third party certification of performance
- Reduce installation and set up costs

# Factory Installed Sub-Meters







Camana Bay has 300,000 sq ft of office space at two locations in The Town Centre. Plans for a third commercial building housing 90,000 sq ft of office/retail space and a six-level, 365-space parking garage are under way.

## With BTU Meters, Planned Community Can Bill Tenants for Actual Energy Use

*Meters also are used to identify system deficiencies*

Developed by Dart Realty (Cayman) Ltd. in collaboration with a team of architects, city planners, landscape designers, and wind, water, and lighting experts, Camana Bay in the Cayman Islands is a planned community consisting of four pedestrian-friendly villages, which include residential neighborhoods, public parks, gardens, and

energy and bill for energy usage, Camana Bay's engineering team chose a factory-calibrated BTU measurement system from ONICON Inc.

"By acquiring all the information from physical sensors for flow rate and temperature differential, you

# Chilled Water from Central Plant

magnetic flow meters is used. The measurement systems are placed out of the view of building occupants, yet are accessible to maintenance personnel. The data provided include totalized energy, energy rate, volume total, volume rate, supply temperature, and return temperature.

In addition to precise measurement, accurate data collection and trending was a high priority for the metering program. Project engineers recognized the benefit of using a serial network to gather meter data. The System-10 BTU meters connected directly to the Johnson Controls N2 communication network installed as part of the building automation system. Subsequent additions to the community utilized a BACnet MS/TP network, which also is System-10 BTU-supported. Along with providing a more accurate and reliable data-collection method, the serial-network approach avoids costly expansion of the automation system, which would be required with traditional hard-wired analog and digital input points.



# Installation Best Practices

## Insertion Style Meters

Installation Hardware Depends on Pipe Material and Application



**Note:** Make sure the kit provided meets the installation requirements.

Saddles may fit on a given pipe size, but may not meet the system pressure required!

# Installation Best Practices

## Clamp-on Style Meters

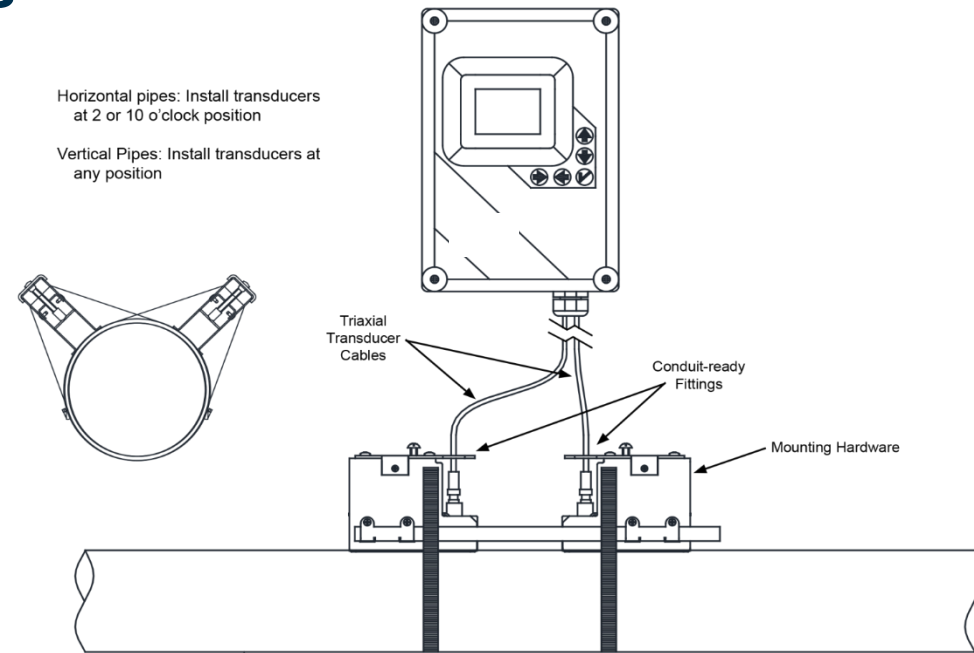
### Carefully Follow Instructions

Complete Installation Kit Includes:

