ENGINEERING STANDARD

FOR

FLOW INSTRUMENTS

FIRST EDITION

JANUARY 2013

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the “Company" where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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APPENDICES:

1. SCOPE

This Standard covers recommended practices for the design and engineering aspects of different types of flow measurement instruments. These meters are commonly used to indicate, record, transmit, and control fluid flow.

Flow measurement falls into two broad classifications: process flow measurement and custody transfer. This standard is primarily concerned with process flow measurement. Liquid custody transfer is normally done with positive displacement meters or turbine meters, usually combined with meter proving equipment.

In this regard reference to be made to IPS-E-IN-240.

It is intended to be used in oil, gas, and petrochemical industries.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Oct. 1997. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 9 on Oct. 1997. These modifications are included in the present issue of IPS.

Note 2:

This is a revised version of this standard, which is issued as revision (1)-2013. Revision (0)-1993 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

MPMS 5.2	"API Manual of Petroleum Measurement Standards, Chapter 5.2, Measurement of Liquid Hydrocarbons by Displacement Meters"
MPMS 5.3	"API Manual of Petroleum Measurement Standards, Chapter 5.3, Measurement of Liquid Hydrocarbons by Turbine Meters"
MPMS 4	"API Manual of Petroleum Measurement Standards, Chapter 4, Proving Systems"
MPMS Chapter 7	"Manual of Petroleum Measurement Standards, Temperature Determination"
MPMS 14.3	"Part 1: Manual of Petroleum Measurement Standards Chapter 14—Natural Gas Fluids Measurement, Section 3—Concentric, Square-edged Orifice Meters, Part 1—General Equations and Uncertainty Guidelines"
MPMS 14.3	"Part 2: Manual of Petroleum Measurement Standards Chapter 14—Natural Gas Fluids Measurement, Section 3—Concentric, Square-Edged Orifice Meters, Part 2—Specification and Installation Requirements"
MPMS 14.3	"Part 3: Manual of Petroleum Measurement Standards Chapter 14-Natural Gas Fluids Measurement, Section 3-Concentric, Square-Edged Orifice Meters, Part 3-Natural Gas Applications"

API 551	"Process Measurement Instrumentation"

8) PTC 19.5.4, Instruments and Apparatus, supplement to ASME Performance Test Codes, American Society of Mechanical Engineers, New York.

BSI (BRITISH STANDARD INSTITUTION)

BS 6739	"Instrumentation in Process Control Systems: Installation Design and Practice"

ISA (THE INTERNATIONAL SOCIETY OF AUTOMATION)

RP16.1, 2, 3	"Terminology, Dimensions, and Safety Practices for Indicating Variable Area Meters (Rotameters, Glass Tube, Metal Tube, Extrusion Type Glass Tube)"
RP16.4	"Nomenclature and Terminology for Extension Type Variable Area Meters (Rotameters)"
RP31.1	"Specification, Installation, and Calibration of Turbine Flowmeters"
Tr 20.01	"Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100	"Engineering Standard for Units"
IPS-M-IN-130	"Material and Equipment standard for flow instruments"
IPS-E-IN-240	"Engineering standard for Measurement of Liquid Hydrocarbons (Custody Transfer)"
IPS-M-IN-240	"Material Standard of Volumetric Liquid Measurement Methods (Custody Transfer)"
IPS-G-IN-210	"General standard for Instrument Protection"
IPS-E-IN-190	"Engineering Standard for Transmission Systems"

3. UNITS

This standard is based on international system of units (SI), as per IPS-E-GN-100, except otherwise specified.

4. TERMINOLOGY AND DEFINITIONS

4.1 Differential Pressure Instruments

The differential-head type of instrument measures flow inferentially from the differential pressure caused by flow through a primary element. This differential pressure is sensed by diaphragms, bellows, or manometers. Transmitters of the force or motion type are either pneumatic or electronic. Electronic transmitters use strain gages, capacitance detectors, or other solid state detectors to provide output with minimal sensing element displacement.

Primary elements are generally one of the types described in 4.1.1 through 4.1.6

4.1.1 Orifice

Orifices are usually thin concentric plates, but they may be eccentric, segmental, quadrant edge, or some other special form, depending upon their application.

4.1.2 Flow nozzle

Flow nozzles are used in installations where higher velocity and moderately better pressure recovery are required than are obtainable with an orifice plate.

4.1.3 Venturi tube

Venturi tubes are used in installations where high capacity and good pressure recovery are required or where the measured stream contains some solids.

4.1.4 Flow tube

Flow tubes are used in installations where low pressure loss is a major consideration or where piping configurations are restrictive.

4.1.5 Pitot tube

Generally, pitot tubes are used in installations where no appreciable pressure drop can be tolerated on high-volume flows, such as on cooling water. The accuracy of the measurement depends upon the determination of the average velocity from the velocity profile. An averaging pitot tube is also available.

4.1.6 Elbow taps

Elbow taps are used in installations where the velocity is sufficient and where high accuracy is not required. Although they are less accurate than other differential pressure instruments, elbow taps possess good repeatability. A water velocity of 17 feet per second (5 meters per second) will produce a water differential of approximately 100 inches (2500 millimeters). Some test data are available.

4.2 Variable Area Flowmeters

Variable area flowmeters are normally used when local indication only is required.

4.3 Force or Target Flowmeters

Force or target flowmeters measure flow inferentially by measuring the force developed at a disk-shaped target suspended in the flow path.

4.4 Turbine Flowmeters

Turbine meters measure flow from the rotation produced by the flow past a turbine or propeller.

4.5 Electromagnetic Flowmeters

If a fluid has some degree of electrical conductivity, an electromagnetic flowmeter can measure its average flow velocity inferentially from the voltage generated by the fluid as it moves through a magnetic field.

4.6 Positive Displacement Meters

This meter measures flow by isolating, counting, and totaling segments of known volume as they are displaced through its body.

4.7 Vortex Flowmeters

Vortex meters are oscillatory flowmeters that utilize the vortex train generated by an obstruction placed in a fluid stream. They measure flow by counting the vortices.

4.8 Ultrasonic Flowmeters

There are two main classes of sonic flowmeters. Contrapropagating meters measure the difference in the transit times of sounds transmitted upstream and downstream. Doppler or reflection meters measure the frequency shift of sound reflected back from particles or bubbles in the flow stream.

4.9 Mass Flowmeters

These meters use the principle of coriolis acceleration which allow true mass flow rate measurements of fluids to be made directly, without the need for external temperature, pressure, or specific gravity measurements.

4.10 The other field proven technologies may be applied. In these cases the vendor documents shall be referred.

5. DIFFERENTIAL PRIMARY ELEMENTS

5.1 Thin-Plate Orifices

5.1.1 Concentric orifice plates

The sharp-edge, concentric orifice plate is the most frequently used primary element because of its low cost, adaptability, and the availability of accurate coefficients.

For most services, orifice plates are made of corrosion-resistant materials, usually type 316 stainless steel. Other materials are used for special services.

The upstream face of the orifice plate should be as flat as can be obtained commercially. It must be smooth, and its finish should be at least equivalent to that given in Fig. 1.

The thickness of the orifice plate at the orifice edge should not exceed (minimum requirements governing in all cases):

D/50	(one-fiftieth of pipe diameter)
d/8	(one-eighth of orifice diameter)
(D-d)/8	(one-fourth of dam height)

In some cases, including large pipe diameter and high pressure and temperature, the thickness of the orifice plate will be greater than is permitted by the limitations for the thickness of the orifice edge. In such a case the downstream edge shall be counterbored or beveled at an angle of (45±15) degrees to the required thickness at the orifice edge. The word "upstream" or "inlet" should be stamped on the orifice tab on the square-edge side of the plate. Dimensions for orifice plates are shown in Fig. 1.

Bores must be round and concentric. Practical tolerances for orifice diameters, as given in MPMS

14.2 & 14.3, are shown in Table 1.

The upstream edge of sharp edge orifice should be square and sharp. It is usually considered sharp if the reflection of a beam of light from its edge cannot be seen without magnification. The edge radius should not exceed 0.0004 times the bore diameter. It should be maintained in this condition at all times. For two-way flow, both edges must be square. Orifice plate details and schedule of thicknesses are shown in Fig. 1. Detailed tolerances are discussed in MPMS 14.2 & 14.3 and American Society of Mechanical Engineers Publications.

In wet-gas or wet-steam services, where the volume of condensate is small, a weep hole flush at the bottom of the orifice run may be used to prevent a build-up of condensate in horizontal lines. The weep hole serves as a drain to prevent freeze-up during shutdown periods. A weep hole flush with the top of the pipe can also be used to pass small quantities of gas in liquid streams. If the diameter of the hole is less than one-tenth of the orifice bore diameter, the maximum flow through the drain hole is less than 1 percent of the total flow.

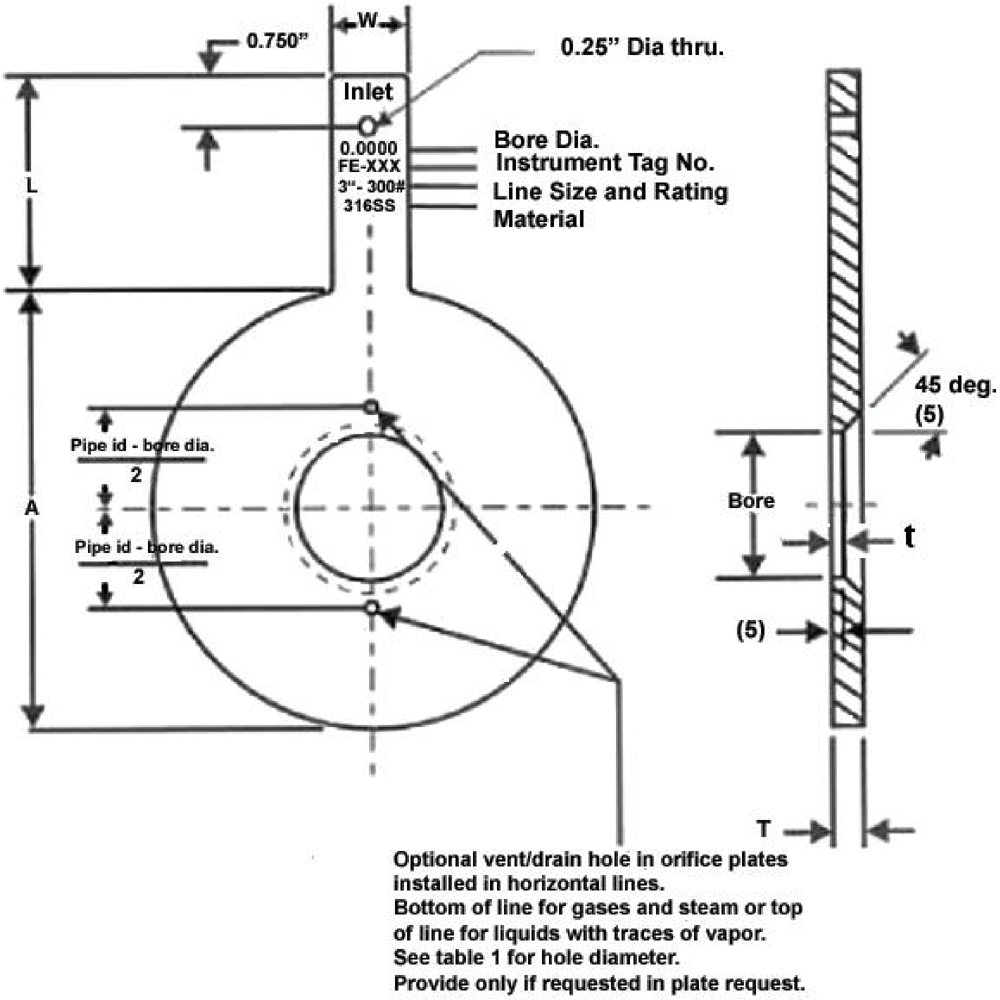
Because more test information is available for thin-plate orifices than for other primary devices, it is possible to design orifice installations to acceptable accuracies. Sometimes the layout of equipment precludes the use of the most accurate design. A lower order of accuracy is often acceptable in installations used only for control purposes than in installations used for accounting, material balance, or custody transfer.

TABLE 1- ROUNDNESS TOLERANCE FOR ORIFICE PLATE BORE DIAMETER, d_m OFFICE BORE DIAMETER, d_m TOLERANCE

(inches)	(± inches)
≤ 0.250[a]	0.0003
0.251 – 0.375[a]	0.0004
0.376 – 0.500[a]	0.0005
0.501 – 0.625	0.0005
0.626 – 0.750	0.0005
0.751 – 0.875	0.0005
0.876 – 1.000	0.0005
>1.000	0.0005 inch per inch of diameter

Note:

[a] Use of diameters below 0.45 inch is not prohibited, but may result in uncertainties greater than those specified in Chapter 14, Section 3, Part 1.



ORIFICE PLATE OUTSIDE DIAMETERS TO FIT ANSI SERVICE RATED FLANGE UNIONS

NOMINAL PIPE SIZE DN	T	t	CLASS					TAB	
			300	600	900	1500	2500	L	w
50 (2)	3 (1/8)	0.8 (1/32)	110 (4 3/8)	110 (4 3/8)	143 (5 5/8)	143 (5 5/8)	146 (5 ¾)	100 (4)	20 (¾)
80 (3)	3 (1/8)	0.8 (1/32)	150 (5 7/8)	150 (4 7/8)	168 (6 5/8)	175 (6 7/8)	197 (7 ¾)	100 (4)	20 (¾)
100 (4)	3 (1/8)	1.6 (1/16)	181 (7 1/8)	194 (7 5/8)	305 (8 1/8)	210 (8 ¼)	235 (9)	150 (6)	25 (1)
150 (6)	3 (1/8)	2.4 (3/32)	251 (9 7/8)	267 (10 ½)	289 (11 3/8)	283 (11 1/8)	317 (12 ½)	150 (6)	25 (1)
200 (8)	3 (1/8)	3 (1/8)	308 (12 1/8)	321 (12 5/8)	359 (14 1/8)	352 (13 7/8)	387 (15 ¼)	150 (6)	25 (1)
250 (10)	6 (¼)	4.8 (3/16)	362 (14 ¼)	400 (15 ¾)	435 (17 1/8)	435 (17 1/8)	476 (18 ¾)	150 (6)	25 (1)
300 (12)	6 (¼)	5.6 (7/32)	422 (16 5/8)	457 (18)	498 (19 5/8)	521 (20 ½)	549 (21 5/8)	150 (6)	25 (1)
350 (14)	6 (¼)	5.6 (7/32)	486 (19 1/8)	492 (19 3/8)	521 (20 ½)	578 (22 ¾)		150 (6)	25 (1)
400 (16)	9 (3/8)	7.2 (9/32)	540 (21 ¼)	565 (22 ¼)	575 (22 5/8)	641 (25 ¼)		150 (6)	25 (1)
450 (18)	9 (3/8)	7.2 (9/32)	597 (23 ½)	613 (24 1/8)	638 (25 1/8)	705 (27 ¾)		150 (6)	25 (1)
500 (20)	9 (3/8)	9 (3/8)	654 (25 ¾)	683 (26 7/8)	698 (27 ½)	756 (29 ¾)		180 (7)	25 (1)
600 (24)	9 (3/8)	9 (3/8)	775 (30 ½)	790 (31 1/8)	838 (33)	902 (35 ½)		180 (7)	25 (1)

CONCENTRIC ORIFICE PLATE

Fig. 1

Notes: (Related to Fig. 1)

1) All measurements inside parenthesis are in inches and the rest are in mm.

2) The outside diameter (OD) of the orifice plate is that required to fit inside the bolts of standard ANSI flanges. The outside diameter is equal to the diameter of bolt circle minus the nominal diameter of bolt, within a manufacturing tolerance of +0 millimeters, -0.8 millimeters (+0 inches, -1/32 inch).

3) For orifice plate outside diameters in flange sizes and ratings not listed above, refer to gasket OD dimensions given under Fig. 3, Table 1, Appendix E in ANSI B 16.5-1981, "Steel Pipe Flanges and Flanged Fittings", available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

4) The upstream face of the orifice plate shall be as flat as can be obtained commercially; any plate departing from flatness along any diameter more than 0.25 millimeters (0.010 per inch) of dam height, (D-d)/2, shall be unacceptable. Surface roughness shall not exceed 1.3 microns (50 microinches) in a band at least 0.25 diameter wide around the orifice bore.

5) All seating surfaces for spiral-wound gaskets should be clean and free of rust, burrs, nicks, and so forth. Any surface not meeting the following tolerances should be relapped:

a) Roughness

Should not exceed 2 microns (80 microinches) root mean square with 1.6 microns (63 microinches) root mean square or better as optimum.

b) Flatness

Out-of-plane tolerances must not exceed 0.06 millimeter (0.0025 inch). The cumulative out-of-flatness for two mating surfaces shall not exceed 0.1 millimeter (0.0040 inch).

5.1.2 d/D (β) Ratio

Orifice diameters should be selected so that the ratio of orifice diameter to actual internal pipe diameter, d/D, does not exceed the limits as shown on MPMS 14.3, as follows:

1) With meters using flange taps, β shall be between 0.15 and 0.70.

2) With meters using pipe taps, β shall be between 0.20 and 0.67.

With either type of pressure taps, diameter ratios as low as 0.10 may be used while ratios as high as 0.75 may be used with flange taps and as high as 0.70 may be used with pipe taps. The flow constants, F_b, for these extreme values of β are subject to higher tolerances, and it is recommended that the use of these extreme ratios be avoided (see MPMS 14.3).

When using small bores, care should be exercised to prevent plugging by pipe scale or other foreign material.

5.1.3 Other orifice plates

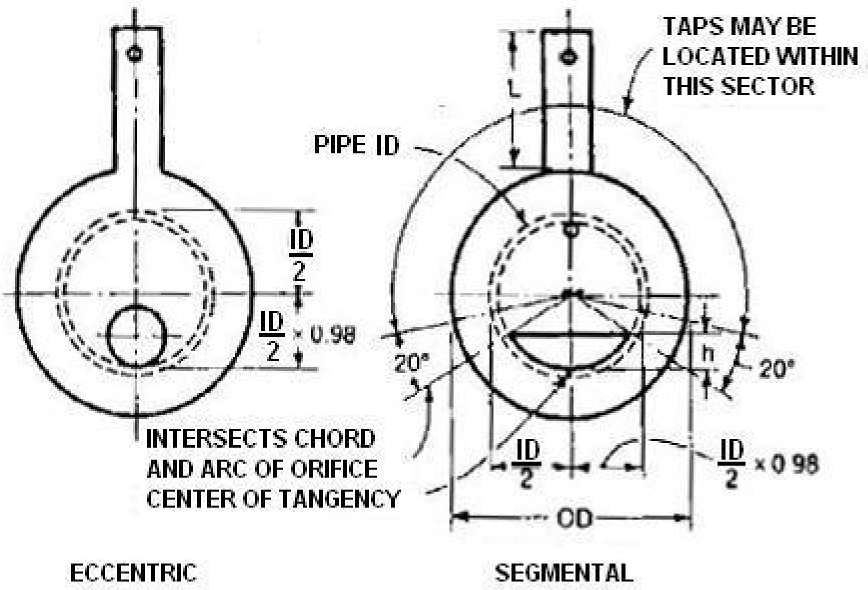
Eccentric or segmental orifices may be used in horizontal runs for special services where concentric orifices cannot be used. In some installations, the fluid stream possesses a large quantity of undissolved gas or a gas containing condensables, which may be carried along the pipe. This type of plate can produce full venting or full drainage, whichever is required, if the orifice opening is properly located.

Segmental orifices are recommended for slurry services because of their insensitivity to changes in the liquid-solid ratio and their relatively satisfactory accuracy (approximately 2.2 percent for plate calculations).

The eccentric orifice usually is placed with its edge tangent to a circle having a diameter 0.98 of that of the pipe. The point of tangency is at the top, vertical centerline for liquids containing some vapor, and at the bottom, vertical centerline for vapors containing some liquids. Coefficients are also available for differential pressure taps at 90 or 180 degrees from the point of tangency. Eccentric and segmental orifice plates are shown in Fig. 2. Segmental orifices are usually constructed with a circle diameter (D) between 0.97 and 0.98 percent of the inside pipe diameter (ID). They are generally used in services which require that the orifice be placed at the bottom of the line. For best accuracy, the tap location should be 180 degrees from the center of tangency. However, to avoid gas bubbles in the taps, the location may be anywhere within the sector shown in Fig. 2.

The quadrant-edge, or quarter-circle, orifice is a device in which the upstream edge is rounded to form a quarter circle.

The thickness of the plate near the orifice is equal to the radius of the quarter circle. See typical drawing No. 9 of IPS-M-IN-130.



ECCENTRIC AND SEGMENTAL ORIFICE PLATES

Fig. 2

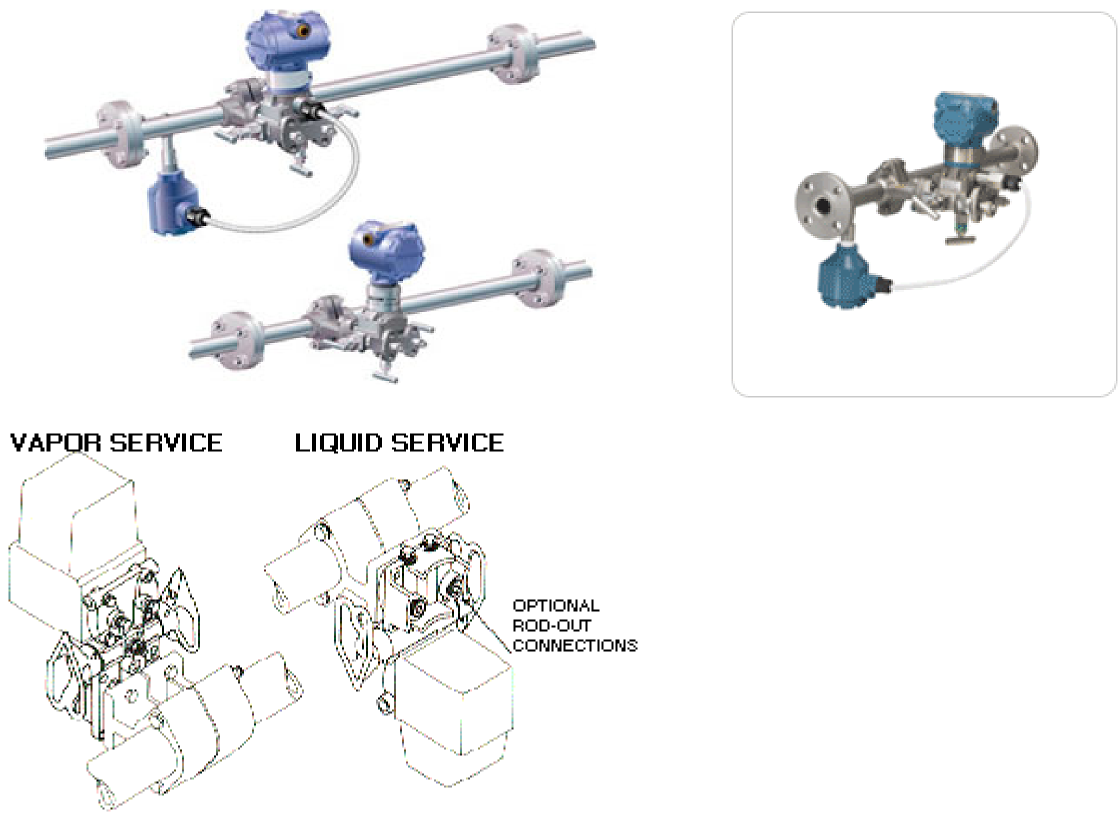
The quadrant-edge orifice is used for the flow measurement of viscous streams because of its relatively constant coefficient over a wide range of low Reynolds numbers. It is especially valuable where the viscosity is high and variable. In contrast, the square-edge orifice coefficients show increasing dependence on orifice Reynolds number(1), R_d, below 100,000. Square-edge orifice coefficient correction factors are available for Rd down to approximately 25,000.

