CONSTRUCTION AND INSTALLATION STANDARD

FOR

FLOW INSTRUMENTS

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1. SCOPE

This Standard discusses recommended practices to be used in installation and commissioning of different types of flow measurement instruments, such as differential pressure and area flow-meters, target flow meters, turbine meters, mag-meters ...etc.

These meters are commonly used to indicate, record, transmit, and control fluid flow.

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

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant.

API (AMERICAN PETROLEUM INSTITUTE)

Manual of Petroleum Measurement Standards, chapter 5.2, "Measurement of Liquid Hydrocarbons By Displacement Meter Systems," First Edition, 1977.

Manual on Installation of Refinery Instruments and Control Systems

Part 1- "Process Instrumentation and Control", Section 1- Flow.

Manual of Petroleum Measurement Standards chapter 5.3, "Turbine Meters," First Edition, 1976.

Manual of Petroleum Measurement Standards chapter 4, "Proving Systems,: First Edition, 1978.

API Standard 2534 "Method of Measuring the Temperature of Petroleum and Petroleum Products. 1956. (ANSI/ASME D 1806)

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)

ANSI/API 2530 "Orifice Metering of Natural Gas, and Other Related Hydrocarbon Fluids" (AGA Report No. 3 Second Edition, 1985)

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

PTC 19.5.4 "Instruments and Apparatus, supplement to ASME Power Test Codes" (February, 1959)

"Fluid Meters: Their Theory and Application, report of ASME Research Committee of Fluid Meters, 6th Edition, 1971"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-IN-190 "Transmission Systems"
IPS-E-IN-210 "Instrument Protection"
IPS-E-IN-240 "Liquid Custody Transfer"

3 . UNITS

This standard is based on International System of Units, (SI) except where otherwise specified.

4. DIFFERENTIAL PRESSURE PRIMARY ELEMENTS

4.1 Installation and Inspection of Metering Runs

Meter run pipe (tubing) should be carefully selected for a uniform, but unpolished, internal surface free of striations and grooves. It should also be selected for roundness, for concentricity of inside and outside diameters, and for conformance with published diameters. Sometimes it is preferable to buy specially selected pipe (tubing) for meter runs. Or sometimes it is preferable to buy preassembled meter runs of select, calipered pipe, complete with orifice flanges for installations where accuracy is important.

Fifteen diameters of the special pipe upstream of the orifice is sufficient to correct wall effects on the flow pattern. Therefore, mill run pipe of the same schedule shall be used for added straight lengths needed to meet the requirements listed in Table 1. A pair of break out flanges may be installed, without affecting accuracy, at a minimum of 5 diameters downstream from the orifice to allow inspection of the meter run bore.

Out-of-roundness tolerance varies with the d/D ratio. When the d/D ratio is 0.70, the out-of roundness tolerance is 0.5 percent for the upstream sections and 1 percent for the downstream sections. For tolerances for other d/D ratios see ANSI/API 2530. It is recommended that all meter runs be designed as if for a 0.70 minimum d/D ratio. If published orifice coefficients are used, the diameters of the pipe should match published diameters within 0.5 percent for flange taps and within 0.2 percent for pipe taps.