- Transducer Mounting Bracket(s)
- Clamping System
- Ultrasonic Couplant or Pad

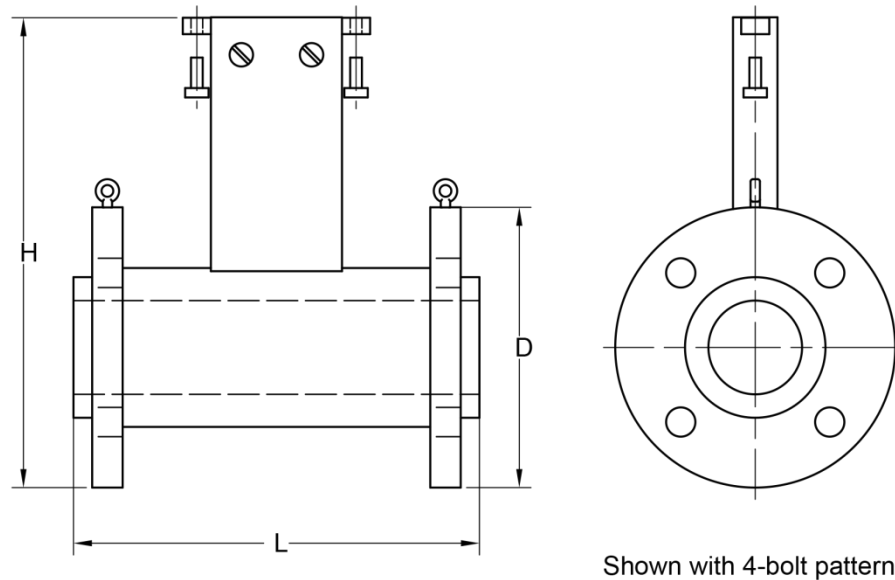
**Note:** Be careful of "Zero Maintenance" claims regarding Clamp-On transducers.

Changes occurring at the pipe wall and transducer interface, expansion / contraction, rust and scaling, may require periodic reseating of the transducers.



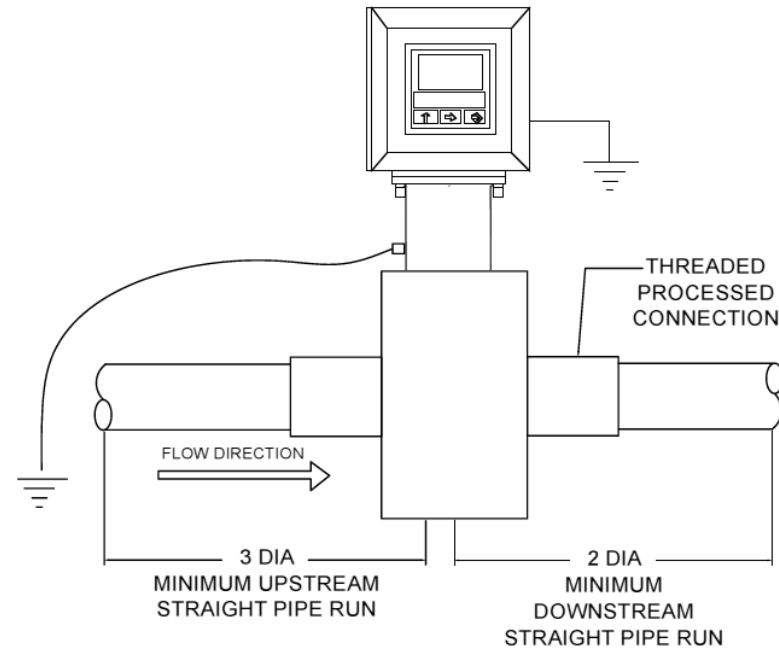
# Installation Best Practices

## Inline Style Meters (Flanged or NPT)



**Note:** Confirm the flange rating matches the system rating, Class 150 and Class 300 flanges cannot be interchanged.

Make sure the right gasket is used based on system pressure and fluid type.



**Note:** Threaded systems may require union fittings in order to allow for future meter removal. Fitting selection may impact straight run requirements.



# Common Mistakes When Installing Flow Meters

## DON'Ts



Can you find what's wrong with these installations??



# Common Mistakes When Installing Flow Meters

## DON'Ts



Don't modify the flow meter. If it doesn't fit, re-evaluate the installation!