(1) In some data, R_D (The Reynolds number for the pipe) is given; in other data, R_d, (the Reynolds number for the restriction) is given. The difference between these two numbers is shown in the following equation $R_D = \beta R_d$

The quadrant-edge orifice may be used when the line Reynolds numbers (R_D) range from 100,000 down to 3000 to 5000, depending upon the β ratio. It has a standard deviation of ± 1 percent for β from 0.3 to 0.6 and ± 1.25 percent for β from 0.25 to 0.3. It is recommended for measurement of flows when the Reynolds number, based on pipe diameter, is less than 10,000. When R_D is below the 3000 to 5000 range, the coefficient curve shows a hump, which is proportionally higher for longer upstream runs. The hump may be suppressed, even at values of RD below 1000, by taking the flow straight out of a vessel nozzle through a meter run of only a few pipe diameters ahead of the orifice. The hump may also be suppressed by using a screen, such as a multiplate flow straightener, a few diameters upstream.

Readings for flows exceeding the maximum Reynolds number limits may be very inaccurate. High-quality machining of quadrant orifice plates is important because the dimensions, shape, and smoothness of the edges can affect the accuracy of its readings.

A very small orifice plate or capillary that is an integral part of a diaphragm pressure transmitter is sometimes used for the measurement of very small flows. Flows as low as 0.04 cubic centimeters per minute of water equivalent or 0.027 standard cubic feet per minute of air may be measured using this method (see Fig. 3).



INTEGRAL ORIFICE FLOWMETER-LIQUID AND GAS

Fig. 3

Notes:

1) Upstream strainers or filters are optional, but highly desirable.

2) For continuous services, provide block and bypass valves to allow meter calibration.

3) Provide breakout unions where piping cannot be spread to remove meter body.

5.1.4 Sizing orifices

Equation and its terms definitions for Concentric, Square-Edge Orifice which are mentioned in API-MPMS-14.3.1,3 should be used for Concentric, Square-Edge Orifice plate Sizing.

For other Orifice Plates, Manufacturer producers with purchaser approval could be applied for orifice plate sizing.

It is common to size the orifice for a 2500 millimeter (100 inch) water column (dry calibration) at maximum flow. This permits either an increase or decrease in maximum flow, without changing the orifice bore, by an adjustment of the differential transmitter range. Smaller differentials, 1250 millimeters (50 inches) or 500 millimeters (20 inches), are now commonly used to save energy. For gas or steam flow, a good rule of thumb is that the meter range, in mm of water (inches of water), should not exceed the flowing pressure, in m bar absolute (pounds per square inch absolute).

The procedures for computing orifice sizes and flow through orifices are given in various publications (such as API-MPMS-14.3.1,3). Special slide rules are specially valuable for checking longhand or computer computations and for preliminary orifice sizing.

Programs and softwares to size orifices are also available for various computers and programmable calculators. Orifice calculations can be purchased from the manufacturers of orifice plates or flowmeters. Occasionally, only approximate physical properties of the flowing fluid are known before startup; in such cases a flow slide rule may be used to determine orifice size. Computations can be made later using actual flow conditions, or corrections can be applied to preliminary computations made with the approximate values.

Note:

Meter range shall be selected in accordance with the following:

a) For orifice meters, normal flow rate shall be between 70% and 80% of capacity, provided anticipated minimum and maximum flow rates will be between 30% and 95% of capacity;

b) If rangeability larger than 30% to 95% is required, two differential pressure transmitters connected to the same orifice taps shall be used.

5.2 Flow Nozzles

Flow nozzles are used less frequently than orifice plates. Their principal advantages are better pressure recovery and approximately 65 percent higher flow capacity for a given diameter than can be obtained under the same conditions with orifice plates. Flow nozzles may be used in light slurry service; however, accuracy is poor below certain Reynolds numbers. Meter run requirements, flange ratings, and tap requirements are generally the same as for orifice installations. However, because the d/D ratio for the same flow and line size is smaller, a shorter meter run may be used where the run length is based on the minimum run for the actual d/D ratio.

A typical flow nozzle is shown in Fig. 4. There are several forms of flow nozzles, one of the most common being the American Society of Mechanical Engineers' long-radius form. Properly installed and calibrated, flow nozzles are nearly equal in accuracy to sharp-edge orifices.

5.3 Venturi Tubes and Flow Tubes (Lo-Loss, Dall and Gentile Tubes)

5.3.1 General

Venturi tubes and flow tubes are frequently used in petroleum industries. Permanent head loss for these devices is lower than for other constricting primary elements. Venturi and flow tubes should be considered for all applications where minimizing head loss is an important factor. These primary devices are more costly than orifice or flow nozzle installations, and the long-form venture is the most expensive. The venture tube and flow tubes are shown in Fig. 4.

5.3.2 Venturi tubes

Venturi Tubes (see Fig. 4) give a much lower permanent head loss than orifices or flow nozzles. For a long-form venture tube, the approximate head loss will be between 10 and 14 percent of the measured differential, dependent upon the d/D ratio. Minimum runs are usually shorter for these tubes than for orifice plates or flow nozzles. As a rule, the manufacturer of the venture tube can supply the minimum length meter run data.

Although coefficients are available for the calculation of flow through venture tubes, the manufacturer may specify the flow for a given differential. Venturi tubes usually give an accuracy nearly equal to that of a thin-plate orifice.

Venturi tube flow coefficients are relatively stable over a wider range of Reynolds numbers than are the coefficients of sharp-edge orifices.

When properly purged, venture tubes are suitable for metering streams that contain solids. An increase in the solid liquid ratio will cause a higher reading.

5.3.3 Dall tubes

The dall tube is available as a fabricated line insert, approximately 2 diameters long. The static pressure tap is in a linesize section followed by a sharp shoulder and a steep, conical entrance to a short, cylindrical section, which has an annular slot, followed by a 15-degree conical diffuser, terminating with a shoulder (see Fig. 4).

Upon examination, the Dall tube gives the impression that a fluid flowing through it would be subject to a very high permanent head loss. Actually, the Dall tube head loss is only about 2½ to 6 percent of the measured differential as compared to 10 to 14 percent for the same flow in a long-form venture. The coefficient may vary for line Reynolds numbers below 500,000. Rounding of the sharp edges will cause slight variations in the coefficients.

Unless it is purged, the Dall tube should not be used for slurries or fluids that contain suspended solids because the annular throat slot is subject to plugging. Dall tubes require longer minimum meter runs than venture tubes.

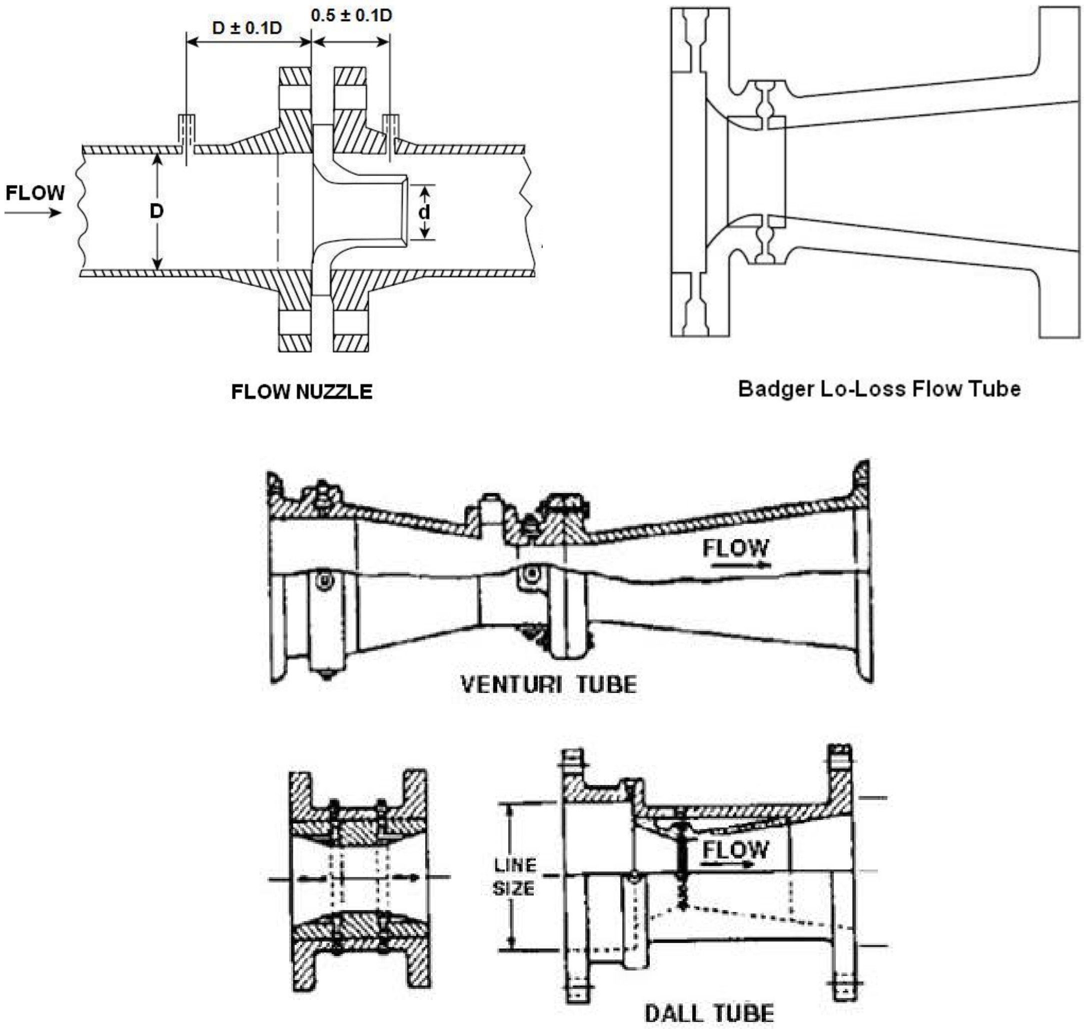
5.3.4 Gentile tubes

The Gentile tube has impact- and suction-type piezometer openings to increase the measured differential. The Gentile tube is short and gives a good differential with a relatively small amount of constriction (approximately 1½ diameters) (see Fig. 4). Its coefficients are the same for flow in either direction, and it is less expensive than a venture tube. However, Gentile tubes are very susceptible to line roughness.

Until sufficient data has been accumulated on the effect of manufacturing tolerances and upstream piping configurations on its accuracy, a Gentile tube should be calibrated for any application where accuracy is important.

5.3.5 Lo-loss tubes

The Lo-Loss tube is another type of differential producer designed for very high-pressure recovery. Its installation requires much less length than the venture tube, but its use should be restricted to relatively clean services (see Fig. 4).



FLOW NOZZLE, VENTURI TUBE, AND FLOW TUBES

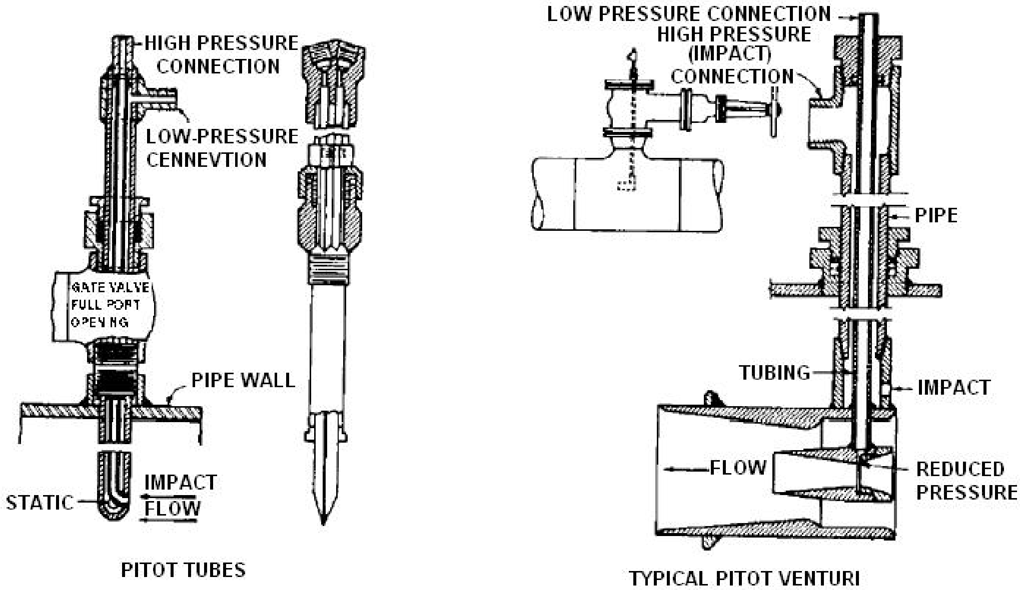
Fig. 4

5.4 Pitot Tubes and Pitot Venturis

Pitot tubes and pitot venturis are used where the pressure drop or power loss through other devices cannot be tolerated where accuracy is not of prime concern and where the pipe diameter is too large for acceptable orifice plate design (see Fig. 5). Frequently, these devices are used to measure high air and water flow rates. Pitot venturis are useful in applications where an ordinary pitot tube does not give satisfactory differential. However, they require a larger tap size. Pitot venturis should not be used in a liquid service of greater than 2.7 m (9 feet) per second if dissolved gases are present.

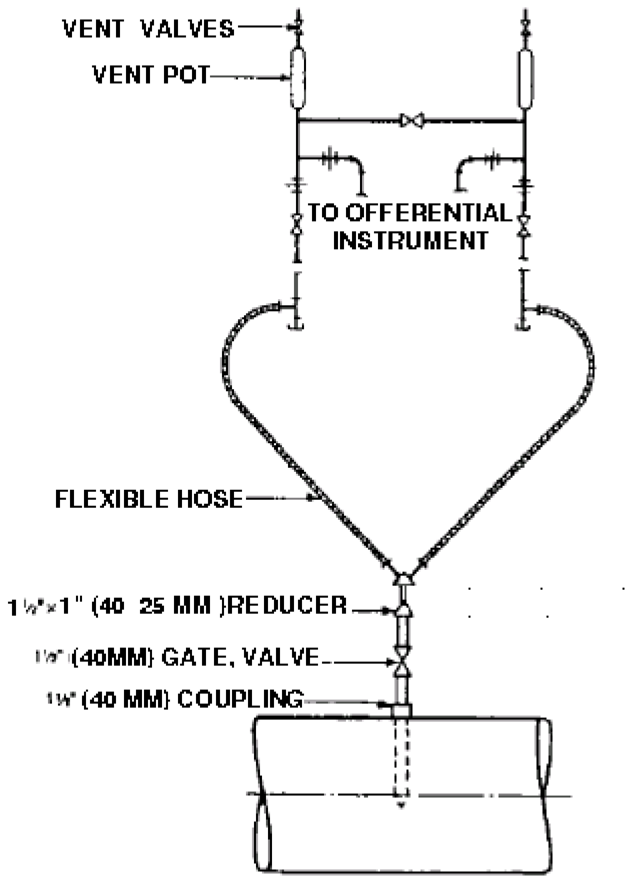
Higher velocities cause cavitation, and gas bubbles collect in the meter connecting lines. A traverse is required for good measurement unless there is sufficient straight upstream run to obtain a uniform velocity profile, except in cases where an averaging type of pitot tube is used.

Proper design will permit the installation or removal of pitot tubes and pitot venturis from lines that are in service. Care should be exercised when considering their use in hot oil or other hazardous service except in fixed installations designed to be leakproof. As the line size increases, the cost of pitot tubes and pitot venturis decreases in relation to other primary elements. A typical pitot tube installation is shown in Fig. 6.



PITOT TUBES AND PITOT VENTURI

Fig. 5



PITOT TUBE INSTALLATION

Fig. 6

5.5 Elbow Taps

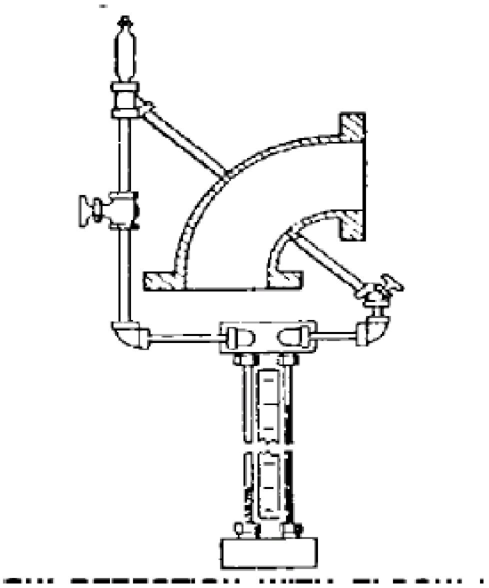
Flow measurement using elbow taps depends on a measurement of the differential pressure developed by centrifugal force as the direction of fluid flow is changed in a pipe elbow. Taps are located at opposite ends of a diameter in the plane of the elbow; the diameter which passes through the taps is at either 45 degrees or 22½ degrees from the inlet face of the elbow (Fig. 7).

Elbow taps have an advantage in that most piping configurations already contain elbows in which taps can be located. This allows economical installation and results in no added pressure loss. The measurement introduces no obstructions in the line. With normal precaution against accumulation of extraneous material in the differential pressure connections, elbow taps may be used to measure flow of almost any fluid.

As with other head-type primary flow measurement devices, the differential pressure developed by a given flow is precisely repeatable. However, the coefficient of an elbow tap calculated from the physical dimensions is generally considered reliable to only ±5 to ±10 percent. This is quite satisfactory for many flow control applications, where repeatability is the primary consideration.

If absolute accuracy is essential, a more precise type of meter is recommended, or an actual flow calibration of the system can be performed, preferably in place and using the working fluid. Data on elbow tap measurement is insufficient to establish precise correction factors for effects of upstream disturbances, viscosity, and roughness in pipe, elbow surfaces, etc.

Elbow taps develop a relatively low differential pressure. For this reason, their use is questionable for measurement of streams with low velocity. Typically, water flowing at an average velocity of 5 feet per second (roughly 200 gpm in a 4 inch pipe or 1.5 meters per second roughly 45 cubic meters per hour in a 100 mm pipe) through a conventional elbow with a center line radius equal to the pipe diameter develops about 10 inches of water differential pressure. This approaches minimum full scale value recommended for reliable measurement. Taps in long radius pipe or tube bends do not develop sufficient differential pressure for good flow measurement at low flow velocities.



FLOW DETECTION WITH ELBOW TAPS

Fig. 7

Care in installation of elbow taps is required, as it is with other head-type meters. Straight runs of pipe at least 25 pipe diameters upstream and 10 diameters downstream are recommended. The tap holes should be perpendicular to the surface of the elbow and slightly rounded at the pipe surface with no burrs or protrusions. Tap hole diameter should not exceed 1/8 of the pipe diameter. Elbows should be of the flange type with the elbow diameter equal to the pipe diameter. An elbow of smaller diameter than the pipe with a reducer between pipe and elbow has the advantage of higher differential for a given flow. Threaded elbows with the flow section larger than the pipe develop less differential pressure and introduce major uncertainty in calculated coefficient. Best results, particularly as to reliability of coefficient, are obtained with elbows with smooth inside surfaces. The elbow should be precisely aligned with the pipe with no projecting surfaces or gaskets protruding into the flowing stream either at the inlet or outlet of the elbow.

5.6 Metering Runs

5.6.1 Orifice taps

Orifice taps may be of several types, as shown in Fig. 8. Flange taps usually are preferred. Vena contracta taps and pipe taps sometimes are used. However, vena contracta taps cannot be used with some sizes and pressure ratings of weldingneck flanges because one or both taps may fall in an undesirable location in the flange hub or weld. Also, when changing orifice bore, the downstream tap must be changed.