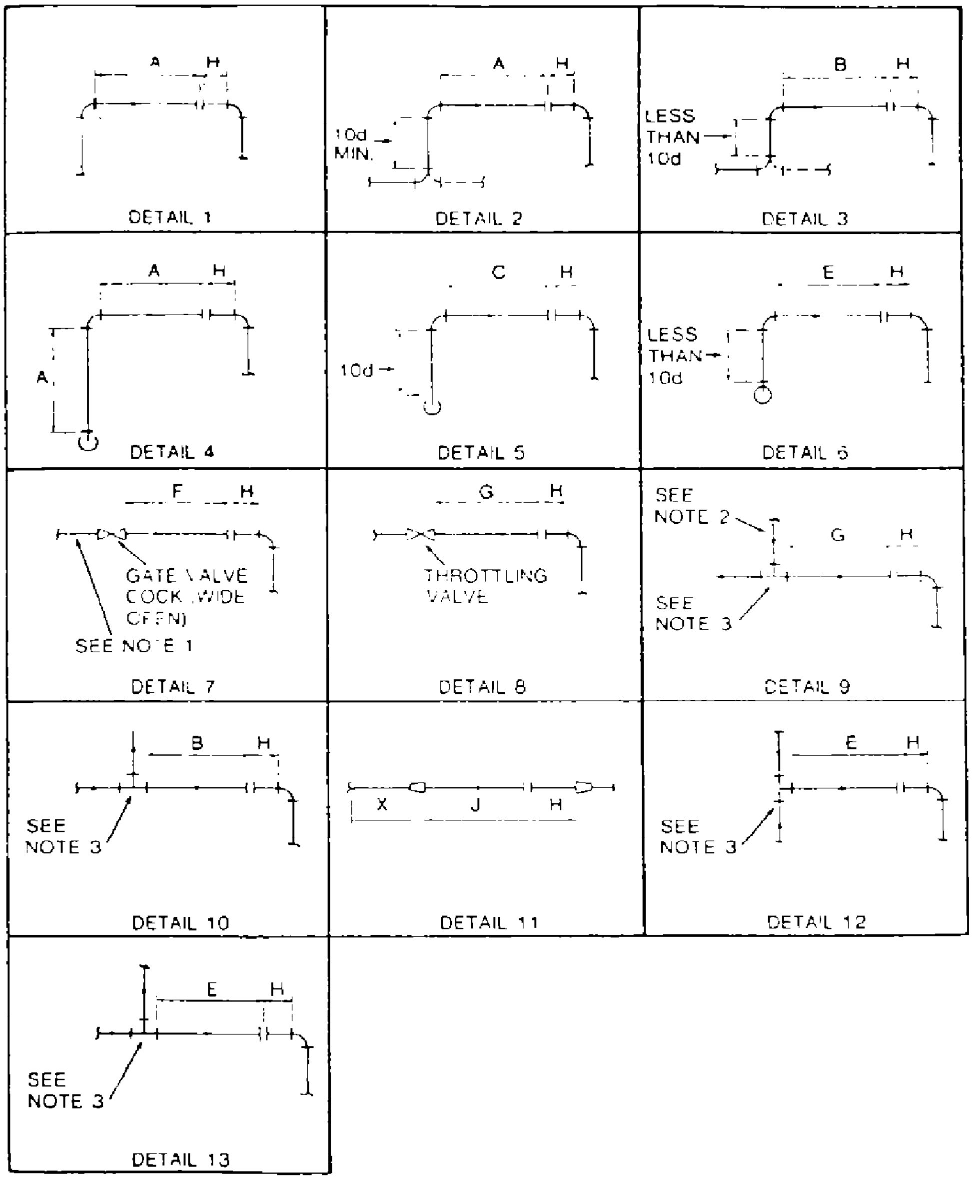
Flange tap orifice flanges are either of the screwed, slip-on, or weld-neck type. If slip-on threaded flanges are used, all burrs must be removed after drilling the taps through the pipe. When slip-on flanges are used, additional care must be taken to see that all weld splatters are removed from the flange face, Any reduction of the diameter or distortion of the pipe caused by welding should be eliminated.

If weld-neck flanges are used, it is essential that the flange bore be the same as the pipe internal diameter and that the bore be concentric and parallel with the pipe. If there is any internal roughness at the weld, it should be ground smooth. Wherever highest accuracy is required, the internal diameter of the pipe shall be bored to diameters and tolerances indicated in ANSI/API 2530 for a distance of at least 4 pipe diameters preceding the orifice or nozzle and at least 2 pipe diameters downstream of the inlet face of the orifice or nozzle and at least 2 pipe diameters downstream of the inlet face of the orifice or nozzle. The bored portions shall be concentric with the flange bolt circles and be flared into the unbored portions at an included angle of not more than 30 degrees. It is desirable to use a tapered mandrel to position the welding-neck flange during welding. Flange taps should be properly oriented during installation.

Before installation, all orifice run fabrications should be inspected for dimensions, straightness, absence of burrs and welding deposits, and internal roundness. Where welding-neck flanges have been used, concentricity of the pipe with the flange neck should be checked. It is essential that the flange bore be the same as the internal diameter of the pipe.