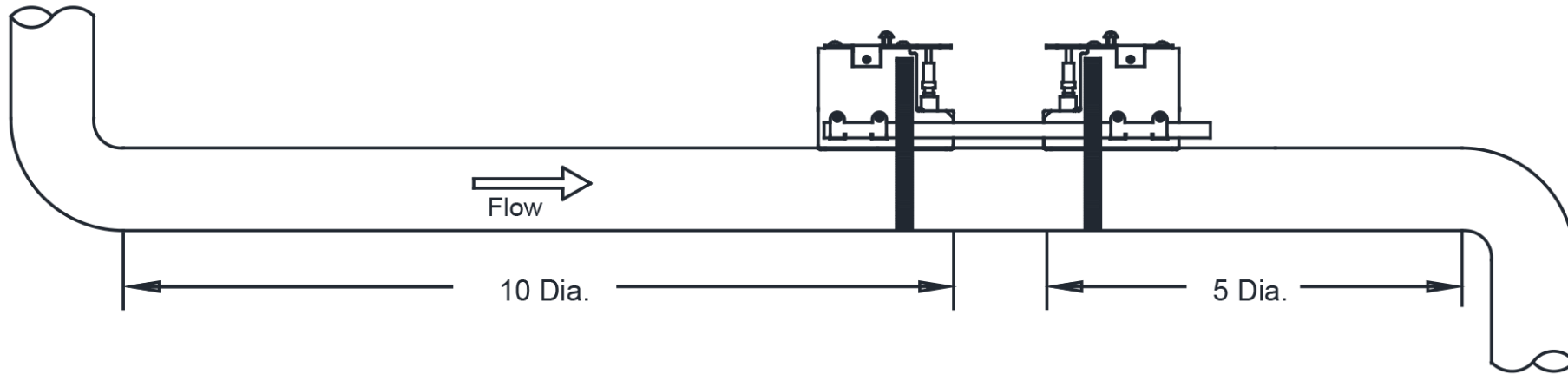


Make sure the right flow meter is selected for the application and installation. The installation kit cannot be used as a take off.

Insertion meters need overhead clearance for future removal! Installing meter at a 45 deg. angle may alleviate this situation.



# DON'T Ignore Straight Run

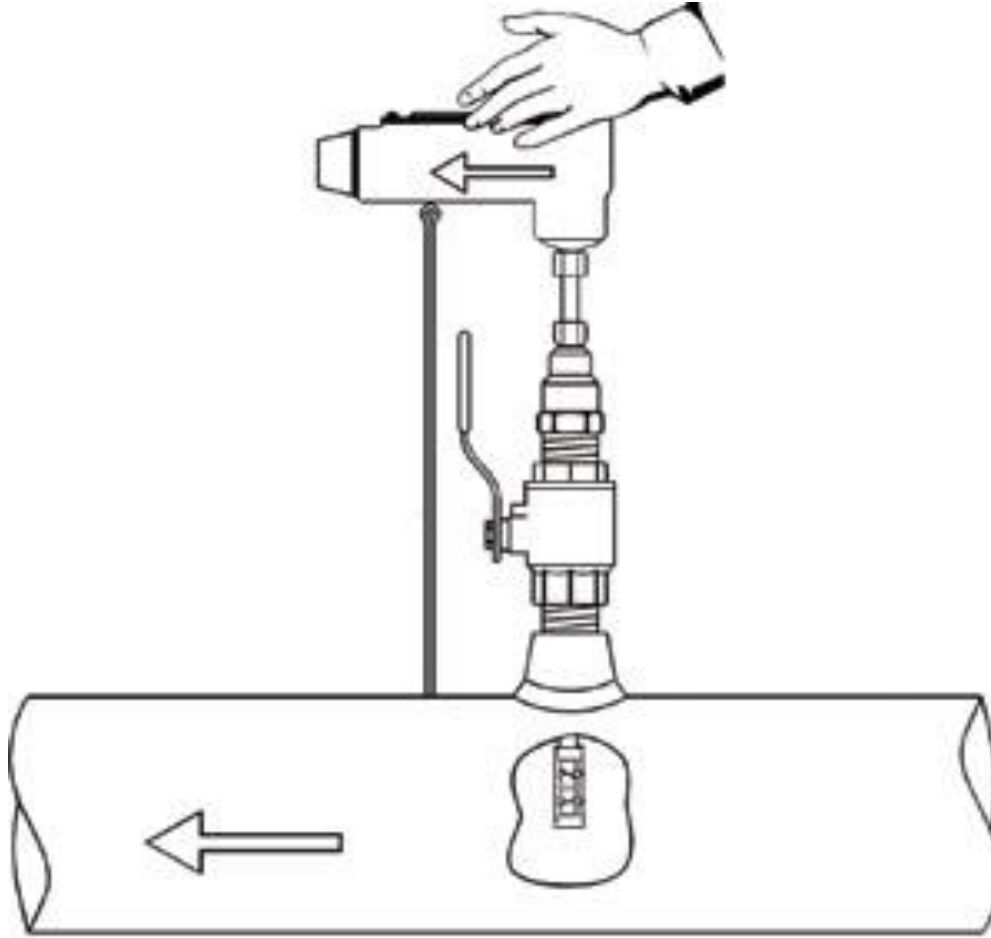


Refer to published upstream and downstream straight run requirements – **Before meter rough-in!**

Straight run is one of the most important criteria for achieving the specified meter performance!