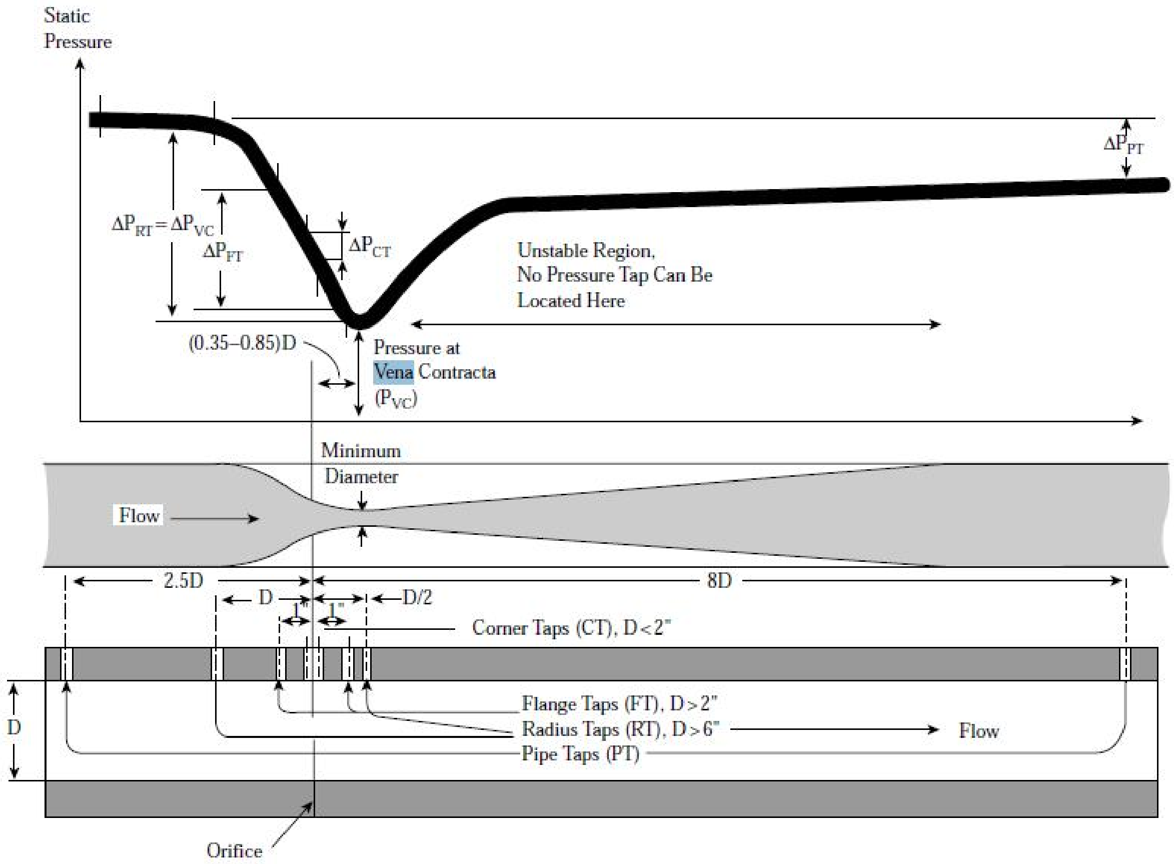
Radius or throat taps (those located 1 pipe inside diameter upstream and ½ pipe inside diameter downstream) can be used for some services. The downstream tap for the radius or throat tap sometimes falls either fully or partially into the flange hub.

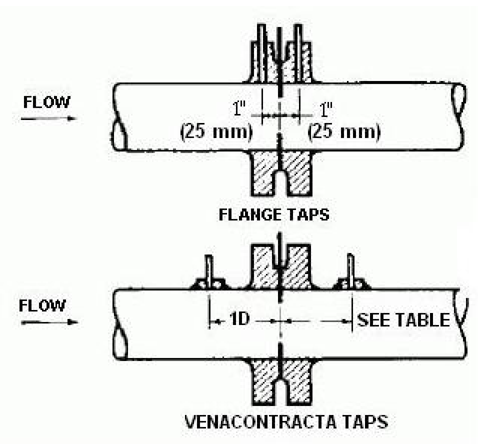
Corner taps are used sometimes, particularly on small lines where flange taps may be at the wrong location in the pressure profile. One type of corner tap orifice flange arrangement is shown in Fig. 9.

Pipe taps or full-flow taps, located 2½ diameters upstream and 9 diameters downstream, measure the permanent pressure loss. These can measure higher flow rates for a given meter differential than can flange, vena contracta, radius, or corner taps.

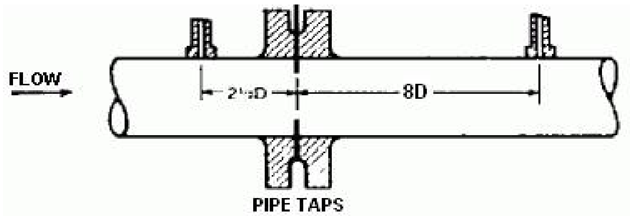
Orifice flanges with flange taps, as shown in Fig. 9 are generally used. These flanges have a minimum thickness of 40 millimeters (1½ inches). In the smaller sizes, they are thicker than the standard class 300 flange. Each tap should be positioned 25 millimeters (1 inch) from the nearest face of the orifice plate. It is important to allow for compressed gasket thickness.

For more detail information about another orifice flange ANSI Class refer to ANSI/ASME b 16.36 Standard.





d/D (β)……………..0.25 0.3 0.4 0.5 0.6 0.7
Distance from
Orifice plate
(in IDs)…………..0.84 0.80 0.74 0.65 0.56 0.45
Tolerance is approximately ± 0.1 D.



FLANGE TAPS, VENA CONTRACTA TAPS, AND PIPE TAPS

Fig. 8

Curves on allowable variations in pressure tap hole location versus β ratio can be found in MPMS 14.2 & 14.3. It is recommended that the tolerances for â ratio of 0.70 minimum be used.

For pipes smaller than 100 millimeters (4 inches), the tolerance is 0.6 millimeters (0.025 inches). This tolerance increases to 2 millimeters (0.065 inches) at a β of 0.40 or smaller.

If 20 millimeter (¾ inch) taps are used, minimum flange thickness should be 40 millimeters (1 ⅝ inches). Where piping specifications exclude threaded joints in primary piping, socket or fillet-weld-taps may be used with socket-weld block valves. If secondary piping may be screwed, the block valves may be socket-weld on one end and threaded on the other. Screwed taps may be seal-welded to minimize leakage. It is recommended that nipples to the first block valves be at least Schedule 160.

Between adjacent lines sufficient space should be provided for orifice taps, block valves, and connecting piping. Consideration should be given to room requirements for rodding or drilling out taps.

Special orifice plate holding fittings are available that make it easier to change orifice plates. With some of these devices, changing orifice plates is possible while the line is under pressure. These types are considerably larger, most costly, and require regular lubrication and maintenance. (see: 5.7)

5.6.2 Minimum length of meter runs

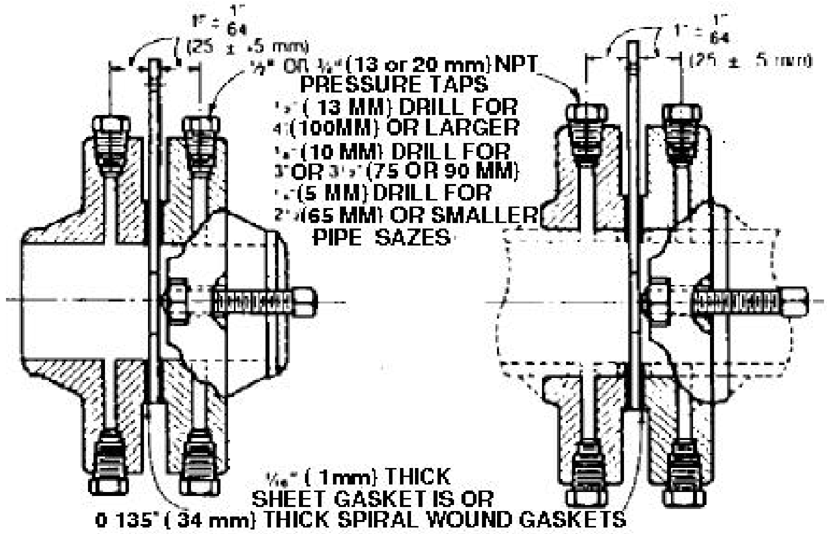
Meter runs should be designed with not less than a minimum length (usually given in nominal pipe diameters) of straight pipe preceding and following the orifice (see details 1 through 13 in Fig. 10 and Table 2). It should be noted that these show minimum lengths of run; these runs should be increased if practicable. If straightening vanes are used, refer to MPMS 14.2 & 14.3 for run requirements. Where pipe taps are used, the upstream run should be increased by 2 pipe diameters and the downstream run increased by 8 pipe diameters. The meter run length shown in Table 2, based on a minimum d/D ratio or 0.70, is recommended wherever practical, even if the actual d/D ratio is smaller. If other reasons make it necessary to use runs designed for less than 0.70 d/D, a future increase in d/D requirements should be considered. Straightening vanes should be avoided because of the possibility of their fouling or loosening.

5.6.3 Orientation of meter runs

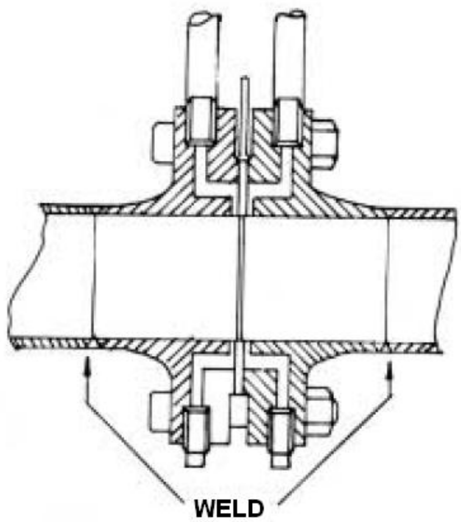
Vertical orifice runs, in liquid service and with widely separated pressure taps, may have a head error due to temperature differences. Although horizontal orifice runs avoid this head error, vertical orifice runs are often preferable for gas or steam flows containing appreciable amounts of condensate and for liquids containing vapor. Vertical flows should be upward for liquids; downward for wet gases and steam. The potential for error in vertical lines can be minimized by proper manifolding, or by using seals or purges. For steam, the condensate pots must be at the same level.

5.6.4 Minimum diameter of metering runs

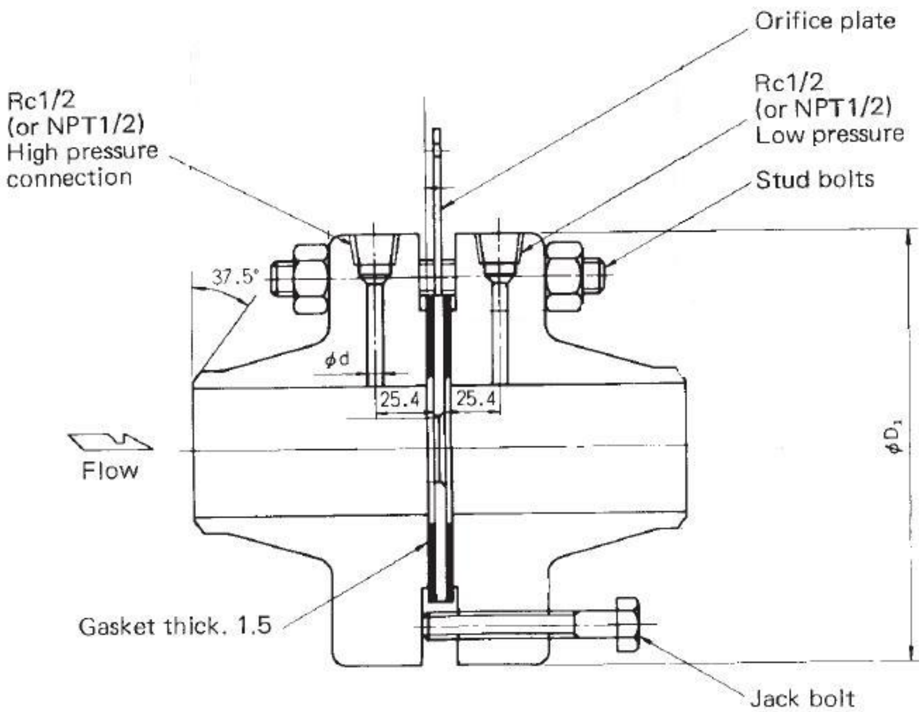
Metering runs for orifices should preferably be 50 millimeters (2 inches) or larger. In lines smaller than 2 inches, it is advisable to swage the line up to the 2 inch size for the metering run or to use rotameters, calibrated meter runs, or other special devices. Errors caused by the roughness of pipe walls become more pronounced in smaller-sized orifice runs. Small-size orifices are subject to plugging in all but the cleanest service.



FLANGE TAP RAISED FACE ORIFICE FLANGES
(WELDING NECK) (SLIP ON)



CORNER TAP FLANGES



Welding Neck Type

ORIFICE FLANGES

Fig. 9

Note:

To provide adequate clearance in 40 millimeters (1½ inch) and smaller pipe sizes, the pipe end is often made flush with the face of the raised face flange. In this arrangement, clearance to the plate is the thickness of the compressed gasket.

TABLE 2- d/D RATIO vs. STRAIGHT RUN REQUIREMENTS FOR ORIFICE MEASUREMENT

d/D Ratio	A	Straight Run Requirement (In Nominal Pipe Diameters) See Fig. 10						
		B	C	E	F	G	H	J
0.80	20	25	33	40	14	50	5	15
0.75	17	21	27	35	11	44	5	14
0.70	14	19	23	31	9	39	5	13
0.65	12	15	21	28	8	34	5	11
0.60	10	14	19	25	8	31	5	10
0.55	9	12	18	22	7	28	5	9
0.50	8	10	17	21	7	25	5	8
0.45	7	9	16	20	5	24	5	7
0.40	7	9	15	18	5	22	5	7
0.35	6	9	14	17	5	21	5	6
0.30	6	9	14	16	5	20	5	6
0.25	6	9	14	16	5	19	5	6

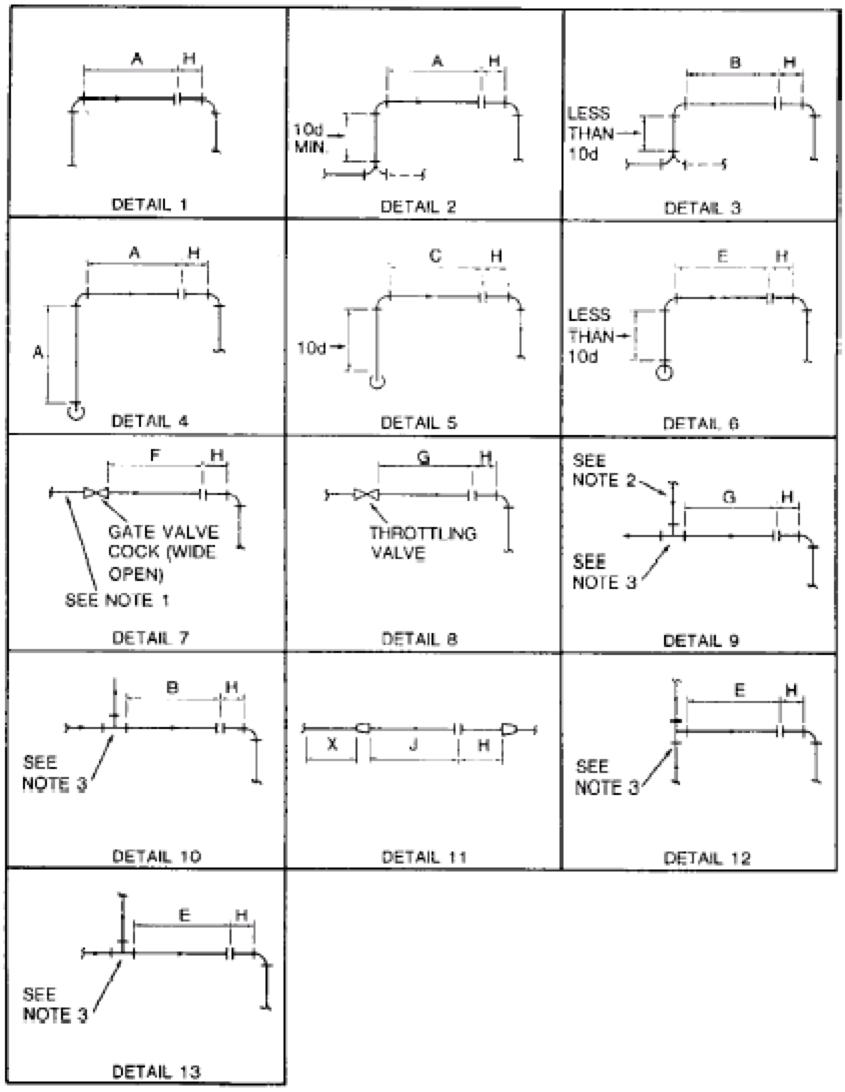
Notes:

1) When the valve is preceded by fittings, the straight run must be sufficient to cover their requirements.

2) If this line contains fittings in another plane, use Dimension C or E as required by Detail 5 or 6 in Fig. 10.

3) Double entry fittings may be considered as single bends when the line is normally blocked off, such as at spare pumps.

4) In fig. 9 Detail 11, X + J must be equal to the number of diameters required by previous fittings.



Straight Run Requirement

Fig. 10

Note:

See Table 2 for d/D values, run requirements, and detail notes.

5.6.5 Static pressure and temperature measurement locations

When metering gases, a static pressure tap should be installed in the main line near the primary measuring device. Either an upstream or a downstream pressure tap can be used, but the appropriate expansion factor must be employed for the type of tap selected. Pressure measurement from the downstream tap is recommended. This method is more commonly used because a given change in differential pressure causes less variation, based on downstream pressure, in the value of the expansion factor. However, the upstream tap may be used if variations in the expansion factor are to be neglected. The tap location is sometimes specified in some custody transfer installations by contractual requirements. A common practice is to use the downstream differential tap instead of a separate tap. Neither the upstream nor the downstream tap of flange taps gives a true measurement of line pressure, nor does the downstream tap of vena contracta taps. However, the error in flow rate is both small and predictable. Measurement of the static pressure is required to correct the apparent reading to a measurement of the actual flow.

It may also be desirable to measure the temperature of the flowing fluid, especially if the fluid is a gas, in order to make required corrections in the apparent flow value. Thermowells, if used, should be inserted in the line a sufficient distance from the primary element so that flow disturbances are prevented from affecting the measurement. On the upstream side, thermowells should precede the orifice by at least 20 pipe diameters. If straightening vanes are used, thermowells should be placed not less than 300 millimeters (12 inches) nor more than 900 millimeters (36 inches) upstream from the inlet edge of the vanes. Downstream thermowells should not be located closer than 5 pipe diameters.

5.7 Senior Retractive Orifice Fitting

This fitting provides a fast, safe and extremely simple method of changing orifice plates under pressure without interrupting the flow and eliminates costly by-passes, valves and other fittings required with conventional orifice flange installations.

The most popular senior orifice fitting, has a weldneck inlet and flanged outlet, see Fig. 11 B.

The senior orifice fitting is composed of two independent compartments separated by a hardened stainless steel slide valve. Side sectional view (Fig. 12 A) shows the slide valve in closed position and orifice plate concentric in line of flow. Slide valve cannot be closed unless orifice is concentric to bore of fitting.

Fig. 12 B shows the top closure in opened position with plate carrier inplace for change or inspection of orifice plate.

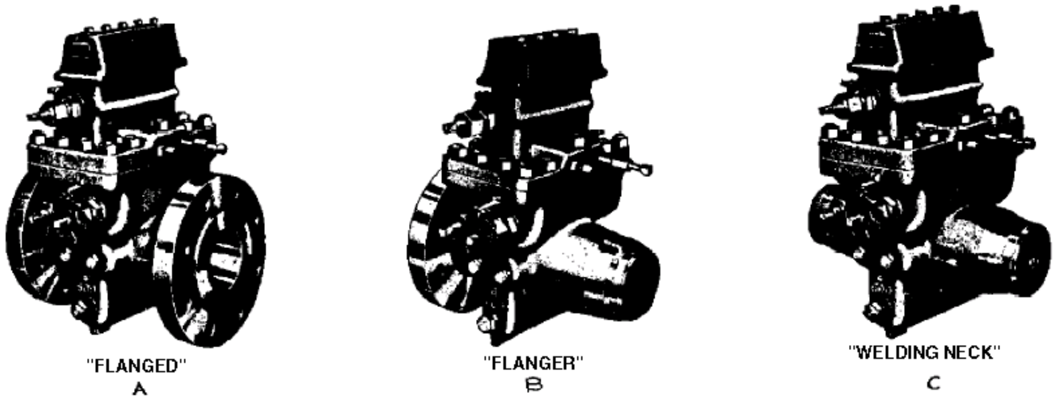
Only a few turns of the speed wrench are required to loosen screws to remove or replace clamping and sealing bars. Set screws always remain in clamping bar.

This feature adds greatly to speed and ease of operation.

Plate carrier is raised and lowered by double rack and pinion mechanism with power applied through speed wrench.

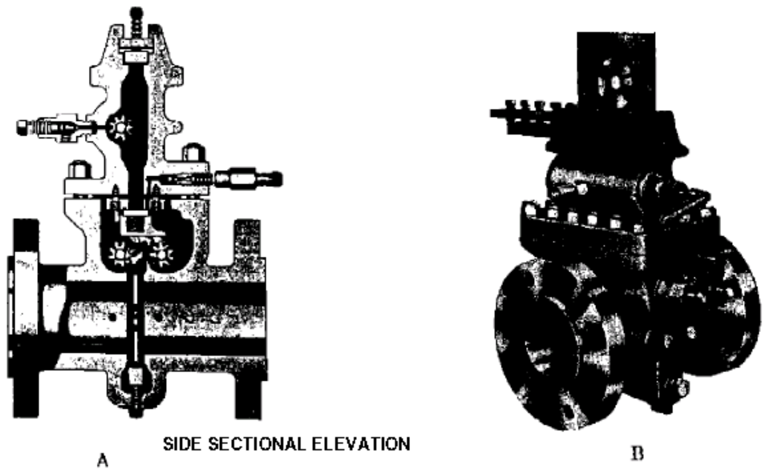
This method provides the quickest means of operation with the least amount of effort and assures positive control of plate carrier at all times.

All parts, including the essential slide valve assembly, may be replaced or repaired without removing fitting from line (see Fig. 13).



DIFFERENT TYPES OF SENIOR ORIFICE FITTING

Fig. 11



SIDE SECTIONAL VIEW OF SENIOR ORIFICE FITTING

Fig. 12

6) Lower plate carrier gear shaft.

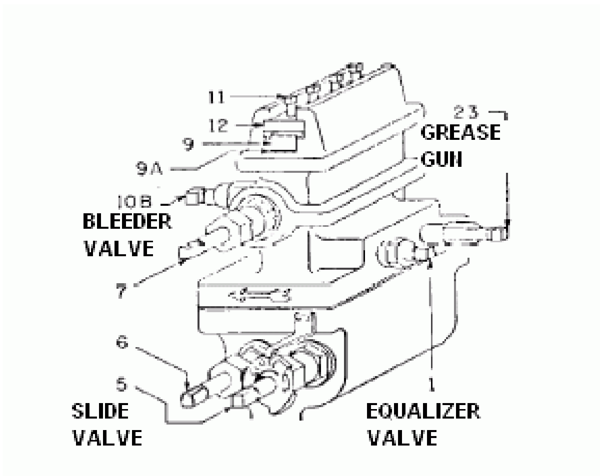
7) Upper plate carrier gear shaft.

