Primary Flow Signal, Inc.
PFS
THE LEADER IN RELIABLE FLOW MEASUREMENT

Quality System ISO 9001-2000 CERTIFIED

DIFFERENTIAL FLOW METER SELECTION GUIDE

PRODUCT BULLETIN

DOCUMENT NUMBER: 2005-1001

Purpose:

The purpose of this guide is to provide an objective method of selecting the type of differential flow meter that best suits a particular application. The comparative information presented is based on 25 years of field experience as well as a wide range of technical papers and codes which offer valuable guidance and insight into the performance and characteristics of differential devices.

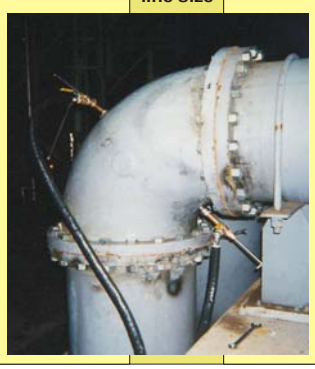
Format:

Each section focuses on a particular flow meter type. Within the section, key characteristics and performance attributes are enumerated. Notes are provided for each section that further elaborate and qualify certain statements, and should be considered integral to the presentation and to any conclusions the reader makes with respect to the flow meters considered.

Meter Type	Line Size Range (inches)	Headloss % of Differential	Basic Accuracy (% of Total)	Minimum pipe Reynolds number	Required Straight Piping	Beta Range	Useful Service Life	Service Functional Limits	Cost Range
ORIFICE	No Limit	50 to 70 percent	+/- 0.50 to +/-1.50** +/-0.67 ***	Must be greater than 10,000	Approach and Downstream Required	0.20 through 0.75	Accuracy is adversely affected by any change in bore edge****	Non-abrasive, clear low viscosity liquid or gas	LOW
WEDGE PFS Wedge-type™	½" thru 24.0"*	30 to 60 percent	+/- 2.0 to +/-4.0**	Must be greater than 500	Approach and Downstream Required	0.20 through 0.5 H/D***	Long	Ideal for harsh, high viscosity, liquid, slurry or gas service	LOW ****
ELBOW	1.0" to any line size	N/A*	+/- 4.0 **	Must be greater than 10,000	Approach (Upstream) Required	N/A	Long	Clear liquid and gas.	VERY LOW

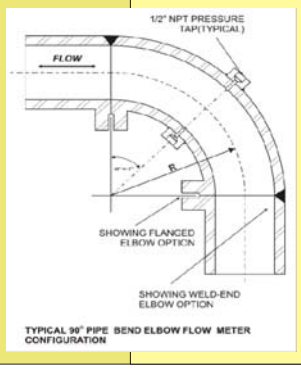
*Per ASME Fluid Meters;
**Depending on bore size (smaller bores 70%, larger bores less than 70%);
***If in compliance with AGA 3 requirements;
****The accuracy of an orifice plate is influenced by any change to the sharpness of its bore edge. This demands regular field inspection and replacement if change is noted. Approach and discharge straight piping must comply with ASME Fluid Meter requirements, including need for flow straighteners, if indicated;

*Larger line sizes are available but must be laboratory flow calibrated.
** Accuracy stated is standard, non-laboratory flow calibrated value. Accuracy of +/- 0.50% is possible with laboratory flow calibration (must include up and down stream piping.)
*** H/D is the ratio between wedge segment opening (H) and the inside diameter of the meter body (D).
**** The relative capital cost of differential producing flow meters can vary. Selection criteria recommending the Wedge meter must emphasize its superior ability to measure harsh, abrasive, high viscosity, and otherwise difficult service conditions.



* The Elbow meter utilizes the headloss created by flow passing through the elbow as a differential pressure signal. This limits the elbow meter application to flow rate range(s) that can accurately be covered by the secondary instrument(DP transmitter) particularly as regards the low end differential pressure. Typically an Elbow meter useful range is 3 or 4 to 1 on flow.

** Per ASME. Better accuracy ca with specially machined elbows and laboratory flow calibration. Repeatability is good at 0.2% or better.