# DON'T

## Ignore Insertion Depth



# DON'T

## Forget to Confirm Pipe Size

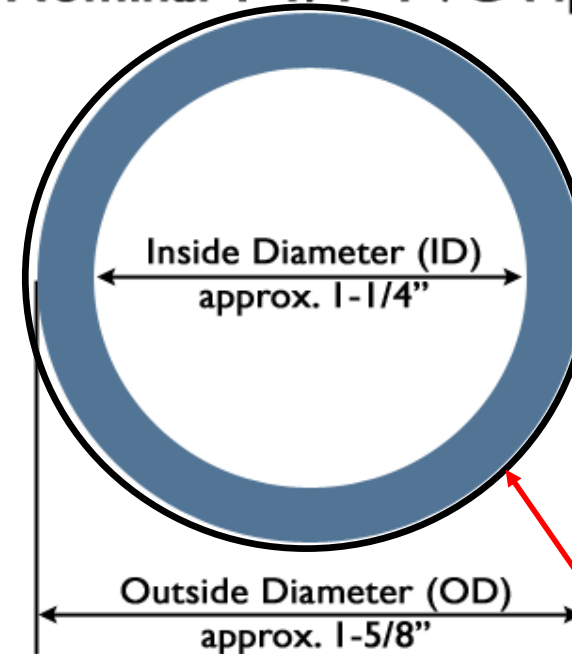
Use the Circumference to determine actual pipe Outside Diameter (OD), don't try to measure the OD directly in the field.

$\text{Circumference} / \pi = \text{Dia.}$

$\pi = 3.142$

It's easier to measure within 6" then to guess, when holding a tape measure across a 10" pipe, 10' in the air!

Nominal 1-1/4" PVC Pipe



Measured Circum. for 1.25" PVC = 5.1"

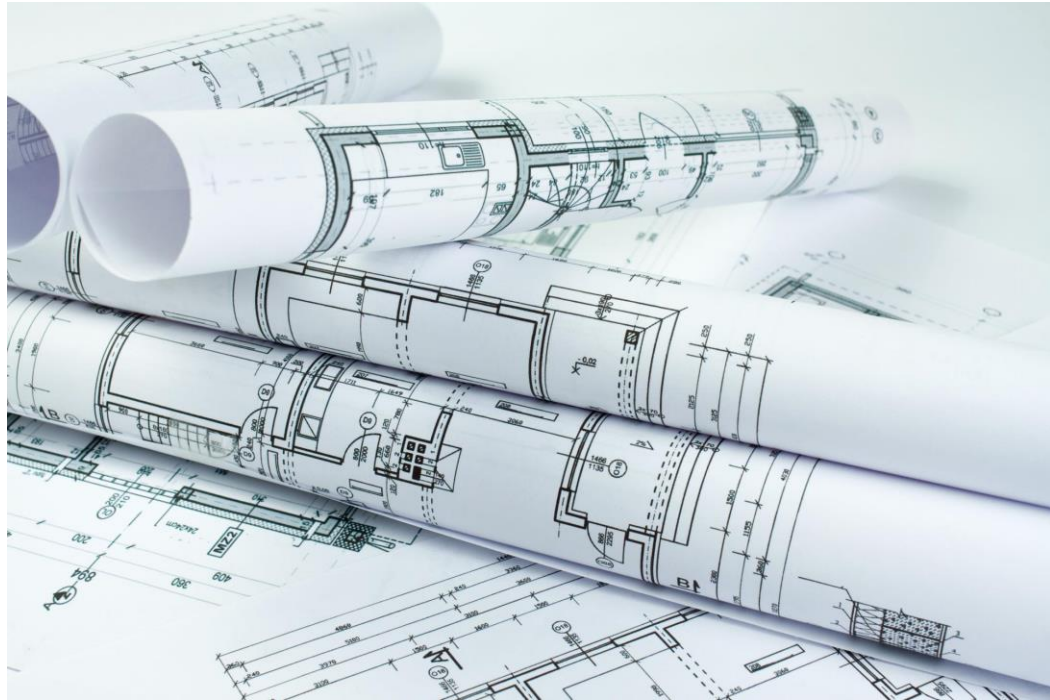
Measured circumference for 1.5" PVC = 6.0"