9) Sealing bar

9A) Sealing bar gasket

11) Clamping bar screws

12) Clamping bar



ILLUSTRATING DRAWING OF SENIOR ORIFICE FITTING

Fig. 13

6. DIFFERENTIAL MEASURING DEVICES

Several types of measuring devices are used to determine the differential produced by the primary element. Flow is proportional to the square root of the differential; therefore, in order to maintain accuracy at low flow readings, a rangeability greater than three to one is not recommended.

For flow recorders, the charts most generally used are the 0 to 10 square root charts. Square root charts are available with various linear secondary scales for recording pressure, level or temperature on the same chart. A suitable meter factor is multiplied by the reading to give the actual flow.

By judicious sizing of the orifice, meter factors can be obtained in round figures. However, when the physical properties of the flowing stream change, it is much more convenient to change meter factors than it is to change the orifice plate or the meter range.

A large variety of special charts are offered as standard by various flow recorder manufacturers. Some users require direct reading charts or scales wherever practicable (or some reasonable combination of standard chart graduation with a whole number factor, preferably factors in multiples of 10).

For calibration of the flow measuring or differential device, a manometer or large multiturn test gage should be used to read the differential input. It is most convenient for the calibration devices to be graduated in the same units as the meter range (for example mm of water). Pneumatic outputs may be read on the same type of device. Electronic devices would utilize a high-quality volt or ammeter which would read these units directly, rather than on a square root or other scale related to the read-out device. Total flow may be obtained by planimetering flow charts or by equipping the meter with an integrator. Corrections must be applied for changes in the condition of the flowing stream.

Some flow transmitters are available only as blind transmitters, without direct reading scales. An output indicator with a 0 to 10 square root or other suitable scale may be furnished with this type of transmitter. An output indicator will allow flow to be read at the transmitter or control valve location, but it should not be used to calibrate the transmitter.

Some of the devices mentioned in 5.1 through 5.3 are usually supplied as blind transmitters without direct flow scales. In this case an output indicator with a 0 to 10 square root, or other suitable scale, may be furnished so that flow can be read at the transmitter or control valve location. This device should not be used to calibrate the transmitter.

Differential pressure transmitters used for protective systems duty shall be sized such that the cut in or cut out flow rate is at least 30% of the transmitter full-scale flow.

6.1 Diaphragm Transmitters

Different types of differential pressure transmitters of the diaphragm capsule are extensively used in petroleum plants, such as pneumatic, electronic and micro-processor based transmitters, with different types of sensors, such as capacitance, resonance wire and strain gage.

To provide overrange protection and damping, the body or capsule is liquid filled. The transmission signal may be either pneumatic, electronic or digital. These instruments generally are used without a seal or condensate pot because of their low displacement and corrosion-resistant construction. Gas meters are mounted slightly above the line to allow liquids to drain back. Liquid meters are mounted below the line to allow gas bubbles to work back to the line. If leads are short enough, the transmitter may be mounted level with the center of the line. With this arrangement, it makes little difference in accuracy if the opposite legs of the connecting piping contain liquid or vapor in different amounts.

Piping arrangements for diaphragm transmitters are according to IPS-C-IN-130.

6.1.1 Pneumatic transmitters

These transmitters are either force or motion-balance, with 3-15 psig output signal, and accuracy better than 1%. Usually applied when pneumatic control system is preferred.

6.1.2 Electronic transmitters

These transmitters utilize different types of sensors such as: piezoresistive, capacitance, resonance wire and strain gage, with solid state electronic, capable of transmitting a 4-20 mA output signal, via a 2 wire system. The usual accuracy is about 0.25% usually applied when electrical control system is preferred.

6.1.3 Micro-processor-based transmitters

These transmitters are called: smart, wise or intelligent transmitters up to the manufacturer.

Micro processor is partially utilized for ambient temperatures compensation. This feature is the main reason for the high accuracy of this type of transmitters.

The output signal is either 4-20 mA with accuracy of about 0.1%, and better, or digital signal with accuracy of about 0.07% or better.

These transmitters can be reranged and communicated remotely from any point of the loop through the hand held communicator, which is called hand held terminal (HHT), or smart field communicator (SFC), up to the manufacturer.

This type of transmitters is usually applied to be connected to D.C.S. system.

6.2 Bellows Meters

In the bellows-type meter, the bellows is opposed by a calibrated spring system and is filled to prevent rupturing when overpressured and to provide pulsation damping.

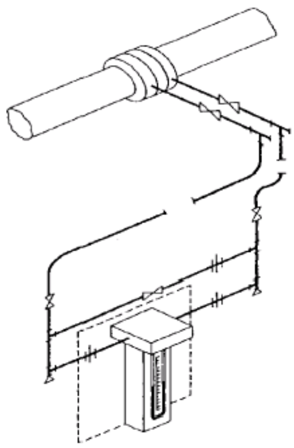
Seal chambers or condensate pots are not generally used. A 20 millimeter (¾ inch) tee has sufficient volume for a liquid seal or as a condensate pot in steam or condensable vapor service for instruments that displace less than 16 cm^3 (1 cubic inch) with full-scale deviation. However, if the displacement is much greater than 16 cm^3 (1 cubic inch), or if the differential of the instrument is low in comparison to the column displacement, regular condensate pots should be used.

Bellows meters have both top and bottom body connections. The top connections are used for liquid flow installations, and the bottom connections are used for gas flow installations to avoid the error caused by trapping gas or liquid, respectively, in the meter body. It is desirable to use 12 millimeter (½ inch) connections, which may require rotating the body chambers in some cases, where both 12 millimeter and 6 millimeter (½ inch and ¼ inch) connections are provided. It is suggested that the alternate tapped opening can be used as a drain or vent.

Typical meter piping is shown in Figs. 13 and 14.

6.3 Manometers

The simplest measuring device is the glass manometer, which may vary in form from the simple U-tube to the more highly developed singletube devices. These are of little use in process plants, except as test devices and as indicators on nonhazardous low-pressure streams. A manometer with manifold is shown in Fig. 14.



GLASS TUBE MANOMETER

Fig. 14

7. VARIABLE AREA METERS

7.1 General

Variable area meters are often called rotameters. They work on the principle that a float within a vertical tapered tube will assume a position that is a function of the flow rate passing through the tube from the bottom. The float must have a density greater than the measured fluid. The area (annular area) through which the flow must pass is the difference between the internal area of the taperd tube at the point of balance and the area of the float head. Since the internal area of the tube increases constantly and is continuously variable from bottom to top while the float head area remains constant, the term "variable area meter" is derived. At a constant differential pressure, flow is directly proportional to area.

7.2 Applications

Variable area meters are often used when wide rangeability, linear output, or the measurement of very low flow rates is required. When local indication only is required, their cost (especially in small sizes) is very attractive. Variable area flowmeters can be applied to relatively clean liquids and gases which have not deposit on the measuring tube or float.

7.3 Features

Variable area meters have the following characteristics:

a) Wide range of flow rates (frequently 10:1 or higher);

b) Accuracy of uncalibrated meters is typically ± 2 percent of full scale; of a calibrated meter ± 1 percent of rate over 10:1 range is not uncommon;

c) Good linearity;

d) High viscosity immunity;

e) Minimal effects of gas compressibility, since its expansion factor is near unity;

f) Common sizes are available from 3 to 50 millimeters (1/8 inch to 2 inches).

7.4 Typical Uses

Variable area meters are used in the following services:

a) Liquified petroleum gas or other volatile liquid measurement.

b) Freezing or congealing liquids such as waxes and asphalts. Steam-jacketed meters are available.

c) Streams with suspended solids, within reasonable limits.

d) Low flows, including purges.

e) Various acids.

7.5 Options

Variable area meters are available as indicators, transmitters, recorders, local pneumatic controllers, totalizers, or many combinations of the above, with or without alarms. Most meters are available with the through-flow or float extension design (see Figs. 15 and 16). Protective armor and steam tracing are available in many designs.

7.6 Limitations

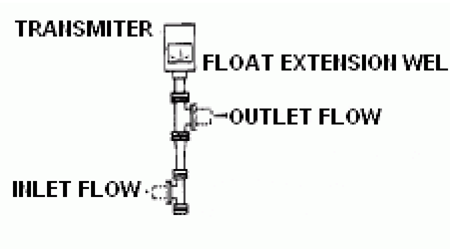
Variable area meters have the following limitations:

a) In large sizes (especially when exotic materials of construction are required) rotameters become quite expensive.

b) Glass tube meters, unless protected by suitable armor, should not be used on hazardous service. Metal tube meters as well as armored meters are available for hazardous service.

c) The user is unable to check calibration or change range.

d) Meters having magnetically coupled indicators or transmitters are subject to error if ferrous metal particles accumulate.



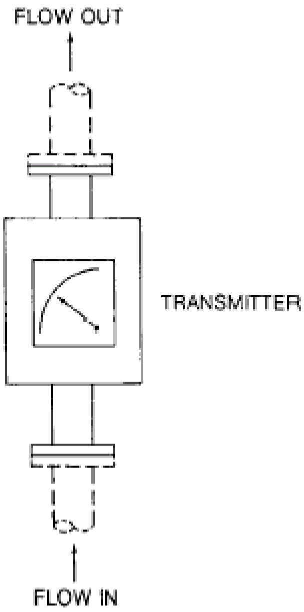
EXTENSION TYPE ROTAMETER

Fig. 15

7.7 Selected Range

For variable area meters, the maximum flow rate shall be selected to use manufacturer's standard tube and float, if possible.

Normal flow rate shall be between 60% and 80% of capacity, provided anticipated minimum and maximum flow rate will be between 10% and 95% of capacity.



THROUGH-FLOW TYPE ROTAMETER

Fig. 16

8. TARGET FLOWMETERS

8.1 General

The target flowmeter is a fluid flow measuring transmitter that generates an output signal directly proportional to the force applied on a target suspended in the fluid stream.

Flow is measured as the square root of the transmitted signal. The meter is contained in a body that fits between flanges, or it may have a short pipe sections extending upstream and downstream. A square-edge circular or a shaped metal target is secured to a beam, which holds the target at the center of the flow stream. The flow path is through the annular orifice around the target. The force on the target or the deflection of it becomes the variable that is related to flow rate by the square law (see Fig. 21).

8.2 Applications

Target meters are used for measuring the flow of viscous hydrocarbon streams. They may also be used for the measurement of other liquids, gases, or vapors.

8.3 Features

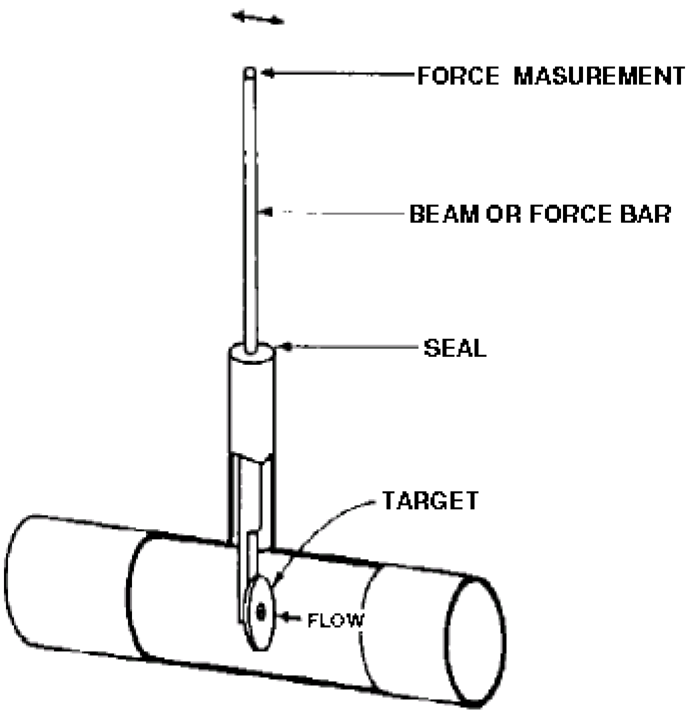
Target meters have the following characteristics:

a) Accuracy is typically ±2 percent of full scale reading;

b) They are available in a wide range of nominal line sizes, from 15 to 100 millimeters (½ inch to 4 inches);

c) They eliminate the need for pressure taps or purging;

d) They eliminate the need for heating when used for viscous flows.



TARGET-TYPE METER

Fig. 17

8.4 Typical Uses

Target meters are used in the following services:

a) Viscous flows

b) Hot asphalt

c) Tars

8.5 Options

Pneumatic or electronic transmission is available with either forcebalance or motion-balance transmitters.

Meters may be of either welded or flanged construction and, depending on design, may be used in relatively high pressure, 100 bar (1500 pounds per square inch), and temperature, 260°C (500°F), applications.

8.6 Limitations

Target meters are limited by the following characteristics:

a) Relatively high pressure drop;

b) Normal usable range (3:1 as for an orifice plate);

c) Inability to calibrate in place;

d) Cost of blocks and bypasses;

e) Possible plugging of the flow stream by large pieces of foreign matter;

f) Possible damage to the meter by large pieces of foreign matter.

g) Fluids that coat the target can cause it to become heavy.

h) Pressure effects, physical effects and flowmeter orientation can affect the zero adjustment of target flowmeters.

i) Rapidly changing flow, such as two-phase flow, and start up conditions (gas to liquid transitions), can similarly affect the mechanics of the target flowmeter and hence its zero.

9. TURBINE METERS

9.1 General

The turbine meter is a volumetric, fluid flow measuring meter with a pulse train output, the frequency of which is linearly related to flowrate. A turbine (rotor) located directly in the flow stream rotates at a rate proportional to the average velocity of the fluid passing it and hence proportional to the volume of the fluid being measured. Rotation of the turbine is usually sensed either magnetically or inductively by a sensing coil located outside the flow stream (see Fig. 18a).

Alternatively, the rotary motion may be mechanically extracted from the body magnetically or by a shaft through a packing gland. In some cases, the pulses generated are conditioned before transmission by a preamplifier mounted directly on or adjacent to the meter.

There are two type of turbine meter which has difference in rotary (impeller) part (see Fig. 18b)

a) Rim type

b) Helical type

For more details regarding turbine meter in liquid custody transfer refer to IPS-E-IN-240 Section 6.

9.2 Applications

Turbine meters are used primarily because of their accuracy and rangeability. The major application is the custody transfer (1) of light products or light crude oils. They are also used extensively for in-line product blending in refineries. Occasionally, turbine meters are used for process flow measurement where highly accurate, wide range measurement of very small flow rates is required.

Note:

(1) For more details regarding custody transfer refer to IPS-E-IN-240.

9.3 Features

Turbine meters have the following characteristics (for process flow measurement):

a) Accuracy of 0.25 percent of rate with repeatability of 0.10 percent is typical. To obtain the highest possible accuracies, some form of meter proving is required.

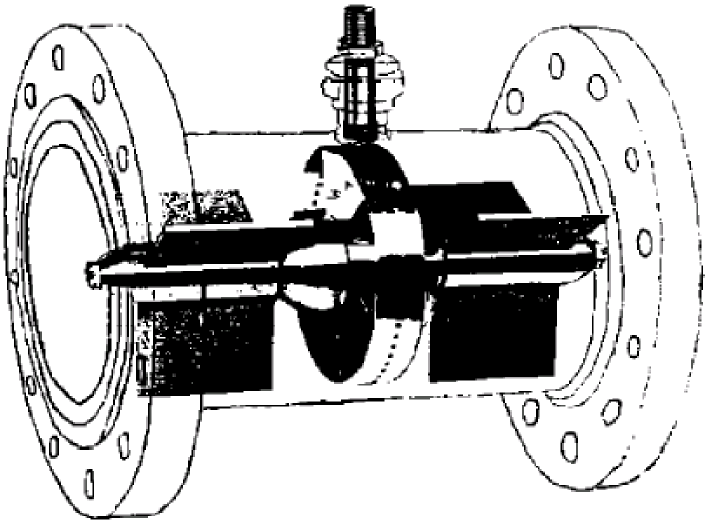
b) Rangeability typically varies from 7:1 to 75:1, depending on meter design, fluid viscosity, and meter size.

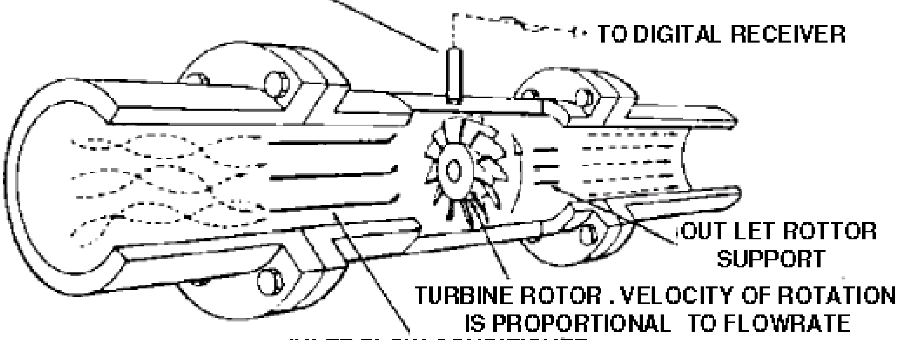
c) A high flow rate for a given line size is obtainable. Line velocity may be as high as 8 to 9 meters (25 to 30 feet) per second.

d) Very low flow rate designs, as low as 0.02 liters (0.005 gallons) per minute (although normally nonlinear in these ranges) are available.

e) Availability of very wide temperature ranges and pressure ratings.

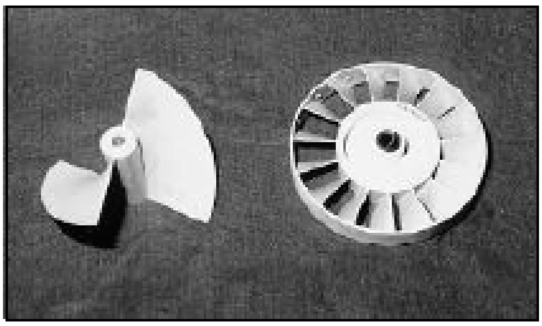
f) Turbine meters are available for bi-directional flow (as a special design).





TURBINE METER

Fig. 18a



(HELICAL) (RIM)

TURBINE METER IMPELLERS

Fig. 18b

9.4 Typical Uses

Turbine meters are commonly used in the following services:

a) Custody transfer of light products or crude oils;

b) In-line product blending;

c) Very accurate volumetric totalization;

d) Low flow rates of additives.

9.5 Limitations

Turbine meters are limited by the following characteristics:

a) Susceptible to wear or damage if process stream is dirty or nonlubricating.

b) Require considerable maintenance. Some meters must be returned to manufacturer for recalibration after bearing change.

c) Relatively high cost.

d) Strainers usually are required, and air eliminators (if applicable).

e) Turbine meters have unique relationship between accuracy, rangeability, viscosity, and meter size. Highest accuracy is obtainable with low-viscosity fluids. (Helical type turbine meters has lower relationship to viscosity than rim type)

f) Susceptible to damage from overspeed.

10. MAGNETIC FLOWMETERS (MAGMETERS)

10.1 General

A magnetic flowmeter measures the volumetric rate of flow of any liquid that has the required measure of electrical conductivity. Most petroleum hydrocarbons have insufficient conductivity to be measured with a magnetic flowmeter. For this reason, its use in the petroleum industry is restricted to certain services, such as water, acids, emulsions, and certain other solutions.

The meter consists of two parts, the magnetic flowmeter primary installed directly in the process line and a secondary element, the electronic transmitter. The meter generates a signal proportional to the volume of the flow.

The magnetic flowmeter operates on the principle of an electrical generator. It is based on Faraday's law of electromagnetic induction: when a conductor cuts across magnetic lines of flux, a voltage will be induced in the conductor that is directly proportional to the rate (velocity) at which the lines of flux are being cut. In the case of a magnetic flowmeter, the actual spool piece is an insulated section of pipe. An alternating magnetic field is impressed across it, and the process fluid itself becomes the moving conductor that cuts across the flux. A voltage that is proportional to the velocity of the process fluid is then induced and extracted via two metal electrodes located on opposite sides of the meter (see Fig. 19). This small alternating current (a.c.) voltage is then amplified and conditioned by the secondary transducer. Some magnetic flowmeters are excited by a pulsed direct current (d.c.) signal to eliminate noise and zero drift.

10.2 Applications

Magnetic flowmeters are widely applied on slurries, since they are obstructionless, and on corrosive fluids, since only the liner and electrodes are in contact with the process stream. They are suitable for very viscous fluids or where negligible pressure drop is desired.

Be especially careful when operating magnetic flowmeters in vacuum service because some magnetic flowmeter liners can collapse and be sucked into the pipeline in vacuum service. Note that vacuum conditions can occur in pipes that seemingly are not exposed to vacuum service such as pipes in which a gas can condense (often under abnormal conditions). Similarly, excessive temperature in magnetic flowmeters (even briefly under abnormal conditions) can result in permanent flowmeter damage.

Do not operate a magnetic flowmeter near its electrical conductivity limit because the flowmeter can turn off. Provide an allowance for changing composition and operating conditions that can change the electrical conductivity of the liquid.

For slurry service, be sure to size magnetic flowmeters to operate above the velocity at which solids settle (typically 1 ft/sec), in order to avoid filling the pipe with solids that can affect the measurement and potentially stop flow. Magnetic flowmeters for abrasive service are usually sized to operate at low velocity (typically below 3 ft/sec) to reduce wear. In abrasive slurry service, the flowmeter should be operated above the velocity at which solids will settle, despite increased wear. These issues may change the range of the flowmeter, so its size may be different than the size for an equivalent flow of clean water.

10.3 Features

Magnetic flowmeters have the following characteristics:

a) Accuracy of the magnetic flowmeter is typically 0.5 per-cent of full scale.

b) The magnetic flowmeter responds only to the velocity of the flow stream and, therefore, is independent of density, viscosity, and static pressure.

c) Since this type of meter tends to average the velocity profile between the electrodes, neither long runs of upstream or downstream pipe nor flow straighteners are needed, unless percent of rate accuracy is required.

d) Rangeability is 10/1 or greater.