TABLE 1 - d/D RATIO VS. STRAIGHT RUN REQUIREMENTS

STRAIGHT RUN REQUIREMENTS (IN NOMINAL PIPE DIAMETERS) SEE Fig. 1								
d/D Ratio	A	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



STRAIGHT RUN REQUIREMENTS

Fig. 1

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 Details 5 or 6 in Fig. 1.

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. 1 Detail 11, X+J must be equal to the number of diameters required by previous fittings.

5) See Table 1 for d/D values, run requirements, and detail notes.

For gas measurements, the tolerances should be in accordance with ANSI/API 2530.

For liquid service where the taps are horizontal, sufficient clearance should be available between adjacent lines for installation of block valves and fittings. Taps at 45 degrees below horizontal may be used to permit closer spacing of adjacent piping.

Before installation, orifice plate bores should be inspected for concentricity, roundness, sharpness, and absence of burrs and nicks. The bore should be measured with a micrometer, and the reading should be checked against that stamped on the paddle handle.

If a bevel-edge orifice plate is to be installed, the beveled edge must face downstream. The quadrant-edge orifice plate, on the other hand, is install with the rounded edge upstream. For services requiring high accuracy, the orifice plate must be positioned carefully between the raised face flanges to ensure that the bore is concentric within 3 percent of the inside diameter of the meter run. For ordinary services, the inside diameter of the flange bolt circle may utilized to facilitate centering the orifice plate. The flow coefficients can easily be repeated to within +0.10 percent in metering runs of the longer straight lengths given in Table 1. The inside diameter of the gasket must not be smaller than The inside diameter of t pipe, and the gasket must be positioned concentrically. Orifice plates supported in ring-type joint holders will be positioned within the concentricity tolerances of the ring groove and the orifice bore within the ring.

Installation of orifice plates should be postponed until after the lines have been flushed out. This will prevent debris from piling up in front of the orifice plates. It will also prevent any debris that might be dislodged during initial circulation from damaging the edges of the orifice plate.

4.2 Accessibility of Primary Elements

It is advisable to locate the orifice or other primary element so that it is accessible from grade, a walkway, or platform. However, if the orifice is not over 4.5 meters (15 feet) above grade, it should be accessible from a movable platform.

4.3 Connecting Piping

4.3.1 Meter location

Flow recorders, indicators, controllers, or remotely mounted transmitters should be mounted at a convenient height of about 1.2 or 1.5 meter (4 or 5 feet) above grade, platforms, walkways, or other permanent means of access. Close-coupled meters are preferred. They should be conveniently placed for easy maintenance and for making zero checks with a manometer or test gage. The mounting location of a flow transmitter must be carefully selected because it is susceptible to damage or malfunctioning caused by vibration. The transmitter output gage in a flow control installation should be visible from both the control valve and the control valve bypass.

This arrangement will facilitate emergency local and manual control. If clear access is available to the space below a meter, a rolling platform of moderate height may be used.

4.3.2 Meter leads

Meter leads should be as short as possible, preferably not exceeding 6 meters (20 feet). For liquid measurement the leads should slope at least 25 millimeters per 30 centimeters (1 inch per foot) downward from the orifice taps. For gas measurement the leads should be slope upward at least 25 mm per 30 cm from the orifice taps, or downward toward the drain post if the meter must be mounted below the orifice run.

Meter piping should be designed and installed in accordance with the piping specification for the service involved. It is preferable to use 12 mm (½ inch), carbon steel or stainless steel type 304 or better piping schedule 80 or heavier for meter impulse leads. In some cases or where user preference dictates 10 mm (3/8 inch) or 12 mm (½ inch) tubing may be used, with mutual agreement of Vendor and User.

All locally mounted instruments and lead lines handling water or process fluids which may freeze, become excessively viscous, or form hydrates in cold weather should be installed in accordance with IPS-E-IN-210 "Instrument Protection".

Attention should be given to meter-connecting piping and manifolding as a source of meter inaccuracy. There may be more liquid head in one meter lead than the other because of differences in specific gravity, temperature, or amount of gas or water in the leads. For example, if the meter is 2.5 meters (100 inches) below the orifice with one side filled with water and the other side filled with a liquid of 0.65 specific gravity, the zero error will be 35 percent of full scale for a 2.5-meter (100 inches) range. It should be noted that, at times, most hydrocarbon streams will contain water.