# **DON'T**

## **Forget to Confirm Meter is Going Into the Right Pipe**

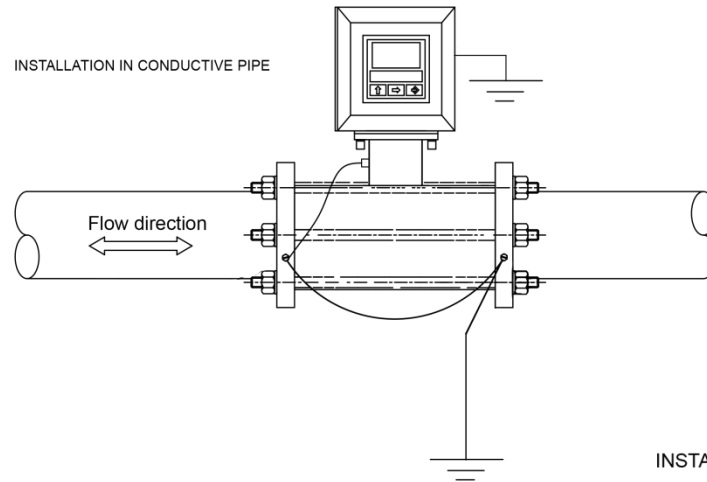
Make sure the schedule, if there is one, **matches the print!**

Insertion meters must be installed in the correct pipe size in order to provide accurate, volumetric flow information.



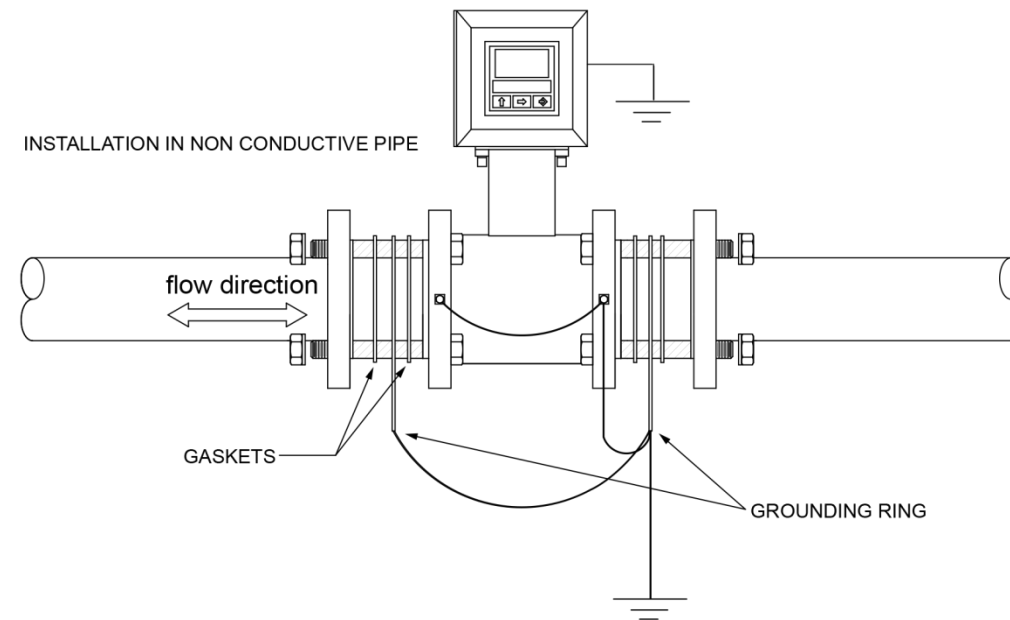
# DON'T

## Forget Grounding for Electromagnetic Meters



Signal ground and electrical safety grounds are not the same!

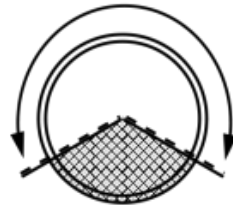
Refer to IOM for best practices when grounding magmeters.