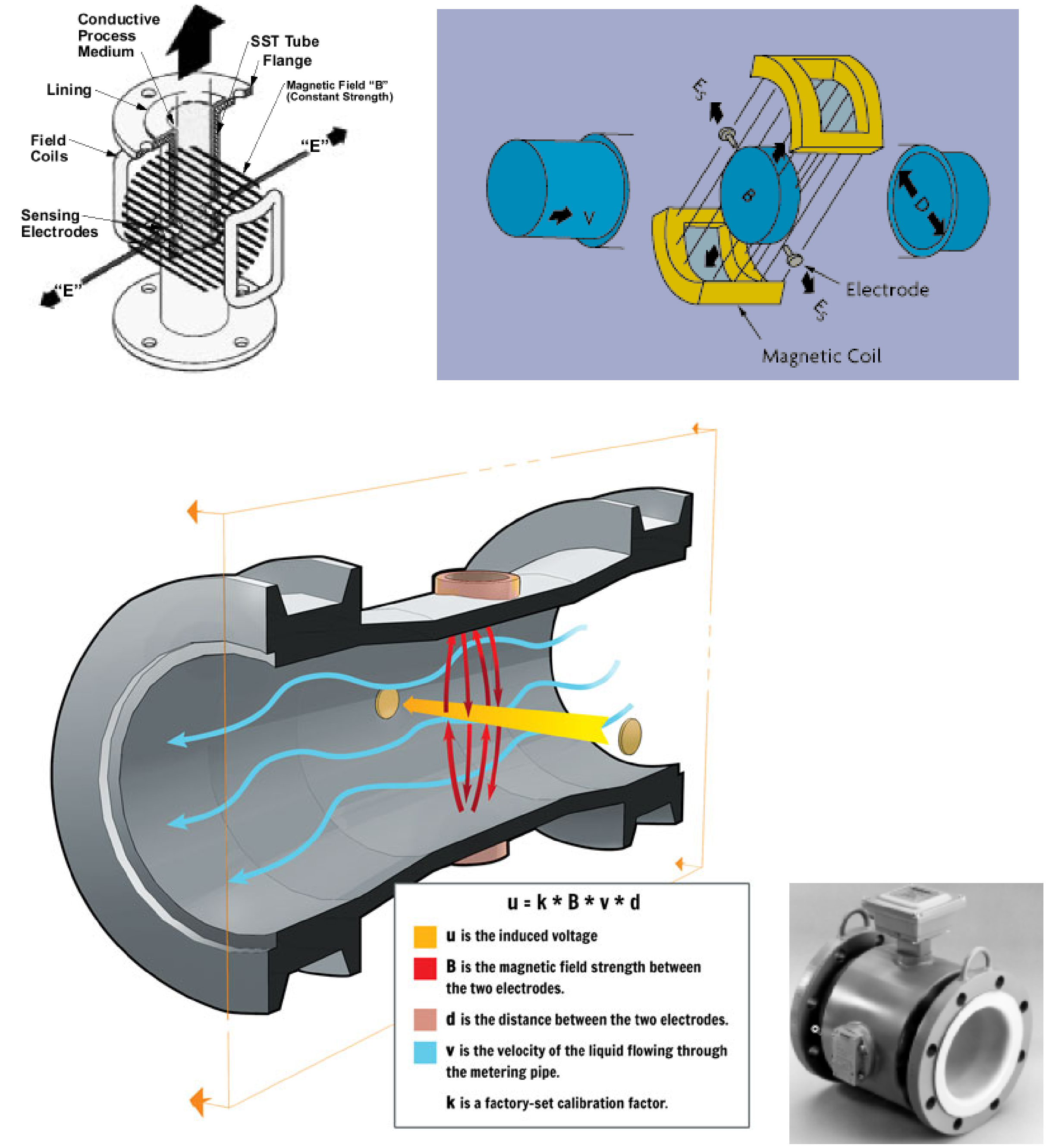
e) Bi-directional flow may be measured.

f) Temperatures from -40 to 260°C (-40 to 500°F) may be handled.

g) Pressures from full vacuum to 2000 bar (30,000 pounds per square inch) are possible.

h) There is a negligible pressure drop.

i) A large variety of sizes are available, from 2.5 millimeters to 2.5 meters (1/10 inch to 96 inches), or even larger.



MAGNETIC FLOWMETERS

Fig. 19

10.4 Typical Uses

Magnetic flowmeters are commonly used to measure the following types of flows:

- **a)** Slurries;
- **b)** Acid streams;
- **c)** Very small flows;
- **d)** Very large flows;
- **e)** Very viscous fluids.

10.5 Options

A wide variety of options are available for recording, indicating, controlling, totalizing, or batching. Percent of rate accuracy is one option. Various electrode cleaning devices are also available.

10.6 Limitations

Magnetic flowmeters are limited by the following characteristics:

a) The process fluid typically must have a conductivity of 2 micromhos per centimeter. Special conductivity units are available for fluids with a conductivity as low as 0.1 micromhos per centimeter.

b) Special care is required for erosive application.

c) Magnetic flowmeters cannot be calibrated in place.

d) Relatively high cost.

e) Is not suitable for petroleum hydrocarbons.

11. POSITIVE DISPLACEMENT METERS

11.1 General

There are five main types of positive displacement meters: nutating disk (wobble plate), oscillating piston, fluted rotor, rotary (lobed impeller and sliding vane), and oval-shaped gear.

All positive displacement meters measure flow by mechanically trapping successive volumetric segments of the liquid passing through the meter. The number of segments is converted to shaft rotation. A gear train and a calibrator convert shaft rotation to appropriate volumetric units. The output is usually a mechanical register or ticket printer. Temperature compensators are available to correct the output as the fluid temperature changes. Pulse generators are available to provide pulse outputs for meter proving or remote read-out and local indicator.

11.2 Applications

Positive displacement meters are used because they are accurate over a wide flow range. They are often used for custody transfer, particularly for heavy or viscous fluids.

Occasionally, positive displacement meters are used for heavy product blending or for refinery process flows.

11.3 Features

Positive displacement meters have the following characteristics:

a) Typical accuracies are 0.2 percent of actual flow. Highest accuracy requires some form of meter proving. Typical repeatabilities are: 0.05 percent.

b) Rangeability is typically 10:1 or more. Positive displacement meters have good rangeability and accuracy, particularly with heavy or viscous fluids.

c) Positive displacement meters come in a range of sizes from 0.38 liter per minute (0.1 gallon per minute) to 34000 liters per minute (9000 gallons per minute) or better.

11.4 Typical Uses

Positive displacement meters are used in the following services:

a) Custody transfer

b) Relatively heavy, viscous hydrocarbon streams

c) Water, caustic, or acid measurement

d) Volumetric totalization rather than rate of flow

11.5 Optional Features

Positive displacement meters are available with the following options:

a) Temperature compensators to provide read-out in 15°C (60°F). Some temperature compensators include a manual adjustment to permit setting an appropriate specific gravity.

b) Calibrators to correct the register reading after the meter is calibrated.

c) Ticket printers, and counters.

d) Pulse generators to provide pulse trains suitable for meter proving or remote transmission of flow data.

e) Pressure lubrication to allow the meter to be used with nonlubricating fluids.

f) Strainers and air eliminators.

11.6 Limitations

P.D meters are limited by the following characteristics:

a) The material selection and low internal clearances of positive displacement meters are usually designed to match a range of specific fluid properties and design conditions. Operating the meters outside of this design range may cause serious inaccuracy or premature meter failure.

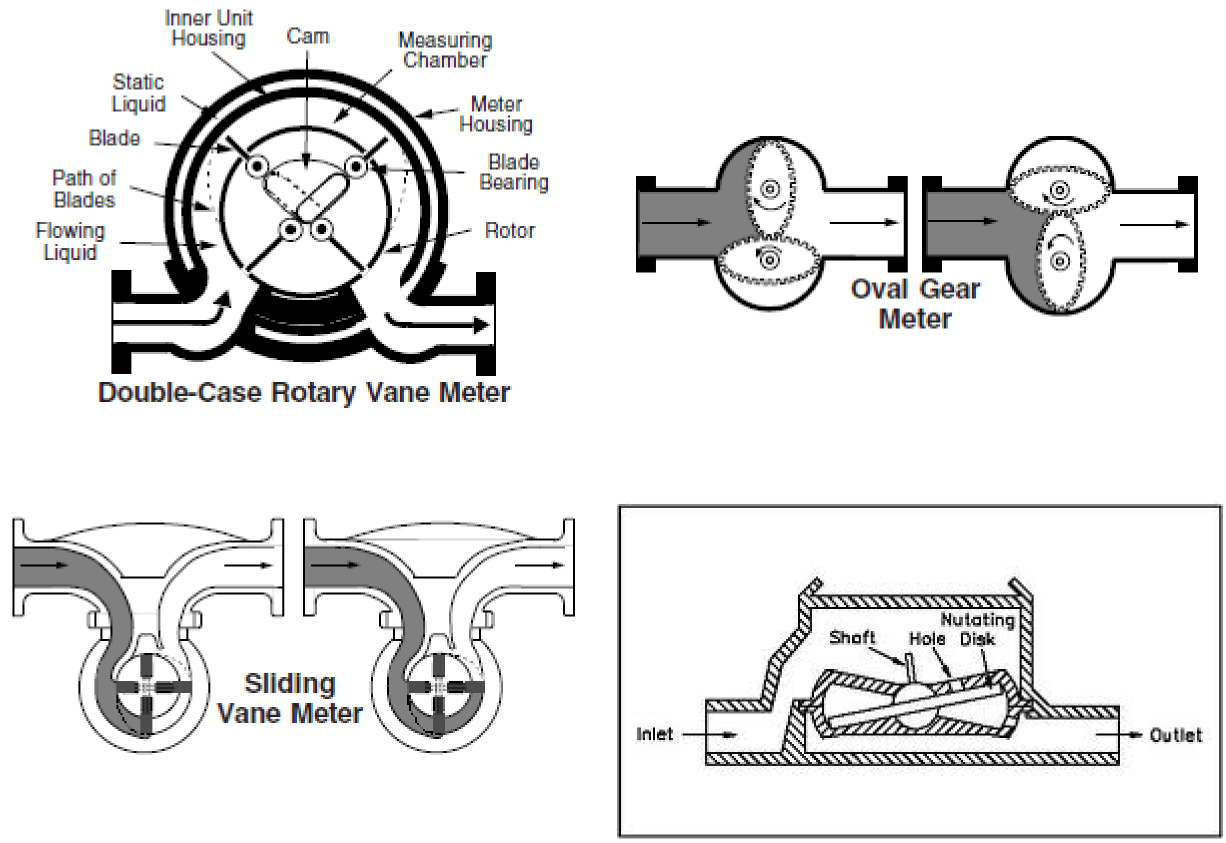
b) Susceptible to wear or damage if process stream is dirty.

c) Require considerable maintenance.

d) Relatively high cost.

e) Strainers and air eliminetors are usually required.

f) Susceptible to damage from overspeed.



NUTATING DISK

POSETIVE DISPLACEMENT TYPE METERS

Fig. 25

12. VORTEX FLOWMETERS

12.1 General

When a specially designed bluff body obstruction is placed in a liquid or gas stream, a vortex train is generated. This train of highland low-pressure areas can be measured by sensors on the body or the pipe wall. The frequency of the pressure changes is directly and linearly related to the velocity of the fluid stream. Since flow in any pipeline is a function of cross-sectional area and velocity, there is a direct relationship between frequency and flowrate.

12.2 Applications

Vortex meters are used primarily because of their wide rangeability and accuracy. In certain cases, their relatively low cost may also dictate their use.

12.3 Features

Vortex meters have the following characteristics:

a) Wide rangeability (15:1 for liquids; 50:1 for gases)

b) Reasonable accuracy

c) Sizes from 2.5 to 30 centimeters (1 to 12 inches) (larger sizes are insertion-type)

d) Linear output

e) Pulse output (makes totalization easy and accurate)

12.4 Typical Uses

Vortex meters are commonly used in the following services:

a) Steam

b) Cooling water

c) Process water

d) Light hydrocarbons where large turndown is required

e) Any gas flow where large turndown is required

12.5 Options

Either pulse or analog output is available. Local indicators are also available. Certain manufacturers offer two-wire transmitters.

12.6 Limitations

Vortex meters have the following limitations:

a) A limited range of construction materials is available;

b) On liquids, vortex meters should not be used for slurries or for high-viscosity liquids;

c) As with most flowmeters, users cannot check fluid calibration or change range without reducing rangeability;

d) Vortex meters have an upper temperature limit;

e) Bouncing ball types are limited to clean fluids;

f) Fully developed turbulent flow is required;

g) Most meters will not tolerate much greater than 50 percent overrange.

13. MASS FLOWMETERS

13.1 General

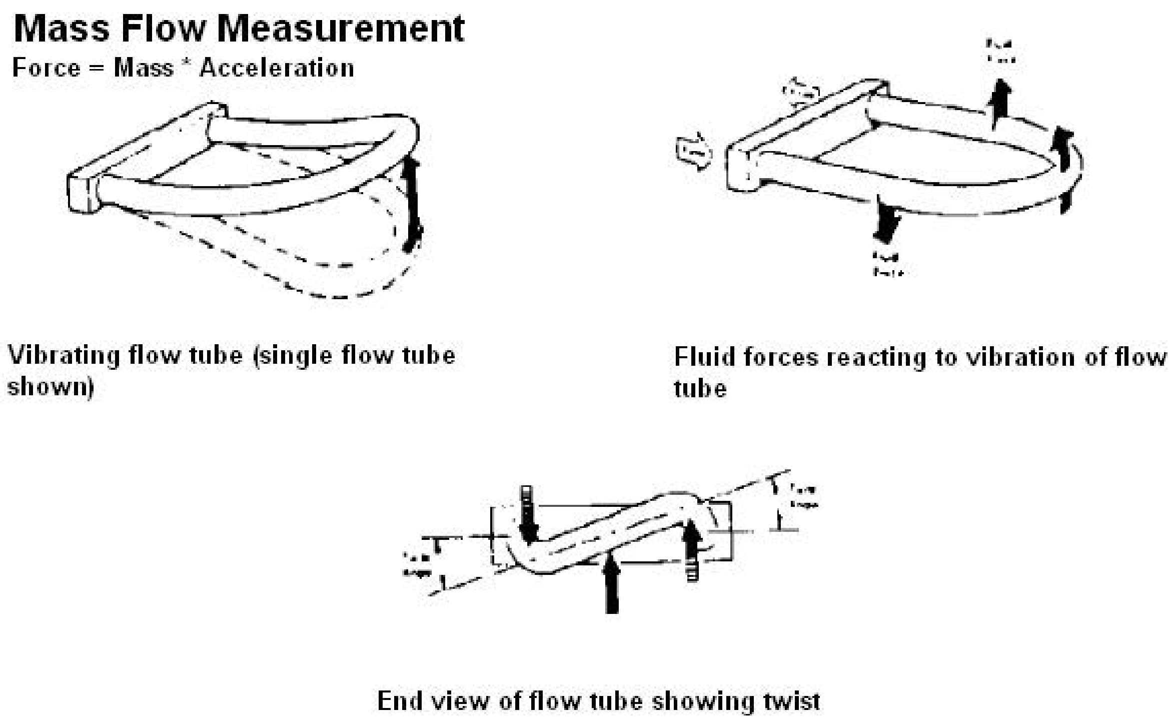
A Coriolis flow meter directly measures the mass of a fluid in motion. The basic theory behind operation of a Coriolis sensor is Newton's second law of motion:

Force= Mass. Acceleration

By applying a known force to an unknown mass and measuring its acceleration, mass rate can be precisely determined.

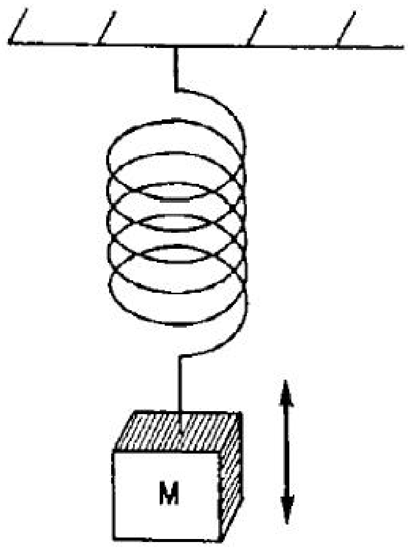
Application of this theory to actual Coriolis flow measurement is illustrated in Fig. 20. In a Coriolis flow meter, a given force is applied to a flow tube assembly causing it to vibrate. As mass is passed through the tube, it resists the perpendicular acceleration of the tube assembly causing the tube to twist slightly. The resulting tube velocity is determined by measuring the time delay between the two ends of the tube assembly as indicated by the twist angle shown in the Figure. With a known force and a measured velocity, the mass rate is directly determined. In Coriolis instruments, mass rate is measured at accuracies as high as ±0.15% of full scale.

Unlike other flow measurement technologies, a Coriolis meter has the capability to directly measure density in addition to mass flowrate. The theory of direct density measurement is based on the physics of a spring and mass assembly as illustrated in Fig. 21.



DIRECT MASS FLOW MEASUREMENT IN A CORIOLIS SENSOR

Fig. 20



DENSITY MEASUREMENT IN A CORIOLIS SENSOR

Fig. 21

Spring and mass assemblies can be characterized by the following relationship:

Frequency of Oscillation = $\frac{1}{2\pi}(\frac{K}{MASS})^{\frac{1}{2}}$

Here, k represents a constant which is characteristic of a given spring assembly. Once a spring has been calibrated with a known mass to determine this constant, an unknown mass can be directly determined by measuring the oscillation frequency of the spring.

In a Coriolis instrument, the flow tube acts as the vibrating spring assembly (Fig. 26) with the mass inside the tube rather than on the end of a spring. While the tube is driven to vibrate at a given amplitude, the tube is driven to vibrate at a given amplitude, the tube frequency changes as the mass of material in the tube gets heavier or lighter. Measuring the frequency of oscillation of the tube provides a direct mass measurement of a known volume of fluid (based on the tube diameter and length) and a direct density measurement is obtained. A Coriolis instrument can measure density to an accuracy of ± 0.0005 g/cc.

Density measurement

Frequency of oscillation = $\frac{1}{2\pi}(\frac{K}{\rho v})^{\frac{1}{2}}$

Where ρ is the density on the metering conditions and V is the volume under metering conditions.

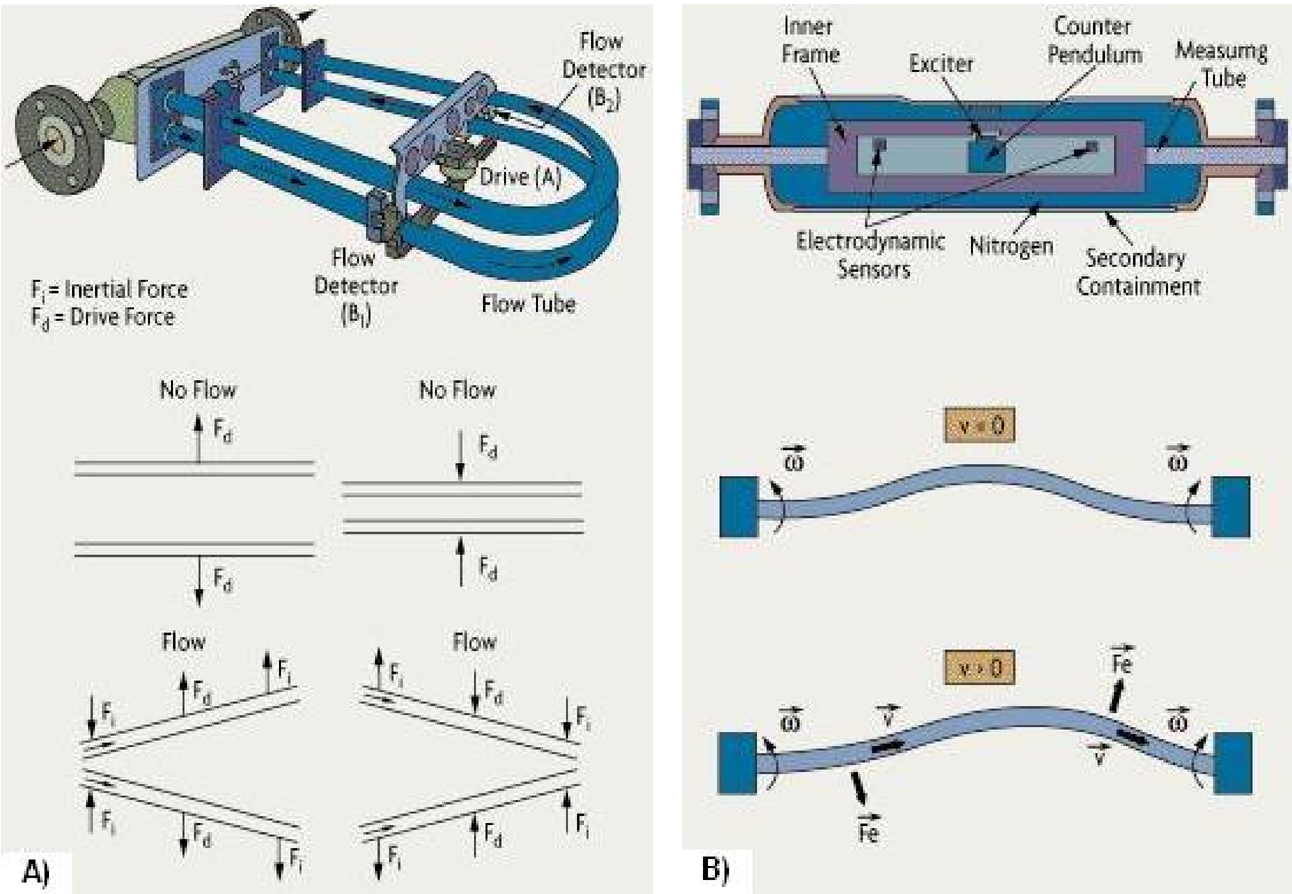
Frequency of oscillation is a function of fluid density results in 2 measurements from 1 sensor.

THE VIBRATING SPRING AND MASS ANALOGY

Fig. 22

13.2 Applications

Coriolis technology has been applied throughout the chemical industry since 1976 for precision flow and density measurement of fluids. Early sensor designs were limited to application in controlled environments due to their sensitivity to external environmental changes. In 1983, a more practical design was developed, utilizing two flow tubes to reference fluid measurement in each tube directly to the other tube (fig. 27). This design essentially eliminated problems with environmental sensitivity and greatly expanded Coriolis application.