Mounting the meter or transmitter close-coupled to the meter taps eliminates the possibility of error from specific gravity differences.

4.3.3 Meter manifolds

Manifolds are necessary on all differential-measuring devices for checking zero and for putting the meter into or out of service. Figures 2 through 5 show only the use of tubing and tube fitting installations. For piping and pipe fitting installation see the attached typical drawings (1 through 15), using 3-way manifold in combination with primary element tapping valves.

a) Close-coupled meters

There are three generally acceptable methods of valving close-coupled meters to provide process blocks at the orifice and an equalizing bypass valve at the meter.

1) Conventional line-class gate valves may be installed with rigid pipe nipples between the flange and the valve and short impulse leads terminating at a special bypass manifold valve attached directly to the meter. These bypass manifolds have generally universal adaptations to fit most manufactures' meters. See Figs. 2 and 3.

2) Special orifice flange valves may be installed with male inlets to fit directly into the orifice flange with impulse leads and a bypass manifold valve as in Method 1 above. See Figs. 2 and 3.

3) A special combination orifice flange block and bypass manifold may be installed, which permits the closest possible direct coupling of the meter to the orifice flanges and supports the meter. See Figs. 2 F and G.

Method 1 and 2 provide greater flexibility in meter location, but do require a meter support bracket. Generally speaking, present practice has all but eliminated a bypass valve arrangement because of simpler, cleaner installations made possible with the direct-connected manifold equalizing valve.

b) Grade-mounted or Semi-remote Installations

Grade-mounted or semi-remote installations require additional considerations. Conventional gate valves or the special orifice tap valves described in 4.3.3. a (Methods 1 and 2) are generally used at the orifice flanges for the main process blocks. Valving at the meter requires several different configurations depending upon individual requirements.

Three separate types are described below and illustrated in Figs. 4 and 5 (See also the attached typical drawings, 1 through 15).

1) For remotely mounted meters where the orifice flange blocks are easily accessible, a single bypass valve may be used.

2) To provide for greater ease of maintenance and for safety, redundant impulse line block valves may be added at the meter.

3) The bypass-equalizing valve must be installed between the redundant impulse line blocks and the meter. The bypass may be either a single tight shutoff, globe or needle-type valve or a double block-and-bleed arrangement to assure positive shutoff.

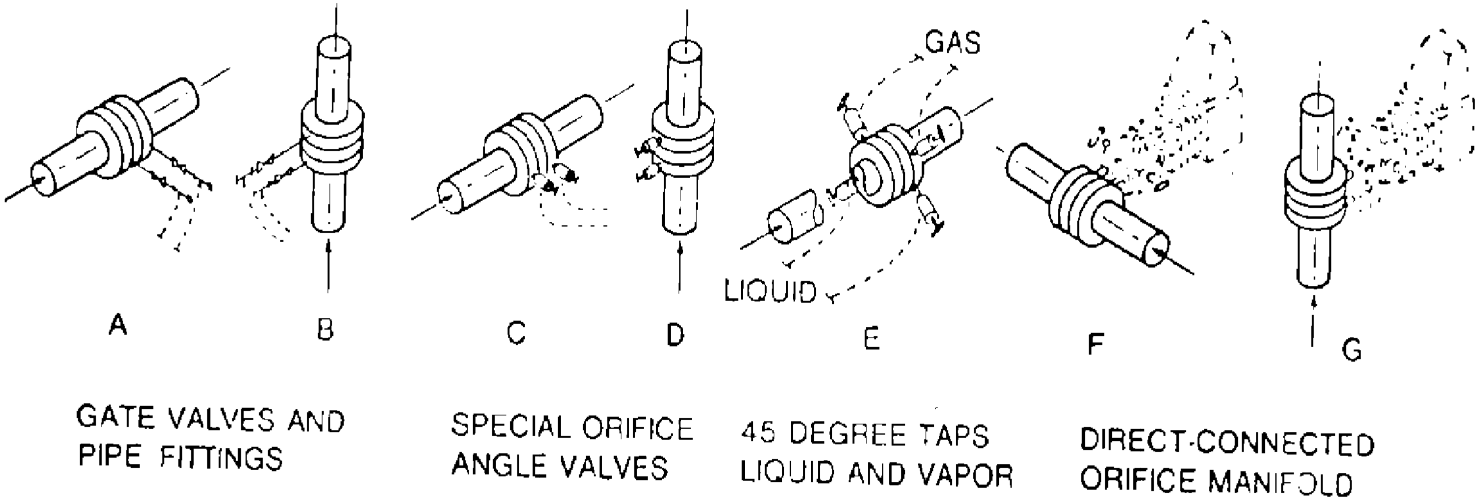
Special three-valve and five-valve block manifolds that provide reliable, convenient, and simplified installations are suitable alternatives to individual valve assemblies.