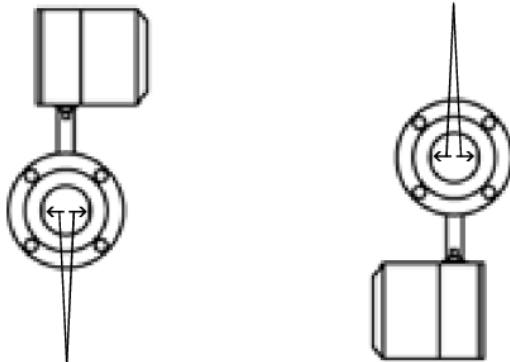
# DON'T Ignore Meter Orientation

## Insertion Meters

- Install in vertical or horizontal pipe.
- For horizontal pipe position meter anywhere in upper 240°.



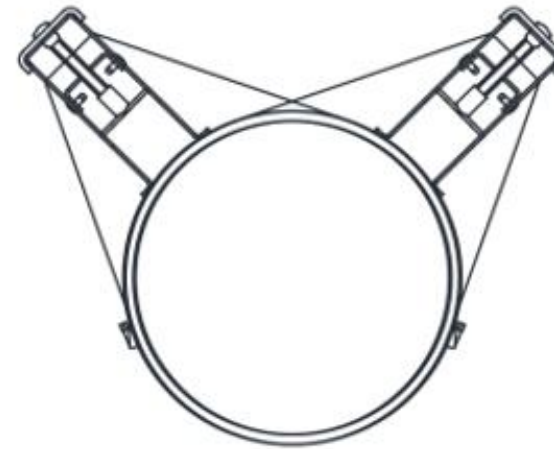
## Inline Meters



## Clamp-On Meters

Horizontal pipes: Install transducers at 2 or 10 o'clock position

Vertical Pipes: Install transducers at any position





# DON'T

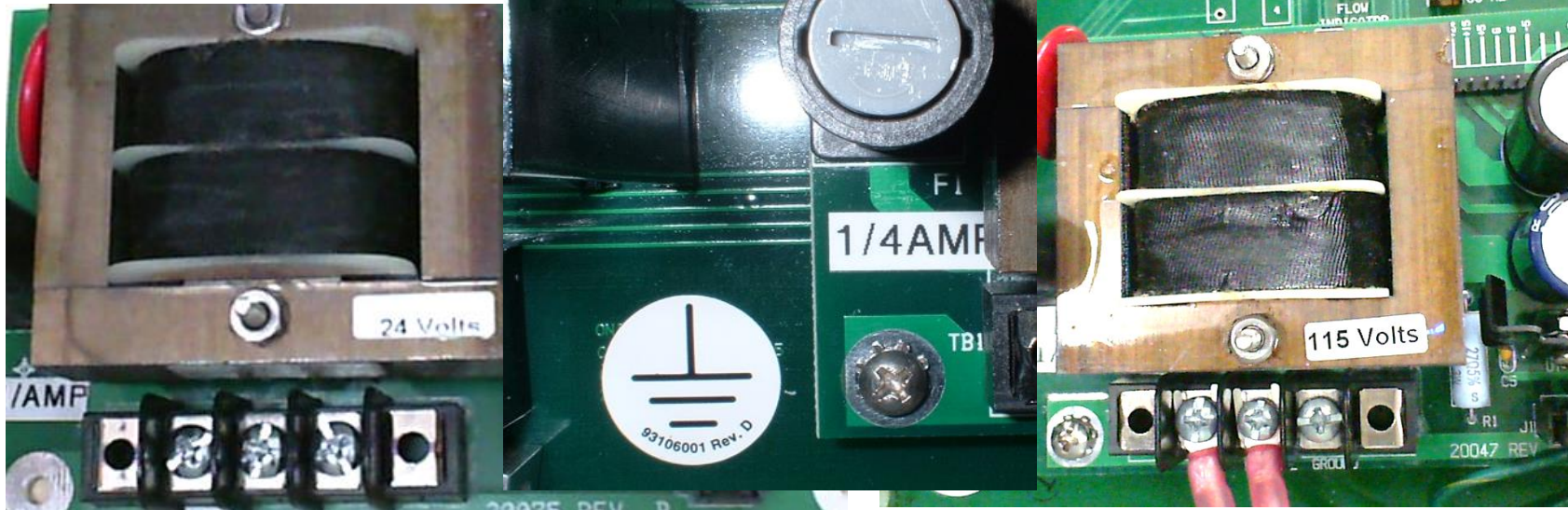
## Separate the Tag/Information from Meter





# DON'T

## Ignore the Power Supply



Confirming the power supply requirements **prior** to connecting the meter to mains power will keep from letting the "magic smoke" out.



**Thank you.  
Any questions?**