MASS FLOWMETER WITH TWO FLOW TUBES

Fig. 23

13.3 Features

Coriolis (Mass flow) meters have the following characteristics:

a) Accuracy of the mass flowmeter is typically ±0.2% of full scale.

b) Rangeability is 80/1

c) Repeatability is as high as ±0.05%.

d) Line sizes are from 6 mm to 200 mm (¼ inch to 8 inch).

e) They are non-intrusive (obstructionless) meters, and without moving parts.

f) They eliminate the need for pressure taps or purging.

g) Availability of very wide temperature ranges, from -204°C to +204°C (-400°F to +400°F) and pressure ratings (up to 330 barg or 5000 psig depending on size).

h) Coriolis technology provides direct mass measurement independent of changing fluid properties, therefore, temperature, pressure, viscosity and specific gravity compensation is not required.

i) Can be used to measure, the density, volumetric flow rate, %concentration (% solids) of a two component (or slurry) stream. Use of % concentration measurement with the direct mass rate also provides a device to measure and batch net materials such as catalyst slurries.

j) Direct, in-line coriolis mass measurement eliminates the need for expensive, high maintenance weigh scales, which have traditionally been used in batch loading applications.

k) Upstream / downstream straight piping not required.

13.4 Typical Uses

Mass flowmeters are commonly used in the following services:

a) Can be used in every process industry, from food and beverage manufacturing to oil refining and petrochemical processing.

b) Batch loading applications;

c) Material balances applications;

d) Custody transfer,light and heavy fluids;

e) Slurries;

f) Very viscous fluids;

g) Low flow rates of additives;

h) In-line product blending;

i) Multi-phase fluids.

13.5 Options

This type of flowmeters can be provided with micro-processor based transmitters, which can supply: 4-20 mA, pulse, alarm contacts, and digital output signal.

13.6 Limitations

Mass flowmeters are limited by the following characteristics:

a) Sensitive to external environmental changes (pressure and temperature changes).

b) Sensivity to piping vibration.

c) Relatively high weight (about 80 kg, for 2" size flowtubes)

d) The maximum size available is 6 inch, and for some manufacturers is 2 inch.

e) Relatively high pressure drop.

f) Relatively high cost.

g) Meters to be used in/with hazardous locations and fluids are costly.

14. ULTRASONIC FLOWMETERS

14.1 Principle. There are two main types of ultrasonic flowmeter employing different principles to measure flow, e.g. doppler and transit time.
For each of these methods of measurement there are variations for different applications. These include the use of different paths and layouts, e.g. direct or zigzag across the pipe and more sophisticated measurement techniques to give better accuracy.

15. METER PROVING FACILITIES

Meter proving facilities shall be available for all flow meters used for custody transfer unless otherwise agreed in writing by the user.

Depending on the location, the meter proving facilities may be owned and operated by the user, by a body recognized by the user and the local authorities and/or the customer who will purchase the measured product. Where such facilities are not already available, they shall be provided as part of the project.

Note:

Local regulations or the nature of the application may require that meter proving is carried out or witnessed by local authorities or by an independent third party.

The process engineering flow schemes and the instrument data sheets shall indicate:

- Where meter proving facilities are required;
- Specifications of facilities such as master meters, mechanical displacement provers or tank provers;
- Whether these facilities shall be mobile or permanently installed.

Preference shall be given to in-line meter proving under actual operating conditions and flow rates. Permanent installation (including manifolding) of proving facilities shall be fully detailed in the engineering flow schemes.

Where mobile facilities are specified, the piping shall have provisions for the insertion of a master meter or a meter prover into the line in which the meter is installed, the meters shall then be accessible with the mobile prover.

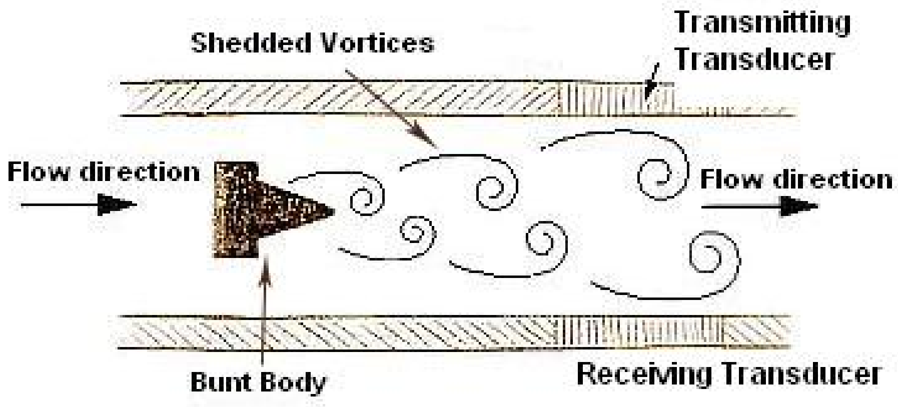
Note:

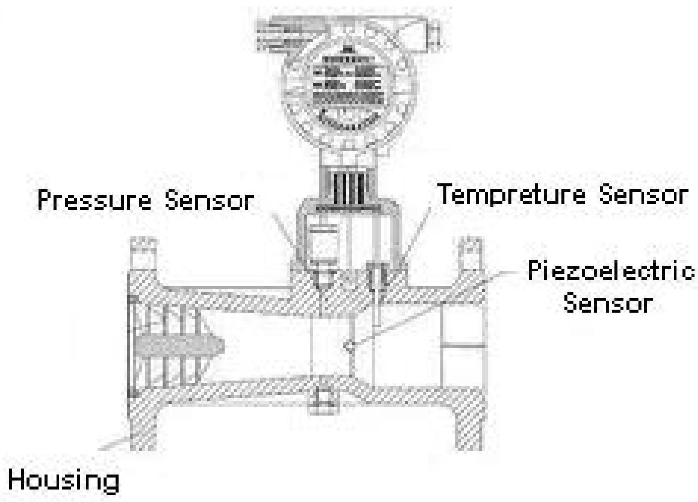
1) For more details concerning custody transfer, refer to IPS-E-IN-240.

Where master meters are used, a meter prover shall be available for their calibration.

For meter provers, preference should be given to mechanical displacement provers. Only where this is not possible or allowed by the local authorities, shall meter prover tanks be provided.

Meter provers shall comply with Chapter 4, of the API Manual of Petroleum Measurement Standards and IPS-M-IN- 240.





VORTEX TYPE FLOWMETER

Fig. 24

APPENDICES

APPENDIX A

FLOWMETERS SELECTION TABLE

		Application																	
		Liquids (see note 1)								Gases (see note 2)					MIscellaneous (see note 3)				
Group	**Type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**S**	**T**
1	Orifice	t	?	t	t	t	t	t		t	?	t	t	t	?	t	?	?	?
	Venturi	t		t	t	t	t			t	?		?	?	?	t	?	?	?
	Nozzle	t		t	t	t	t			t	t	?	?	t	?	t	?	?	?
2	VA	t	t			#	?		t	t	t							?	
	Target	t				#				t				t	?	t	?		
	Averaging pitot	t		t	t	t	?	t		t		t	t	t		t	?	?	?
	Sonic nozzle									t	t	?	?						
3	Sliding vane	t		#			t		t							?			
	Oval gear	t	t	#		#	t		t							?		t	
	Gas diaphragm	t	?			#	t		t	t	t					?		#	
	Rotary gas									t	t								
4	Turbine	t		t	#	t	?	t	t	t		t				?	?	#	
	Pelton	t	t			t		t		?	?					?		?	
	Mechanical	t													#	?			
	Insertion turbine	t		t	t	t		t		t		t	t	?		?	?		
5	Vortex	t				t		t	t	t		?	t	t		?			
	Swirlmeter	t								t									
	Insertion vortex	t		t	t	?		?	?	t		t	?	t		t		?	?
6	Electromagnetic	t	t	t	t	#	?		t						t	t	?	t	
	Insertion electromagnetic	t		t	t	?			t						?	t	?	t	
7	Doppler	t		?	?	#			t						t	t	?	?	
	Transit time	t	?	t	t	#	?	#	?	#					?	?		#	#
8	Coriolis (direct)	t				#	t		t	?					?	?		#	
	Twin rotor (indirect)	t																	
9	Anemometer	t		?	?	#				t									
	Thermal mase		#							t	t								
10	Tracer	t	#	t	t	t	t	t		#		#	t	t		?	t	#	#
	Laser	t		?	?														

Key
t is suitable; generally applicable
? is worth considering; sometimes applicable
is worth considering, limited availability or tends to be expensive
A blank indicates unsuitable; not applicable

NOTE 1. Liquid applications are indicated by the following:
- A General liquid application (< 50 cP) (< 0.05 Pa.s)
- B Low liquid flows (, 0.12 m^3/h) (< 2 L/min)
- C Large liquid flows (> 1000 m^3/h) (> 1.7 × 10^4 L min)
- D Large water pipes (> 0.5 m bore)
- E Hot liquids (temperatures > 200°C)
- F Viscotts liquids (> 50 cP) (> 0.05 Pa.s)
- G Cryogenic liquids
- H Hygienic liquids

NOTE 2. Gas applications are indicated by the following:
- J General gas applications
- K Low gas flows (< 150 m^3/h)
- L Large gas flows (> 5000 m^3/h
- M Hot gases (temperatures > 200 °C)
- N Steam

NOTE 3. Miscellaneous applications are indicated by following:
- P Slunies and particle flows
- Q Liquid/liquid mixtures
- R Liquid/gas mixtures
- S Corrosive liquids
- T Corrosive gases

APPENDIX B

ADDITIONAL REFERENCES

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16) Fluid Meters “Their Theory and Application, Report of ASME Research Committee on Fluid Meters”

TYPICAL DATA SHEETS

1. **Orifice Plates and Flanges**
2. **Venturi Flow Meter Specification Sheet**
3. **Rotameters (Variable Area Flowmeters)**
4. **Magnetic Flowmeters**
5. **Turbine Flowmeters**
6. **Positive Displacement Meters**
7. **Ultrasonic Flowmeter**
8. **Smart Diff. Press. Transmitter**

DATA SHEETS
WITH THEIR FILLING INSTRUCTIONS

	ORIFICE PLATES AND FLANGES				SHEET------- OF------		
					SPEC. No.		REV
	No.	BY	DATE	REVISION			
					CONTRACT		DATE
					REQ.	P.O.	
					BY	CHK'D	APPR.

ORIFICE PLATES

1. concentric b Other ______________________________
2. ISA Standard b Other ______________________________
3. Bore: Maximum Rate b Nearest 3 mm b
4. Material: 304 SS b 316 SS b Other__________________
5. Ring Material & Type ______________________________
6. MFR. & Model No. ______________________________

ORIFICE FLANGES

7. Taps: Flange b Vena Contracte b Pipe b Other _________
8. Tap Size: ½ in. b Other ______________________________
9. Type: Weld Neck b Slip On b Threaded b
10. Material: Steel b Other ______________________________
11. Flanges included b By othersb
12. Flange Rating ______________________________________

FLUID DATA	13	Tag Number				
	14	Service				
	15	Line Number				
	16	Fluid				
	17	Fluid State				
	18	Maximum Flow				
	19	Normal Flow				
	20	Pressure-bar g				
	21	Temperature °C				
	22	Specific Gravity at Base				
	23	Operating Spec. Gravity				
	24	Supercomp. Factor				
	25	Mol. Weight Cp/Cv				
	26	Operating Viscosity				
	27	Quality % or °Superheat				
	28	Base press. Base Temp.				
METER	29	Type of Meter				
	30	Diff, Range-Dry m bar				
	31	Seal sp. gr. at 15°C				
	32	Static Press. Range bar (abs)				
	33	Chart or Scale Range				
	34	Chart Multiplier				
PLATE & FLANGE	35	Beta = d/D				
	36	Orifice Bore Diameter				
	37	Line I.D.				
	38	Flange Rating				
	39	Vent or Drain Hole				
	40	Plate Thickness				

Notes: IPS FORM E-IN-130.1

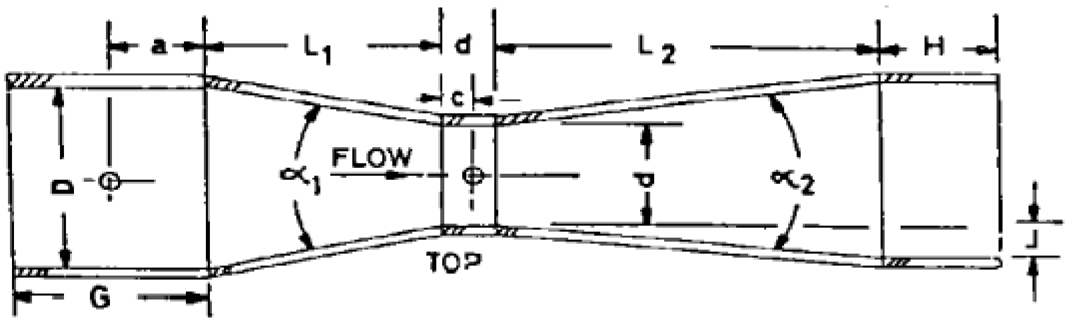
ORIFICE PLATES AND FLANGES

Instructions for filling IPS form E-IN-130.1

Refer to ISA Recommended Practice Tr 20.01, "Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations".

1) Check if concentric bore, or write in eccentric, segmental, etc.
2) ISA Standard reference given above. This also conforms to AGA-ASME requirements.
3) Check whether plate is to be bored odd size for exact maxi mum rate, or to nearest 3 mm (1/8 in) for approximate maximum rate.
4) Select plate material.
5) If ring joint assembly is used, give ring material and configurations.
6) Refers to plate, not flanges.
7) Select one of the standard tap locations or write in other.
8) Select tap size.
9) Select flange construction.
10) Select flange material. If stainless steel, show type; such as, "304 SS."
11) Indicate whether orifice flanges are to be included with the plate, or furnished by others.
12) Note Flange Rating.
13) Tag number or other identification No.
14) Process service.
15) Line number. Include line size.
16) List fluid, unless classified.
17) Liquid, gas, or vapor.
18) Maximum flow assumed to be meter maximum. Give flow units.
19) Figure only if units given above.
20) Upstream operating pressure and units. This is also the contract figure unless otherwise noted.
21) Operating temperature, °C. See comment in 20 above.
22) Specific gravity at Base Temperature.
23) Liquid specific gravity at operating temperature given on Line 21.
24) Applies to gas, at operating pressure. Supercompressibility factor normally required for gases over 7 barg (100 psig) because the gas at this pressure and above does not follow the ideal gas laws.
25) Applies to vapor or gas. C_p specific heat at constant pressure, C_v specific heat at constant volumes - Ratio = K at the operating temperature.
26) Viscosity and units, at operating temperature given on line 21.
27) Applies to vapor or steam. Write "SAT" if saturated; otherwise give % quality degrees superheat, in F or C.
28) Contract base conditions. Pressure must be given in absolute units.
29) Bellows, diaphragm, mercury, etc.
30) Set range and units.
31) Applies to wet meters.
32) Fill in if applicable.
33) Full scale range and units. See comment under 18 above.
34) Fill in if required.
35) Fill in for final records after approved bore calculation is available.
36) For final records, see comment on 35.
37) In mm; or give line size and Schedule.
38) ANSI Flange Rating, i.e., 4 in. 300 lb. RF.
39) If desired, state whether top or bottom.
40) Give plate thickness.

VENTURI FLOW METER SPECIFICATION SHEET	INSTRUMENT SPECIFICATION			SPEC. No.		REV
	PROJECT			DATE	CONT	No.
	No.	BY DATE	REVISION			
				MANUFACTURER		
				REQ.	P.O.	
				BY	CHK'D	APPR.



	TAG No. LINE No. OR SERVICE		SERVICE CONDITIONS FLUID	
	FLANGE RATING		MAX METER FLOW j BASE COND.	
	CONE.. HORIZ. LENGTH L1		NORM. FLOW j BASE COND.	
	CONE.. HORIZ. LENGTH L2		FLOW UNITS	
	THROAT LENGTH d		VISCOSITY FLOW COND. cp	
	PIPE I.D D		S.D. OF SEAL OVER MERCURY	
	THROAT I.D. d		FLOW TEMPERATURE °C	
	THROAT TAP z C= d/2		FLOW PRESS j UPSTRM TAP bar (abs)	
	UPSTRM TAP z a		CONTRACT BASE TEMP °C	
	UPSTRM STR RUN G		CONTRACT BASE PRES bar (abs)	
	DWN STRM STR. RUN H		SP HEAT RATIO CP/CV	
	THROAT TO PIPE I.D. j		MW OR SP. GR.	
	RADIUS 11		COMPRESSIBILIT j FLOW COND.	
	RADIUS 12		COMPRESSIBILIT j BASE COND.	
	PRESS. TAP NIPPLE SIZE		DIFFRANGE mbar	
	PRESS. TAP BORE SIZE		MANOMETER TYPE	
	UPSTRM ANGLE µ1		SEAL MATERIAL	
	DWNSTRM ANGLE µ2		CHART OR SCALE RANGE	
	OVERALL LENGTH mm.		MULTIPLIER	

1) MATERIAL: Venturi to be fabricated from ______ rolled plate Throat may be fabricated from heavier stock and bored to size.

2) TOLERANCES: Throat Tolerance: ± ___ out of Roundness: 3 mm All other Dimensions : ±1.0 %.

3) WELDS: All welds shall be full penetration. Grind all inside welds flush. Welds at throat inlet and outlet to be ground to provide a smooth transition between throat and cones.

4) PAINTING: Entire inside shall have one coat of Westem states Laoquer Co. P-31 wash coat primer (or equal). Outside shall have one coat of rod lead and oil primer.

IPS FORM E-IN-130.2

1	RESPONSIBLE ORGANIZATION	VENTURI OR FLOW TUBE	6	SPECIFICATION IDENTIFICATIONS	
2		w/wo METER TUBE	7	Document no	
3		Device Specification	8	Latest revision	Date
4			9	Issue status	
5			10		

11	BODY OR TUBE		60	PERFORMANCE CHARACTERISTICS	
12	Tube form		61	Max press at design temp	At
13	Fabrication style		62	Min working temperature	Max
14	Inlet conn nominal size	Rating	63	Uncalibrated accuracy	
15	Outlet conn nominal size	Rating	64	Perm head loss at URL	
16	End conn termn type	Style	65		
17	Flange facing finish		66		
18	Pressure tap quantity		67		
19	Press tap conn nom size	Rating	68		
20	Press tap conn type	Style	69		
21	Press tap orientation		70		
22	Body/Tube material		71		
23	Bolting material		72		
24	Exterior coating material		73		
25	End termination material		74		
26	Gasket material		75		
27			76		
28			77		
29			78		
30	THROAT		79		
31	Mounting type		80		
32	Diameter ratio (beta d/D)		81		
33	Throat diameter		82		
34	Cone material		83		
35	Throat material		84		
36			85	ACCESSORIES	
37			86	Purge system	
38			87	Cleaner style	
39	METER TUBE		88	Valve style	
40	Bore type		89	Valves and Nipple matl	
41	End conn nominal size	Rating	90		
42	End conn termn type	Style	91		
43	Flange facing finish		92	SPECIAL REQUIREMENTS	
44	Upstream length		93	Custom tag	
45	Pipe schedule no		94	Reference specification	
46	Downstream length		95	Special preparation	
47	Coupling quantity		96	Compliance standard	
48	Coupling nominal size	Rating	97	Construction code	
49	Coupling locations		98	Calibration report	
50	Internal bore diameter		99	Weld radiographs	
51	Flow straightener type		100		
52	Pipe/Tube material		101	PHYSICAL DATA	
53	Bolting material		102	Estimated weight	
54	Exterior coating material		103	Face-to-face dimension	
55	End termination material		104	Removal clearance	
56	Gasket material		105	Mfr reference dwg	
57			106		
58			107		
59			108		

110	CALIBRATIONS AND TEST		INPUT OR TEST			OUTPUT	
111	TAG NO/FUNCTIONAL IDENT	MEAS/SIGNAL/TEST	LRV	URV		LRV	URV
112		Flow rate – Diff pressure					
113		Test pressure					
114							
115							
116							
117							

118	COMPONENT IDENTIFICATIONS		
119	COMPONENT TYPE	MANUFACTURER	MODEL NUMBER
120			
121			
122			
123			
124			
125			

Rev	Date	Revision Description	By	Appv1	Appv2	Appv3	REMARKS

			ROTAMETERS (VARIABLE AREA FLOWMETERS)				SHEET------- OF------	
			No.	BY	DATE	REVISION	SPEC. No.	REV
							CONTRACT	DATE
							REQ. P.O.	
							BY CHK'D	APPR.

GENERAL	1	Tag Number				
	2	Service				
	3	Line No./Vessel No.				
	4	Function				
	5	Mounting				
	6	Power Supply				
	7	Conn. Size Type				
	8	Inlet Dir. Outlet D				
	9	Fitting Material				
	10	Packing or O-Ring Mtl.				
	11	Enclosure Type				
METER	12	Size Float Guide				
	13	Tube Mtl. Float Mtl.				
	14	Meter Scale: Length & Type				
	15	Meter Scale Range				
	16	Meter Factor				
	17	Rated Accuracy				
	18	Hydraulic Calib. Required				
FLUID DATA	19	Fiuid				
	20	Color or Transparency				
	21	Maximum Flow Rate				
	22	Norm Flow Min Flow				
	23	Oper. Specific Gravity (Liq)				
	24	Max Oper. Viscosity				
	25	Oper. Press. Oper. Temp.				
	26	Oper. Density (Gases)				
	27	Std. Density Mol. Wgt.				
	28	Max. Allowable Press. Drop				
	29					
EXT	30	Extension Well Mtl.				
	31	Gasket Mtl.				
XMTR	32	Transmitter Output				
	33	Trans. Enclosure Class				
	34	Scale Range				
ALARM	35	No. of Contacts Form				
	36	Rating Housing				
	37	Action				
	38					
OPTIONS	39	Valve Size & Material				
	40	Valve Location				
	41	Const. Diff. Relay Mtl.				
	42	Purge Meter Tubing				
	43	Airset				
	43a					
	44	Manufacturer				
	45	Tube Number				
	46	Float Number				
	47					

Notes: IPS FORM E-IN-130.4

ROTAMETERS (VARIABLE AREA FLOWMETERS)

Instructions for filling IPS form E-IN 130.4 (Refer to ISA RP 16.1, 2, 3, 4)

1) List tag number.

2) Refers to process applications.

3) Show line number, vessel number, or line specification.

4) Give functions such as INDICATE RECORD, CONTROL TRANSMIT, INTEGRATE, etc.

5) FLUSH PANEL, FRONT PANEL, PIPE, etc.

6) Give voltage, dc or ac, and ac frequency.

7) Give nominal connection size and type such as SCREWED, 150 lb. FLANGED, etc.

8) Select orientation of inlet and outlet and designated as RIGHT, LEFT, VERTICAL or REAR.

9) Select material of end fittings. Note if lining is required.

10) Select either packing or "O" ring design and note material.

11) Select type of enclosure, if any, such as SIDE PLATE, SAFETY GLASS, etc.