Special process or maintenance considerations sometimes require the addition of drain or blowdown valves, condensate drip legs (with or without pots), and vents (with or without pots). These are illustrated in Fig. 3 for liquid, gas and steam or wet vapor services.

Manifolds usually are classified as three-valve manifolds, five-valve manifolds, or three-valve manifolds with drains (see Figs. 2 through 5). Generally, three-valve manifolds are used in liquid service and with close-coupled transmitters (see Fig. 3).

When the meter is close-coupled, the tap block valves may serve as two of the three valves of the meter manifold unless double blocking is required for removing the instrument while the line is in service. The five-valve manifold installation frequently is used with liquid-sealed meters, with meters in gas service, or with any remotely located installation to provide accessible secondary process blocks along with the double block and bleed bypass (see Fig. 4). Generally five-valve manifold are used on custody transfer meters.

12-millimeter (Half-inch) carbon steel or stainless steel piping should be used for impulse leads. Valving does not need to be stainless steel unless required by service conditions, Special manifolds with either three or five integral valves are available. Wherever a bypass double block-and-bleed arrangement is required, a five-valve manifold block assembly installation provides a more economical approach than individual valving and accompanying fittings.

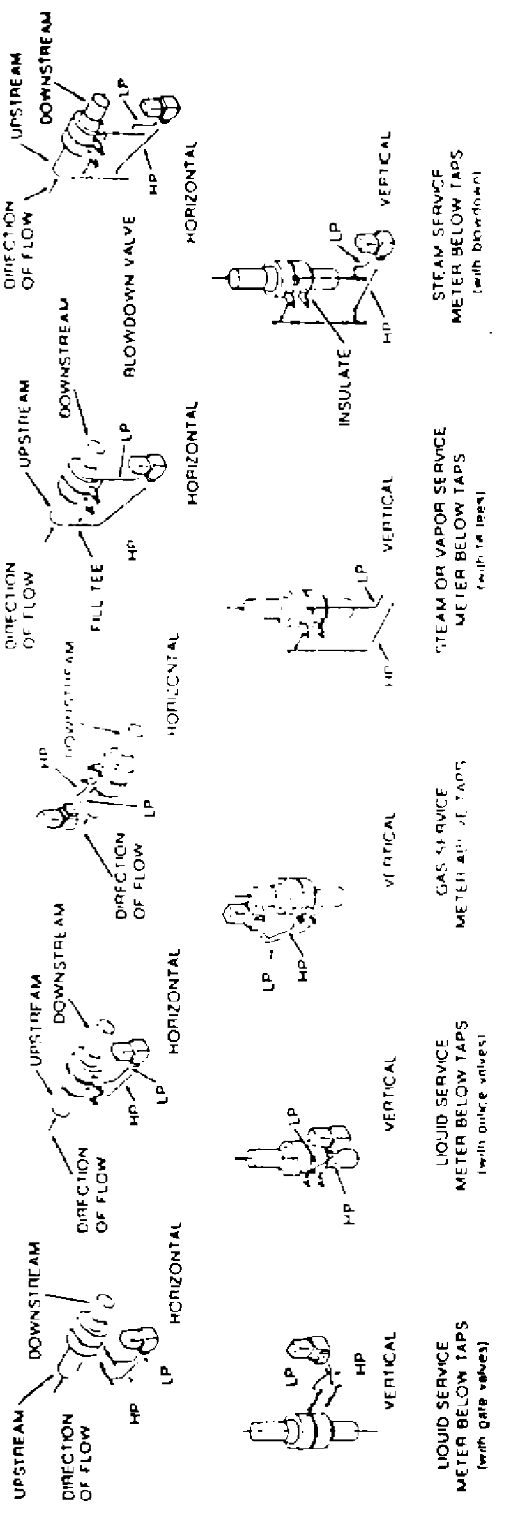


NOTES:

1. A and B—Standard gate valves with Schedule 160 nipples and fittings provide convenient tap cleanout connections. Gate valves must be staggered for installation clearance, which requires extra space.
2. C and D—Special orifice tap valves with dual side taps, one flush-plugged, can be used for a purge connection. The male inlet threads directly to the orifice tap. Pipe fittings are not required. This type of valve can be installed without spreading flanges.
3. E—Alternate 45-degree taps (off the top for gas; off the bottom for liquid) may also be used.
4. F and G—Special direct-connected orifice manifolds permit closest possible coupling of meter to orifice and completely supports meter in various vertical positions. Rod-out connections are available after removing transmitter. Considerably more space is required between adjacent piping. Adjustable inlets accommodate 1/8-inch to 1/4-inch (3 to 6 millimeter) orifice plates. Direct connected orifice manifolds require simplified field adaption to transmitters and are available in various configurations.
5. Vents and drains are not shown.

ORIFICE FLANGE CONNECTIONS

Fig. 2

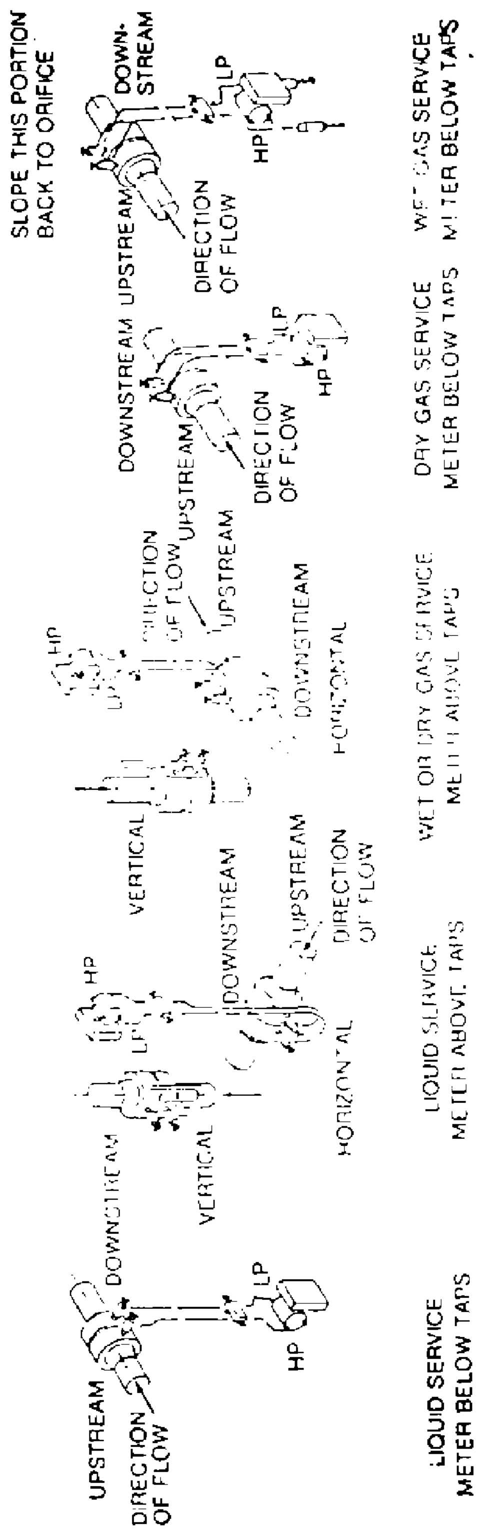


NOTES:

1. Keep impulse leads to minimum length.
2. Provide positive slope, at least 1/12 for all leads. This avoids pocketing and provides positive venting or draining.
3. Connect high-pressure side of instrument to upstream tap
4. For liquid service in vertical lines, up-flow is preferred to avoid vapor or trash buildup above the plate.
5. Install meters below taps for liquid, steam, or condensable vapor service
6. Install meters above the taps for gas service.
7. For steam service both fill-tees (condensate pots) must be installed at same centerline elevation as upper tap.
8. Flow meter installations for vena contracta or pipe tap connections are similar to those shown for flange taps.