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Meter Type	Line Size Range (inches)	Headloss % of Differential	Basic Accuracy (% of Total)	Minimum pipe Reynolds number	Required Straight Piping	Beta Range	Useful Service Life	Service Functional Limits	Cost Range
FLOW NOZZLE	Greater than 2.0”	40 to 95 percent*	+/- 0.25 to +/-2.00**	Must be greater than 10,000	Approach and Downstream Required***	0.20 through 0.80***	Medium to long	Clear Liquids, Gas and steam****	MED. to HIGH
CLASSICAL VENTURI	4.0” thru 48.0”*	12 to 30 percent**	+/-1.0 to +/-2.0	Must be greater than 100,000	Approach only Required	0.40 through 0.80	Medium*** Periodic Tap and annular chamber maintenance is required.	Clear liquids, gas and steam	HIGH
MODIFIED SHORT FORM VENTURI	0.50” to any line size	3.50 to 10.0	+/- 0.50 *	Must be greater than 75,000	Approach (Upstream) Required	0.20 through 0.80	Very Long	Clear liquid, gas, steam, and contaminated line fluid(s).**	MED.

***Headloss is a function of bore size. If nozzle is part of a meter run including straightening vane(as required by some codes) loop headloss will be on high side.**
****Per ASME including ASME PTC-6.**
*****Consult ASME and ISA for specific design requirements as function of Beta ratio.**
******One prominent use of the ASME Nozzle and ASME Nozzle meter run is for steam turbine efficiency testing as specified by ASME PTC-6.**
Note that a number of international codes govern use and design of flow nozzles, ASME, ISA and others. While they cover similar meter embodiments, design parameters and requirements, and stated performance in key areas may differ.

This 24.0” Classical Venturi is being refurbished in PFS Warwick, RI facility. Only the entrance vestibule and throat section are shown. The complete flow meter is nearly twice the length

***Per ASME, ISO 5167 and MFC-3M-85.**
**** Headloss is a function of Beta ratio; the smaller the Beta the higher the headloss.**
***** ASME Classical Venturi meters, by design, have annular chambers, and all prior test data referring to these designs includes the performance effects of these chambers. Since the annular chambers are subject to plugging in contaminated process fluid applications, clear liquids and gases present the best use of this meter design. Because corrosion may produce plugging effects to the annular chamber and impulse taps over time, as well, useful service life is contingent upon material selection. Periodic maintenance work to remove detritus and plugging is recommended.**

*** Modified short form Venturi meters can be made of any machinable material and in any line size. The basic accuracy is substantiated by prior laboratory flow calibrations and there is no effect on performance as a function of line size or Beta ratio. +/-0.25% accuracy (or better) is achievable through individual laboratory flow calibration.**

**** Modified Short Form Venturi meters can be equipped with sealed diaphragm sensors to eliminate plugging concerns by suspended solids in process fluid. Options are available for in-place calibration of secondary instrumentation without necessity for line shut-down or equipment removal.**

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HBX-1 	0.50" to any line size	18 to 25 percent	+/- 0.50*	Must be greater than 6,600	Approach only Required	0.20 through 0.80	Very Long	Clear liquids, gases and steam.	LOW
HBX-2 ELBOW 	0.25" t0 any line size	Standard elbow	+/- 2.0*	Must be greater than 5,000	Very short Approach only Required	Any**	Very Long	Ideal for liquid, gas, steam and contaminated service	VERY LOW

***The PFS-X1 was designed to provide Venturi meter accuracy, repeatability and long service life but including low flow rate capability (down to 6,600 pipe Reynolds number) which cannot be easily achieved using standard Venturi meter designs.**

****The significant beneficial feature of the PFS-X1 is that it is not limited to 75,000 pipe Reynolds number low limit for constant accuracy as is the case for the Modified Short Form Venturi design. This results in a significantly lower flow range-ability of this design while still enjoying high, stable and linear accuracy performance envelope.**

***Laboratory flow calibration will improve meter accuracy to +/-0.25%.**

**** Reduced bore is specifically designed to develop high differentials.**
NOTE: a variety of tap orientations are utilized depending on the type of service intended.

PFSFlowMaster-fully integrated secondary metering system

Primary Flow Signal, Inc. Has developed a wide variety of secondary instrumentation metering systems which can be used with a broad range of differential producer type flow meter primaries. The selection of equipment that is factory installed, tested and calibrated inside a properly sized NEMA 4X enclosure, is dependent upon the specific requirements of each application. Single range systems are most frequently used for 8:1 flow range applications. Dual range systems are used on 64:1applications, and triple range systems can be effectively used up to 500:1 applications.

PFS Self Checking Option-

Short form Venturi and HBX-1 meters can be equipped with a "self checking" system that compares two independent pressure sources and alarms if the change exceeds a range limit. The alarm then signals either a transmitter malfunction or unacceptable change to the internal geometry of the flow meter requiring maintenance or corrective action. This prevents long term undetected accuracy degradation in critical applications. 64:1applications, and triple

ABRASIVE LINE FLUID NOT A PROBLEM!
Novel rectangular Venturi design by Primary Flow Signal, Inc.

Features removable and replaceable segment for harsh and abrasive service

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