12) Give meter size. Note that this is not the same as connection size but refers to the nominal size of the tube and float combination.

Give the method of float guiding such as NONE, FLUTES, POLE, EXTENSIONS.

13) Select tube and float material.

14) Select type meter scale: NONE, ON GLASS, METAL STRIP. Select meter scale length.

15) Select meter scale range and flow units. Remember that rotameters' scales cannot start at zero but typically have rangeability of 10:1 or 12:1.

16) Meter factor if not direct reading.

17) Accuracy statement does not imply any specific calibration.

18) Note if hydraulic calibration is required and state required accuracy.

19) If fluid cannot be identified, state if liquid or gas.

20) Give fluid color or transparency which will affect float visibility in glass tube meters.

21) List maximum operating flow rate and units, usually the same as maximum of meter scale.

22) Show normal and minimum flow rates expected.

23) Give operating specific gravity of liquid. (Numerically equal to density in gm/cm^3).

24) Give maximum expected viscosity and units.

25) Give operating pressure and temperature, with units.

26) For gases give operating density and units, unless molecular weight is given on Line 27.

27) For gases give density at standard conditions atmospheric pressure and 15°C (14.7 psia and 60°F) unless stated otherwise, and/or molecular weight if known.

28) State maximum allowable pressure drop at full flow, if applicable.

30) If meter has an extension well, state material of well.

31) Select material of gasket on extension.

32) If meter transmits, state pneumatic or electronic output such as 0.2-1 barg (3-15 psig), 4-20 mA, etc.

33) Give transmitter electrical classification such as General Purpose, Class 1, Group D, etc.

34) Give transmitter scale size and range. Note that this is not the meter scale but the scale of the attached instrument.

35) Number of alarm contacts in case.

Form of contacts: SPDT, SPST, DPDT, etc.

36) Contact electrical load rating. Contact housing-GP, Class I, GR. D, etc. Use NEMA identification.

37) HIGH, LOW, DEVIATION.

39) Specify needle valve if required.

40) Valve may be on the inlet, outlet or separately mounted. Do not list here if valve is to be furnished by others.

41) This relay may be used on purge assemblies.

44-47) When manufacturer is selected fill in exact model and part numbers.

				MAGNETIC FLOWMETERS				SHEET------- OF------
								SPEC. No.	REV
				No.	BY	DATE	REVISION	CONTRACT	DATE
								REQ. P.O.	
								BY	CHK'D	APPR.

	1	Meter Tag No.					
	2	Service					
	3	:Location					
METERING ELEMENT	4		Line Size, Sched.				
	5		Line Material				
	6		Connection Type				
	7		Connection				
	8		Tube Material				
	9		Liner Material				
	10		Electrode Type				
	11		Electrode Matl.				
	12		Meter Casing				
	13		Power Supply / Elect. Code				
	14		Grounding, Type & Matl.				
	15		Enclosure Class				
	16						
	17		Fluid				
	18		Max. Flow, Units				
	19		Max. Velocity, Units				
	20		Norm. Flow / Min. Flow				
	21		Max. Temp. / Min. Temp.				
	22		Max. Press. / Min. Press,				
	23		Min. Fluid Conductivity				
	24		Vacuum Possibility				
	25						
ASSOCIATED INSTRUMENT	26	**Instrument Teg Number**					
	27	Function					
	28	Mounting					
	29	Enclosure Class					
	30	Length Signal Cable					
	31	Type Span Adjustment					
	32	Power Supply					
	33	TRANS.	Transmitter Output				
	34						
	35	DISPLAY	Scale Size / Range				
	36		Chart Dirve / Speed				
	37		Chart Range / Chart No.				
	38		Integrator				
	39	CONTR.	Modes / Output				
	40		Action / Auto-Man.				
	41						
	42	ALARM	Contact No. / Form				
	43		Rating / Elec. Code				
	44		Action				
	45	Manufacturer					
	46	Meter Model Number					
	47	Instrument Model Number					
Notes:						IPS FORM E-IN-130.5	

MAGNETIC FLOWMETERS

Instructions for filling IPS form E-IN 130.5.

1) Tag number of meter only.

2) Refers to process application.

3) Show line number or identify associated vessel.

4) Give pipeline size and schedule. If reducers are used, so state.

5) Give material of pipe. If lined, plastic or otherwise nonconductive, so state.

6) Give connection type: FLANGED, DRESSER, COUPLINGS, etc.

7) Specify material of meter connections.

8) Select tube material. (Non-permeable material required if coils are outside tube).

9) Specify material of line

10) Select electrode type: STD., BULLET NOSED, ULTRASONIC CLEANED, BURN OFF, etc.

11) Specify electrode material.

12) Describe casing: STD., SPLASH PROOF, SUBMERSIBLE, SUBMERGED OPERATION, etc.

13) Give ac voltage and frequency, along with application NEMA or IEC identification of the electrical enclosure.

14) State means for grounding to fluid: GROUNDING RINGS, STRAPS, etc.

15) State power supply and enclosure class to meet area electrical requirements.

16) Meter factor if not direct reading.

17) State fluid by name or description

18) Give maximum operating flow and units; usually same as maximum of instrument scale.

19) Give maximum operating velocity, usually in m/s.

20) List normal and minimum flow rates.

21) List maximum and minimum fluid temperature °C.

22) List maximum and minimum fluid pressure.

23) List minimum (at lowest temp.) conductivity of fluid.

24) If a possibility of vacuum exists at meter, so state and give greatest value. (highest vacuum).

25) (Void)

26) List tag number of instrument used directly with meter.

27) Control loop function such as INDICATE, RECORD, CONTROL, etc.

28) Mounting: FLUSH PANEL, SURFACE INTEGRAL WITH METER, etc.

29) Give NEMA or IEC identification of case type.

30) State cable length required between meter and instrument.

31) Span adjust: BLIND, ft/s DIAL, OTHER.

32) Give ac supply voltage and frequency.

33) If a transmitter, state analog output electrical or pneumatic range, or pulse train frequency for digital outputs, i.e., pulses per gallon.

34) List scale size and range.

35) List Scale Size and Range for indicating transmitter.

36) Recorder chart drive-ELECT. HANDWIND, etc. and chart speed in time per revolution or inch per hour.

37) List chart range and number.

38) If integrator is used, state counts per hour, or value of smallest count; such as "10 GAL UNITS".

39) For control modes: (Per ANSI C85.1-1963, "Terminology for Automatic Control.") Write-in PI_f, I_f, PI_s, Pif D_f, etc.

P = proportional (gain)

I = integral (auto reset)

D = derivative (rate)

Subscripts:

f = fast

s = slow

n = narrow

State output signal range, pneumatic or electronic.

40) Controller action in response to an increase in flowrate-INC. or DEC.

State auto-man. switch as NONE, SWITCH ONLY, BUMPLESS, etc.

42) Number of alarm lights in case. Give form of contacts; SPDT, SPST, etc.

43) Contact electrical load rating. Contact housing General Purpose, Class I, Group D, etc., if not in the same enclosure described in line 29.

44) Action of alarms: HIGH, LOW, DEVIATION, etc.

45) Fill in manufacturer and model numbers for meters

46) and

47) Instrument after selection.

1	RESPONSIBLE ORGANIZATION	MAGNETIC FLOWMETER w/wo INTEGRAL TOTALIZER INDICATOR Device Specification	6	SPECIFICATION IDENTIFICATIONS
2			7	Document no
3			8	Latest revision / Date
4			9	Issue status
5			10	

11	FLOWMETER BODY		
12	Body type		
13	Flow tube style		
14	End conn nominal size	Rating	
15	End conn termn type	Style	
16	Flow tube diameter	Thickness	
17	Hardware mounting kit		
18	Flow tube material		
19	Lining material		
20	End termination material		
21	Gnd/protective ring matl		
22			
23			
24	END EXTENSIONS		
25	End termination type	Style	
26	Bolting material		
27	End termination material		
28	Gasket/O ring material		
29			
30	SENSING ELEMENT		
31	Electrode type		
32	Insertion length		
33	Electrode material		
34			
35	COILS AND HOUSING		
36	Housing construction type		
37	Coil conn arrangement		
38	Enclosure type no/class		
39	Signal power source		
40	Signal termination type		
41	Cert/Approval type		
42	Housing material		
43			
44			
45	TRANSMITTER OR CONVERTER		
46	Housing type		
47	Output signal type		
48	Enclosure type no/class		
49	Characteristic curve		
50	Digital communication std		
51	Signal power source		
52	Failsafe style		
53	Integral indicator style		
54	Signal termination type		
55	Cert/Approval type		
56	Mounting location/type		
57	Failure/Diagnostic action		
58	Enclosure material		
59			

60	TOTALIZER INDICATOR		
61	Totalizer type		
62	Enclosure type no/class		
63	Signal power source		
64	Contacts arrangement	Quantity	
65	Totalizer reset style		
66	Integral indicator style		
67	Cert/Approval type		
68	Mounting location/type		
69	Enclosure material		
70			
71	PERFORMANCE CHARACTERISTICS		
72	Min press at design temp	At	
73	Max press at design temp		
74	Min working temperature	Max	
75	Accuracy rating		
76	Min velocity URL	Max	
77	Min liquid conductivity		
78	Output signal damping LRL	URL	
79	Min ambient working temp	Max	
80	Contacts ac rating	At max	
81	Contacts dc rating	At max	
82	Max sensor to receiver lg		
83			
84			
85			
86	ACCESSORIES		
87	Connecting cables length		
88	Cable Glands		
89	Ultrasonic cleaner style		
90	Empty tube detector		
91	Calibrator adaptor		
92	Calibrator/configurator		
93			
94	SPECIAL REQUIREMENTS		
95	Custom tag		
96	Reference specification		
97	Compliance standard		
98	Calibration report		
99	Software configuration		
100			
101	PHYSICAL DATA		
102	Estimated weight		
103	Face-to-face dimension		
104	Overall height		
105	Removal clearance		
106	Signal conn nominal size	Style	
107	Mfr reference dwg		
108			

110	CALIBRATIONS AND TEST		INPUT OR TEST			OUTPUT OR SCALE	
111	TAG NO/FUNCTIONAL IDENT	MEAS/SIGNAL/TEST	LRV	URV	ACTION	LRV	URV
112		Flow rate-Analog output					
113		Flow rate-Digital output					
114		Flow rate-Freq output					
115		Flow rate-Scale					
116		Test pressure					
117							

118	COMPONENT IDENTIFICATIONS		
119	COMPONENT TYPE	MANUFACTURER	MODEL NUMBER
120			
121			
122			
123			
124			
125			

Rev	Date	Revision Description	By	Appv1	Appv2	Appv3	REMARKS

	TURBINE FLOWMETERS				SHEET------- OF------	
					SPEC. No.	REV
	No.	BY	DATE	REVISION		
					CONTRACT	DATE
					REQ. P.O.	
					BY CHK'D	APPR.

METER	1	Tag Number					
	2	Service					
	3	Meter Location					
	4	Line Size					
	5	End Connections					
	6	Body Rating					
	7	Nominal Flow Range					
	8	Accuracy					
	9	Linearity					
	10	K Factor, Cycles per vol. Unit					
	11	Excitation					
	12	Materials: Body					
	13	Support					
	14	Shaft					
	15	Flanges					
	16	Rotor					
	17	Bearings: type					
	18	Bearing Material					
	19	Max. Speed					
	20	Voltage					
	21	Pickoff Type					
	22	Enclosure Class					
	23						
FLUID DATA	24	Fluid					
	25	Flow Rate: Min. Max.					
	26	Normal Flow					
	27	Operating Pressure					
	28	Back Pressure					
	29	Operating Temp. Max. Min.					
	30	Operating Specific Gravity					
	31	Viscosity Range					
	32	Percent Solids & Type					
	33						
SECONDARY INSTR.	34	Secondary Instr. Tag No.					
	35	Preamplifier					
	36	Function					
	37	Mounting					
	38	Power Supply					
	39	Scale Range					
	40	Output Range					
OPTIONS	41	Totalizer Type					
	42	Compensation					
	43	Preset Counter					
	44	Enclosure class					
	45	Strainer Size & Mesh					
	46						
	47						
	48						
	49	Manufacturer					
	50	Meter Model No.					
	51	Secondary Instr. Model No.					

Notes: IPS FORM E-IN- 130.6

TURBINE FLOWMETERS

Instruction for filling IPS form E-IN 130.6.

Refer to ISA Standard S31, "Specification, Installation, and Calibration of Turbine Flowmeters"

1) Show meter tag number. Quantity is assumed to be one unless otherwise noted.

2) Refers to process service applications.

3) Give line number or process area.

5) Specify size and style of connections, such as "1 in. NPT", "2 in. 150 lb. ANSI", etc.

6) Pressure and temperature design rating required.

7) Nominal flow range is obtained from manufacturer's data. This usually defines linear range of selected meter.

8) Turbine meter accuracy figures are in terms of percent of instantaneous flow rate.

9) Degree of linearity over nominal flow range.

10) K factor relates cycles per second to volume units. Enter this figure after selection is made.

11) Excitation modulating type only expressed as Volts ___ at___ Hertz.

12-16) Specify materials of construction or write in "MFR STD".

17) Specify sleeve or ball bearings, or none if floating rotor design.

18) Bearing material - will be MFG STD if not stated otherwise.

19) Maximum speed or frequency which the meter can produce without physical damage.

20) ______________

21) Pick-off may be standard hi-temp., radio-frequency type (RF) or explosion proof. Minimum output voltage volts ...... peak to peak.

22) Specify electrical classification of enclosure such as General Purpose, Weather Proof, Class 1, Group D, etc.

23) Specify fluid data as indicated, using line 28 for additional item if required.

24-32) ____________

34) Give Tag No. of secondary instrument if different from meter Tag No.

35) Pre-amplifier if used.

36) Specify function of instrument, such as rate indicator, totalizer or batch control.

37) Flush, surface or rack.

38) Power supply, i.e., 110 Vac.

39) Applies to rate indicator.

40) Give output range such as "4-20 mA", 0.2-1 barg (3-15 psig), etc.

41) May be used for number of digits, and to state whether counter is reset or non-reset type.

42) Specify range of compensation, if required, in pressure and/or temperature units or viscosity units.

43) Pre-set counter.

44) Specify NEMA or IEC classification of enclosure.

45) Specify strainer size and mesh size. Request vendor's recommendation if not known.

49, 50 & 51) Fill in after selection is made.

	POSITIVE DISPLACEMENT METERS				SHEET------- OF------	
					SPEC. No.	REV
	No.	BY	DATE	REVISION	CONTRACT	DATE
					REQ. P.O.	
					BY CHK'D	APPR.

	1	Tag Number				
	2	Service				
	3	Line No./Vessel No.				
	4	Type of Element				
	5	Size				
	6	End Connections				
	7	Press. Rating				
	8	Temp. Rating				
	9	Capacity				
	10	Enclosure Class				
	11	Power Supply				
	12	Accuracy				
	14	Repeatability				
	15	Linearity				
	16	Materials: Outer Housing				
	17	Main Body Cover				
	18	Rotating Element				
	19	Shaft				
	20	Blades				
	21	Bearings: Type & Material				
	22	Packing				
	23	Type of Coupling				
Accessories	24	Register Type				
	25	Totalizer				
	26	Totalized Units				
	27	Reset				
	28	Preset				
	29	Set-Stop				
	30	Counter				
	31	Control Valve				
	32	Printer				
	33	Calibrator				
	34	Shut-Off Valve				
	35	Switch: Single or 2-Stage				
	36	Transmitter Type				
	37	Temp. Compensator				
	38	Transmitter output				
	39	Strainer: Size & mesh				
	40	Air Eliminator				
	41					
	42					
	43	Fluid				
	44	Temperature Range				
	45	Pressure Range				
	46	Oper. Temp.				
	47	Oper. Press.				
	48	Normal Flow Rate				
	49	Flow Rate: Min. Max.				
	50	Oper. Specific Gravity				
	51	Oper. Viscosity				
	52	Coef. of Expansion				
	53	Flow Units				
	54					
	55					
	56					
	57	Manufacturer				
	58	Model Number				

Notes: IPS FORM E-IN- 130.7

POSITIVE DISPLACEMENT METERS

Instructions for filling IPS form E-IN-130.7.

1) Tag No. of instrument.

2) Process service.

3) Pipe line or vessel identification.

4) Write in type of rotating element, such as, disc, piston, vane, helical, rotors, etc.

5) Show connection pipe size.

6) Specify end connections type and ANSI rating such as 300 lb R. F.

7-8) Specify the manufacturer's recommended body pressure and temperature rating, such as 20 bar at 90°C.

9) Write in number of figures or maximum quantity (in flow units) that can be held in counter

10) Specify enclosure electrical classification, if applicable, such as "Class 1, Group D., Div. 2", "General Purpose", etc.

11) Specify power supply, if applicable.

12) Positive Displacement meter accuracy figures are in terms of percent of instantaneous flow rate.

13) The maximum deviation between measurements under the same conditions and with the same measuring instrument.

14) Degree of linearity over nominal flow range.

15) Specify materials of construction. If no preference, write in, MFR. STD. (Manufacturer's Standard).

17-22) Specify materials of construction, if no preference, write in, Manufacturer's Standard (MFG-STD).

23) Specify type of coupling.

24) Specify register type such as horizontal, vertical, inclined, in-line reading, dial reading, print, etc.

25) Specify number of figures such as 6 digit, 5 digit, or 099, 999, etc.

26) Specify required totalizer unit.

27) If totalizer reset required, write in type. If reset is not required, write in "none".

28) If preset function is required, write in type. If preset is not required, write in "none".

29) Specify by writing in "yes" if a set-stop is required to operate shutoff valve, switch, etc

30) Specify type of counter.

31) Specify by writing in "yes" if a control valve is required.

32) Define type of printer if it is required.

33) A device that adjusts the meter's mechanical counter to register the true volume that passes through the meter.

34) Specify by writing in "yes" if a shut-off valve is required. Valve to be manufacturer's standard construction unless otherwise noted.

35) Specify by writing in "yes" if a switch is required. Two switches are required for 2-stage shut-off control.

36) Specify, if transmitter is required, by writing in type such as pulse, rate of flow, etc.

37) Write in "yes" if manufacturer's standard temperature compensator is required. Write in "no" if not required.

38) Specify, if transmitter is required, by writing in type such as pulse, rate of flow, etc.

39) Specify, if strainer is required, by writing in type such as "Y", "Basket", etc. Strainer to have same pressure and temperature rating, end connections and material as meter body unless otherwise noted.

40) Write in "yes" if air eliminator is required, otherwise write in "no".

43-53) Specify fluid data as completely as possible, note at operating conditions. Be sure to note if liquid is at saturation conditions.

57-58) Identify manufacturer's name and model number after selection is made.

1	RESPONSIBLE ORGANIZATION		CORIOLIS MASS FLOWMETER w/wo TOTALIZER INDICATOR Device Specification	6	SPECIFICATION IDENTIFICATIONS	
2				7	Document no	
3				8	Latest revision	Date
4				9	Issue status	
5				10		

11	FLOWMETER BODY AND HOUSING		58	TOTALIZER INDICATOR	
12	Body/Housing type		59	Totalizer type	
13	End conn nominal size	Rating	60	Enclosure type no/class	
14	End conn termn type	Style	61	Signal power source	
15	Body wetted material		62	Contacts arrangement	Quantity
16	Housing material		63	Totalizer reset style	
17	End termination material		64	Integral indicator style	
18			65	Cert/Approval type	
19			66	Mounting location/type	
20			67	Enclosure material	
21	FLOWTUBE ASSEMBLY		68		
22	Flowtube type		69	PERFORMANCE CHARACTERISTICS	
23	Flowtube diameter		70	Max press at design temp	At
24	Flowtube material		71	Min working temperature	Max
25			72	Flow rate accuracy rating	
26			73	Density accuracy rating	
27			74	Min flow URL	Max
28	CONNECTION HEAD		75	Density LRL	URL
29	Housing type		76	Sec enclosure press rating	
30	Enclosure type no/class		77	Pressure drop at flow URL	
31	Signal termination type		78	Min ambient working temp	Max
32	Cert/Approval type		79	Contacts ac rating	At max
33	Housing material		80	Contacts dc rating	At max
34			81	Max sensor to receiver lg	
35			82		
36			83	ACCESSORIES	
37	TRANSMITTER OR COMPUTER		84	Connecting cables length	
38	Housing type		85	Heating kit style	
39	Measurement compensation		86	Calibrator/configurator	
40	Output signal type		87		
41	Enclosure type no/class		88		
42	Span-zero adjustment		89	SPECIAL REQUIREMENTS	
43	Characteristic curve		90	Custom tag	
44	Digital communication std		91	Reference specification	
45	Signal power source		92	Special preparation	
46	Failsafe style		93	Compliance standard	
47	Integral indicator style		94	Calibration report	
48	Signal termination type		95	Software configuration	
49	Cert/Approval type		96		
50	Mounting location/type		97	PHYSICAL DATA	
51	Failure/Diagnostic action		98	Estimated weight	
52	Enclosure material		99	Face-to-face dimension	
53			100	Overall height	
54			101	Removal clearance	
55			102	Signal conn nominal size	Style
56			103	Mfr reference dwg	
57			104		

110	CALIBRATIONS AND TEST		INPUT OR TEST			OUTPUT OR SCALE	
111	TAG NO/FUNCTIONAL IDENT	MEAS/SIGNAL/TEST	LRV	URV	ACTION	LRV	URV
112		Mass flow-Analog output					
113		Meas-Analog output 2					
114		Meas-Analog output 3					
115		Meas-Freq output 1					
116		Meas-Freq output 2					
117		Measurement–Scale					
118		Temp-Digital output					
119		Meas-Digital output					
120		Density-Digital output					
121		Test pressure					

122	COMPONENT IDENTIFICATIONS		
123	COMPONENT TYPE	MANUFACTURER	MODEL NUMBER
124			
125			
126			
127			

Rev	Date	Revision Description	By	Appv1	Appv2	Appv3	REMARKS

	Ultrasonic Flowmeter				SHEET------- OF------	
					SPEC. No.	REV
	No.	BY	DATE	REVISION		
					CONTRACT	DATE
					REQ. P.O.	
					BY	CHK'D APPR.

GENERAL	1	Tag Number				
	2	Service				
	3	Line Number	P&ID Number			
	4	Equipment Number				
	5	Area Classification				
	6	Enclosure Class				
	7					
	8					
CONNECTIONS	9	Pipe Size				
	10	Pipe Wall Thickness				
	11	Connection Size	Rating	Type		
	12	Pipe Material				
	13	Liner Thickness				
	14					
	15					
	16					
PROCESS CONDITIONS	17	Fluid	State			
	18			Minimum	Operating	Maximum
	19	Flow Rate				
	20	Pressure				
	21	Temperature				
	22	Viscosity				
	23	SG @ Base	SG @ Flow Temp			
	24	Ambient Temp. Range				
	25	Max. Design Temp.	Max. Design Pressure			
	26					
SENSOR	27	Function				
	28	Number of Sensor				
	29	Mounting Style				
	30	Measuring Principle				
	31	Sensor Material	Sensor Face			
	32	Sensor Housing				
	33	Flow Calibration Range				
	34	Accuracy (%)				
	35	Repeatability (%)				
	36	Sensor Model				
	37	Sensor Cable Length				
	38	Upstream Piping	Downstream Piping			
TRANSMITTER	39	Tag Number				
	40	Output Signal				
	41	Power Supply	Power Consumption			
	42	Flow Display Type				
	43	Accessories				
	44	Location				
	45	Electrical Connection				
COMMUNICATION	46	Protocol				
	47	Diagnostics				
	48					
PURCHASE	49	Vendor				
	50	Manufacturer				
	51	Model				
	52	Purchase Order Number				

ULTRASONIC FLOWMETER

GENERAL:

Line 1 Tag number:

Insert tag number from P&ID.

Line 2 Service:

A verbal description of the process service in which the flow transmitter is installed. Example; P-101 Stripper Bottoms .

Line 3 Line No. / P&ID No.:

Refer to P&ID for the line number and P&ID number.

Line 4 Equipment No.:

Refer to P&ID for the Equipment number. If the instrument is not associated with any equipment, enter “N/A”.

Line 5 Area Classification:

Electrical Area Classification should be noted such as Class 1, Div. 2, Group B, C, D and T rating. Check the Electrical Area Classification drawing to determine the area classification for the location where the transmitter will be installed. (If in doubt consult the Electrical Design group on the project.)

Line 6 Enclosure Class:

State enclosure class requirements such as weather proof, NEMA 4X or IP66, etc. See electrical area classification for area requirements.

CONNECTIONS:

Line 9 Pipe Size:

Refer to P&ID for pipe size and also the line spec info.

Line 10 Pipe Wall Thickness:

Refer to Piping Line Specification for pipe schedule and wall thickness info.

Line 11 Connection Size / Rating / Type:

Refer to P&ID for the flow meter connection size.

Refer to Piping Line Specification for the appropriate flow meter rating and connection type, such as 3” 300# RF, as well as nozzle length, and nozzle angle. If the sensor is mounted on outside of pipe, enter “Surface Mount”.

Line 12 Pipe Material:

Refer to Piping Line Specification for the piping material info.

Line 13 Liner Thickness:

Refer to Piping Line Specification for this information, as well as Insulation thickness.

PROCESS CONDITIONS:

Line 17 Fluid / State:

The type of fluid in the piping or vessel to which the pressure transmitter impulse line is attached. Such as Air, Gasoline, Water, etc. Fluid name is also found on the Piping Line List or Process Data for a flow meter or valve in the same process pipe.

Refer to Process data for fluid state, including if two phase flow is present.

Line 19 Flow Min / Oper / Max / Unit:

Refer to Process data for min / normal / max and unit of flow.

Line 20 Pressure Min / Oper / Max / Unit:

Refer to Process data for min / normal / max and unit of pressure.

Line 21 Temperature Min / Oper / Max / Unit:

Refer to Process data for min / normal / max and unit of temperature.

Line 22 Viscosity Min / Oper / Max / Unit:

Refer to Process data for min / normal / max and unit of viscosity.

Line 23 SG @ Base / SG @ Flow Temp:

Refer to Process data for Specific Gravity info.

Line 24 Ambient Temp Range:

Refer to Process data or Basic Engineering Design Document (BEDD) for such info.

Line 22 Max. Design temp. / Max Design Pressure:

Refer to Piping Line List for such information, or list maximum operating pressure such as what would be generated from block discharge of pump.

SENSORS:

Line 27 Function:

List if this is for indication, control, etc.

Line 28 Number of Sensors:

Indicate the number of sensors included for the application.

Line 29 Mounting Style:

Indicate if the flow meter is a “clamp-on” type, “integral mounted” type, or “remote mounted” type, based on the application needs.

Line 30 Measuring Principal:

Enter the measurement principle such as “Time of Flight”, or “Multi-Wave”, etc.

Line 31 Sensor Material / Face:

Check with vendor catalog on the material and connection requirements or list Manufacture Standard (MFG STD).

Line 32 Sensor Housing:

Check with vendor catalog on the available housing that is suitable for the specified area classification.

Line 33 Flow Calibration Range:

Refer to Process data for min and max flow range. Normal flow should be in the middle 1/3 of the flow range (between 33% - 66%).

Line 34 Accuracy %:

By vendor.

Line 35 Repeatability %:

By vendor.

Line 36 Sensor Model:

By vendor.

Line 37 Sensor Cable Length:

Check with vendor on the maximum cable length requirement and also work with Design to come up with the approximate cable length between the sensor and the transmitter housing.

Line 38 Upstream Piping / Downstream Piping:

By vendor.

TRANSMITTERS:

Line 39 Tag Number:

List down the transmitter Tag number per P&ID.

Line 40 Output signal:

Normal as 4-20 mA isolated from ground, specify if HART or other protocol is required.

Line 41 Power Supply / Consumption:

Indicate if the power supply is external loop power or self power source.

Power consumption by vendor.

Line 42 Flow Display Type:

Indicate the display such as integral local indicator; also indicate if flow units are required.

Line 43 Accessories:

Indicate any accessories such as local meters, mounting kits, etc.

Line 44 Location:

Indicate the location of the transmitter, etc.

Line 45 Electrical Connection:

Indicate the conduit connection size and type.

COMMUNICATION:

Line 46 Protocol:

Indicate communication protocol type such as HART, Foundation FieldBus, etc.

Line 47 Diagnostics:

Indicate if any advanced diagnostic is required or not.

PURCHASE:

Line 49 Vendor:

Specify Manufacturer representative of the transmitter manufacturer.

Line 50 Manufacturer:

Specify Manufacturer of the transmitter.

Line 51 Model:

Specify model number of the flow transmitter and flow sensor from the manufacturer's catalog.

Line 52 Purchase Order Number:

Specify Purchase Order number.

Notes:

Include any explanatory notes for the Manufacturer here.

Use this space to note any special instructions to the manufacturer such as Tagging requirements. Also, include any instructions to the installation contractor such as Storage, Mounting, or Calibration. List any special sensor mounting hardware or cable requirements. List if wiring from the sensor to transmitter is intrinsic safe.

GENERAL	1	Tag Number			
	2	Service			
	3	Location			
	4	Area Classification			
	5	Mounting			
	6	Certification			
	7	Barrier - Manufacturer / Model			
	8				
PROCESS CONDITIONS	9	Fluid			
	10	Pressure Max	Oper.		
	11	Temperature Max.	Oper.		
	12	Oper. Spec. Gravity	Oper. Viscosity		
	13	Vacuum	Over Pressure		
	14				
TRANSMITTER	15	Application			
	16	Type			
	17	Enclosure			
	18	Housing	Paint		
	19	Power Supply	Load Resist		
	20	Process Connection	Electrical Connection		
	21	Accuracy	Respons Time		
	22	Max. Static Pressure			
	23	Element Material			
	24	Wetted O - Ring Material			
	25	Fill Fluid			
	26	Range Limits			
	27	Calibrated Range			
	28	Elevation	Suppresion		
	29	Allow.Oper. Pressure	Allow.Oper.Temp.		
	30				
DIAPHRAGM SEAL	31	Process Connection & Rating			
	32	Diaphragm Material			
	33	Capillary Material			
	34	Fill Fluid			
	35	Housing Material			
	36	Allowable Over Temperature			
	37				
COMMUNICATION AND SOFTWARE	38	Communication Type			
	39	Baud - Rate			
	40	Communication with:			
	41	Configuration from:			
	42	Internal Diagnostics			
	43	Held Terminal			
	44				
OPTIONS	45	Integral Meter	Scale		
	46	Lightning Protection			
	47	Hydrostatic Testing			
	48	Mounting Brackets			
	49				
PURCHASE	50	Manufacturer			
	51	Model			
	52	Purchase Order Number			
	53	Price	Item Number		
	54	Serial Number			

Notes:

				INSTRUMENT SPECIFICATION Smart Diff. Press. Transmitter			
						Sheet of	
No.	By	Date	Description	Code: 51	Doc. No.:		Rev.:

INSTRUMENT SPECIFICATION

Following are instructions for completion of the SPI Instrument Specification (Code: 51) for Differential Pressure, Flow, and Level Transmitters.

Required reference documents are: P&ID's, Piping Line Class Specifications and D/P Transmitter Manufacturer's catalog.

Following is a link to a vendor site for typical transmitter catalog info. Please note that always use the specific vendor catalog information for the selected manufacturer for your project.

General

Line 1 Tag number:

Insert tag number from P&ID.

Line 2 Service:

A verbal description of the process service in which the Differential Pressure / Flow transmitter is installed. Example; Feed to Reactor .

Line 3 Location:

Location of the transmitter. Example; line, field, local control panel, etc.

Line 4 Area Classification:

Electrical Area Classification should be noted such as Class 1, Div. 2, Group B, C, D.

Check the Electrical Area Classification drawing to determine the area classification for the location where the transmitter will be installed. (If in doubt consult the Electrical Design group on the project.)

Line 5 Mounting:

Line mounted on the process line or mounted on an Instrument Stand at grade.

Line 6 Certification:

Underwriters Laboratory (UL) or Factory Mutual (FM) should be noted on the specification sheet.

Line 7 Barrier-Manufacturer / Model:

Some projects may elect to design their wiring system as Intrinsically Safe. Safety Barriers are installed within the wiring system to provide Intrinsic Safety. Barrier must be compatible with the selected Transmitter. Manufacturer of the Transmitter provides this Barrier Manufacturer's name and model number in the catalogue upon request.

Line 8 Blank:

Modify this line to read **Line No. or Equipment No. / P&ID No,** then enter the line number or equipment number where the transmitter is located and insert P&ID Number.

Process Conditions

Line 9 Fluid:

The type of fluid in the piping or vessel to which the differential pressure transmitter impulse line is attached. Such as Air, Gasoline, Water, etc. Fluid name is also found on the Piping Line List or Process Data for a flow meter or valve in the same process pipe.

Line 10 Pressure Design (Max) /Oper:

The design (or Maximum) and operating pressure for the fluid in the pipe or vessel under upset conditions. Maximum pressure is generally the set pressure for the relief valve on that process pipe or vessel. Operating pressure is found in the Process Data for flow meter or valve in the same process pipe. This data may be provided by Process Engineer in the SPI Module for Process data.

Line 11 Temperature Design (Max) / Oper:

The Design (or Maximum) and Operating temperature at which the fluid in the process pipe or the vessel operates. These values are found on the Piping Line List or Process Data for a flow meter or valve in the same process pipe or the vessel or provided by Process Engineer in the SPI Module for Process data.

Line 12 Oper. Spec Gravity/Oper Viscosity:

Provided by Process Engineer in the SPI Module for Process data.

Line 13 Vacuum / Over Pressure:

Vacuum -- Most manufacturers show in their catalogues these values for Vacuum resistance to a value 0.015 to 0.15 psia.

Over Pressure corresponds to permissible overload of pressure. Ratings are listed in the manufacturer's catalogue. Consult manufacturer's catalogue for Vacuum and Over Pressure ratings.

Line 14 Blank:

Leave blank.

Transmitter

Line 15 Application:

Differential Pressure Transmitters are applied to measure Flow or Differential Pressure. These transmitters can be applied in the measurement of level. Enter either: Flow, Level, or Differential Pressure.

Line 16 Type:

Electronic or Pneumatic.

Line 17 Enclosure:

Enclosure for electronic transmitter must meet the requirements for use in Hazardous Areas. Type in "**Explosion Proof**" for Hazardous areas and **General Purpose** for Non Hazardous areas.

Line 18 Housing / Paint:

Transmitter housing holds the electronics of the transmitter. It is normally Cast Aluminum, Carbon Steel or Stainless steel. Typically it has a NEMA 4X rating. Selection should be made in consultation with the manufacturer's catalogue and plant environmental conditions. Example; Stainless steel transmitter housings may be required for salt atmosphere applications such as Offshore.

Paint is normally manufacturer's standard unless specific paint requirement is stated in the client or project requirements.

Line 19 Power Supply / Load resist:

Power supply required for electronic transmitters is normally 12-30 VDC for Intrinsically Safe Loops and 12 VDC to 45 VDC for Non IS loops, check manufacturer's catalogue for specific requirements.

Load resistance is normally 250 ohms.

Line 20 Process Connection / Electrical Connection:

The thread connection size on the transmitter is normally 1/2" NPT for flow / level / differential pressure transmitters.

Other connection sizes may be required for receiver transmitters, low-pressure transmitters or other special services. Review the manufacturer's catalog for available connection sizes. Review the standard instrument installation details for D/P transmitters to ensure compliance between the connection specified and the installation details. (Note; On many transmitters the instrument body is drilled and tapped as ¼" NPT and adapter flanges{footballs} are furnished where 1/2" NPT connections are required.)

Electrical connections are normally 1/2 NPT for electrical conduit entry. Consult manufacturer's catalogue for available connection sizes and compliance with the design installation detail.

Line 21 Accuracy / Response time:

A Differential Pressure usually provides accuracy of +/-0.2% of Calibrated Span. Consult manufacturer's catalogue for this number, unless a higher accuracy is required in the Basic Engineering Data Book, or client specifications.

Response time depends largely on the type of diaphragm seal used, otherwise the response time ranges from 300-250 ms. Consult manufacturer's catalogue for standard response time.

Line 22 Max. Static Pressure:

Consult manufacturer's catalogue for body material and standard Static Pressure rating. Transmitter body material shall be suitable for the area classification and the environment. Special environmental consideration such as corrosive shall be considered.

Line 23 Element Material:

Element material must be compatible with the process fluid and the maximum pressure and temperature requirements. Element material is generally stainless steel unless corrosion or pressure/temperature requirements dictate otherwise. Teflon or other elastomers may be used for corrosion resistance where pressure/temperature permit. Element material is normally listed as Process material in the manufacturer's catalogue. Metal elements are 316 SS, Hastelloy C, Monel, Tantalum, etc.

Line 24 Wetted O-Ring Material:

O-rings are use to prevent leaks between transmitter body and the process flanges. Material is either Teflon or Viton or Kalrez. Consult manufacturers' catalogue for available materials including compatibility to process fluid, maximum pressure and temperatures.

Line 25 Fill Fluid:

The maximum process temperature and pressure are of critical importance when selecting the fill fluid. This fluid is normally Silicon oil or Glycerin. This fluid should be a safe, no-toxic, inert fluid. For special applications such as Oxygen service care must be taken in the selection of a fill fluid to prevent hazards. Fill fluid must be suitable for the Maximum Temperature of the process fluid. Consult the manufacturer's catalog for available fill fluids.

Line 26 Range Limits:

The differential pressure range that the transmitter measures. This range should be selected from the Manufacture's standard ranges such that the Differential Pressure (Line 10) is in the middle 1/3 of the range. Consult the manufacturer's catalog for available ranges.
NOTE: Care must be taken to ensure that the transmitter will not be destroyed by the Max Pressure (Line 10) of the process fluid. Transmitters are normally suitable for a pressure of 130% of the range. In cases where the Max Pressure exceeds 130%, a transmitter protector or other means is required to protect the transmitter and personnel.

Line 27 Calibration Range:

The pressure ranges that the transmitters will normally measure. This range is selected to cover normal operating pressure that the transmitter will experience. This range can be changed in the field by instrument technicians. Correct operating range will allow a more accurate sensing of the process conditions.

For a flow transmitter, this is the differential that the orifice plate or flow tube is sized for (example; 0-100" H20).

For a level transmitter, this is the range over which the level will vary in equivalent "Inches of Water". Refer to the vessel drawing for the minimum, normal and maximum liquid levels. Level transmitter calibrated ranges should exceed the minimum and maximum liquid levels to allow the transmitter to have a "live zero" and "live 100%" readings. (Rule of thumb for this is 6" below the minimum and 6" above the maximum.) .

Line 28 Elevation / Suppression:

When a transmitter is mounted below the vessel nozzle and when the "low" side transmitter tubing is liquid filled (rather than gas filled), elevation/suppression of the calibration is required. Definitions of elevation and suppression vary with manufacturers. Consult the manufacturer's instruction manual for complete definition and calculation instructions.

Line 29 Allow. Oper. Pressure / Allow. Oper. Temp.:

Consult manufacturer's catalogue for the pressure and temperature ratings.

Line 30 Blank

Leave blank.

DIAPHRAGM SEAL

Line 31 Process Connection / Rating:

This is the connection in the bottom of the seal assembly that admits the process fluid into the seal. Review the Piping Line Class specifications for the line class on which the seal is installed for available connection types and sizes (Piping Line Class may require all flanged connections which necessitates a flanged connection on the seal assembly).

Diaphragm seal rating shall meet the Pressures and Temperatures listed in the Line Class. Consult manufacturer's catalogue for selections.

Line 32 Diaphragm Materials:

Diaphragm material must be compatible with the process fluid and the maximum pressure and temperature requirements. Diaphragm material is generally stainless steel unless corrosion or pressure/temperature requirements dictate otherwise. Teflon or other elastomers may be used for corrosion resistance where pressure/temperature permit. Consult the Piping Line Class specifications for the pipe where the seal is to be installed for materials that are suitable for the process fluid. Consult the manufacturer's catalog for available diaphragm materials.

Line 33 Capillary Material:

Consult with P&ID’s and Piping Line Class to ensure the proper connection size and materials are specified for the capillary. Capillary tubing material is normally stainless steel armored.

Line 34 Fill Fluid:

The top housing of the seal assembly and the pressure transmitter sensing diaphragm are filled with a liquid to provide hydraulic transmission of the process pressure to the transmitter. This fluid is a safe, no-toxic, inert fluid such as silicone oil.

For special applications such as Oxygen service care must be taken in the selection of a fill fluid to prevent hazards. Fill fluid must be suitable for the Maximum Temperature of the process fluid. Consult the manufacturer's catalog for available fill fluids.

Note:

When diaphragm seals are used, the difference in specific gravity between the capillary fill fluid and the process fluid in the vessel will affect calculation of the transmitter calibration. Consult the manufacturer's instruction manual for calculations.

Line 35 Housing Material:

The upper housing material is only in contact with the seal fill fluid. It is isolated from the process fluid by the diaphragm. Where a high alloy lower housing material is required (example: Inconel), the Upper housing materials may be of a less corrosion resistant metallurgy (example: carbon steel) to reduce cost. The bottom housing of the seal assembly is in contact with the process fluid. Therefore, it must be of a material that is corrosion resistant in the fluid. Consult the Piping Line Class specifications for the pipe where the seal is to be installed for materials that are suitable for the process fluid. Consult the manufacturer's catalog for available housing materials.

Line 36 Allowable Over Temperature:

Enter the maximum temperature rating of the fill fluid.

Line 37 Blank:

Modify this line to read **Capillary Type / Length** then enter the type and length of capillary. Consult vendor catalog for the available capillary type such as direct seal or pancake type.

Consult vendor catalog for the maximum length and available capillary length.

COMMUNICATION AND SOFTWARE

Line 38 Communication Type:

Indicate the type of required protocol such as HART, Foundation Fieldbus Module.

Line 39 Baud - Rate:

Indicate the communication rate such as 9600 baud.

Line 40 Communication with:

Indication field devices that will communicate with this device directly for control in the field.

Line 41 Configuration from:

Indicate configuration of this device from the DCS Asset Management system and/or hand held configurator.

Line 42 Internal Diagnostics:

Indicate if advance instrument diagnostic is required.

Line 43 Held Terminal:

Indicate if a hand held configurator is required.

Line 44 Blank:

Leave blank.

Options

Line 45 Integral Meter / Scale :

Consult manufacturer's catalogue for availability and type. Integral meter adds cost to price of the transmitter, specify only when required by the client or project guidelines. See manufacturer's catalogue for available scales and engineering units.

Line 46 Lightning Protection:

Type "no", unless project requires such protection such as pipeline project.

Line 47 Hydrostatic Testing:

Manufacturer's standard testing is required.

Line 48 Mounting Brackets:

Type "Yes" with 2" pipe clamps.

Line 49 Blank

Modify this line to read **Manifold Type / Body Material:**

Specify only if manifold is to be purchased with the transmitter, otherwise type N/A. If the manifold is to be purchased with the transmitters, the type of manifold required will depend upon the installation. For Level transmitters, where the upper leg is wet (fluid filled), a “Two valve manifold" must be used to prevent loss of the fill when the bypass valve is opened. Three valve manifolds should normally be for flow measurement and for level measurement when both legs are dry.

Manifold Body material to be 316SS as a minimum. Refer to installation detail or project specifications for any other requirements. Metallurgy must be compatible with the process fluid.

Purchase

Line 50 Manufacturer:

Specify Manufacturer of the transmitter.

Line 51 Model:

Specify model number of the transmitter from the manufacturer's catalog.

Line 52 Purchase Order Number:

Specify Purchase Order number.

Line 53 Price / Item Number:

Leave this blank.

Line 54 Serial Number:

Leave this blank.

Notes:

Include any explanatory notes for the Manufacturer here. Example; Differential Pressure / Flow transmitters and accessories to be assembled into a unit by the Manufacturer.

Use this space to note any special instructions to the manufacturer such as Tagging requirements. Also, include any instructions to the installation contractor such as Storage, Mounting, or Calibration. Consider adding addition requirements for manifold as stated below:

MANIFOLD

Trim / Packing:

Trim for manifolds shall be minimum 316 L SS.

Manifold packing shall be "Graphite" for high temperature application or Teflon as a minimum. Consult manufacturer's catalogue for materials compatible with the process fluid, maximum pressures and maximum temperatures.

Max. Rating Pressure / Temperature:

Consult manufacturer's catalogue for available highest pressure and temperature rating of the manifold. These ratings must be less than the max temperatures and pressures listed in the Line List furnished by Piping group on the project.

Process Conn. Size / Type / Rating:

Refer to installation detail for Process connection types and sizes and match the sizes in the manufacturer's catalogue. Connection ratings should be listed in the manufacturer's catalogue.

Manufacturer:

Use transmitter vendor recommended manifold vendor, unless another vendor is specified by the client or Project approved vendor's list.

Model:

Consult manufacturer's catalogue for the model number.