CLOSE-COUPLED FLOWMETERS

Fig. 3

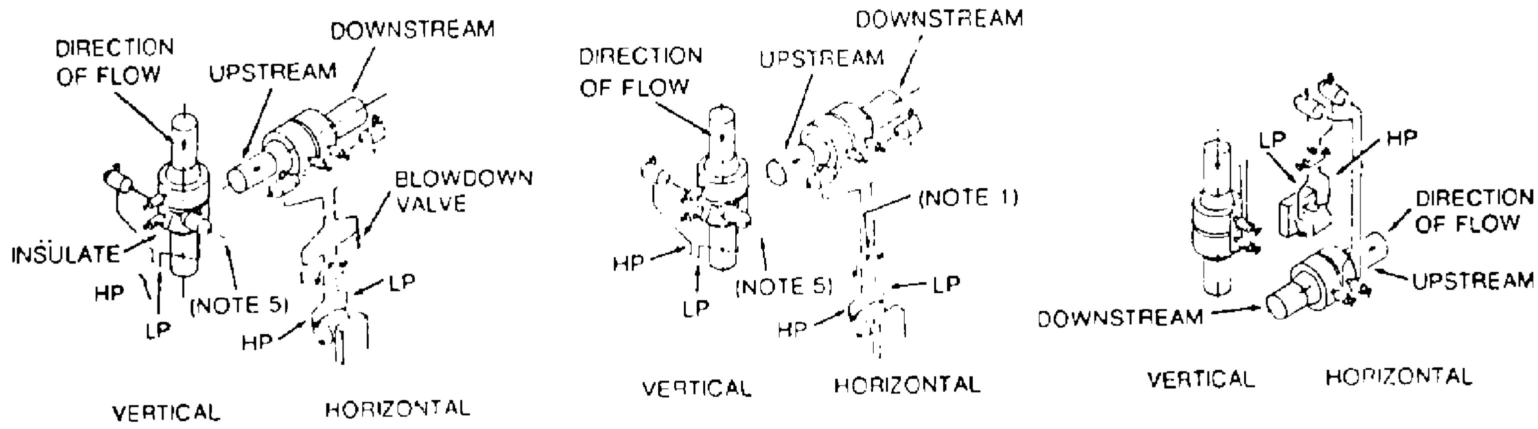


NOTES:

1. Keep meter leads as short as possible (20 feet maximum).
2. 3/4-inch (20 millimeter) fill-tees usually provide sufficient condensate volume for most instruments.
3. Provide secondary process block valves with equalizing bypass. Three-valve or five-valve manifolds may be used.
4. For liquid meters above an orifice, provide a seal leg below each tap. Drain facilities may be desirable.
5. For vapor meters above an orifice, provide continuous slope back to taps.
6. For dry gas meters below an orifice, drip pots may be eliminated.
7. For wet gas meters below an orifice, slope upper section of impulse leads back to orifice and provide suitably sized drip pots at lower meter connections.
8. Where redundant impulse line blocks are not required, a single tube-fitting type bypasss valve may be used.

REMOTELY MOUNTED FLOWMETERS FOR LIQUID AND GAS SERVICE

Fig. 4



STEAM SERVICE
METER BELOW TAPS
(with condensate pots and blowdown)

STEAM OR VAPOR SERVICE
METER BELOW TAPS
(with condensate pots and no blowdown)

STEAM OR VAPOR SERVICE
METER BELOW TAPS
(with condensate pots above meter)

NOTES:

1. Generally 3/4-inch (20 millimeter) tees provide sufficient capacity condensate pots.
2. When required, provide blowdown connections above the three- or five-valve manifold block. Blowdown through block or instrument may cause damage due to high temperature.
3. Install tees or pots level with upper tap.
4. Slope leads of 1/12 or more.
5. Vent valves are optional, but highly desirable. Their vent port should be oriented away from normal operator approach.
6. Where pots are installed above the tap to provide liquid seal for either steam or condensable vapor, the impulse leads should be insulated between the orifice tap and the pot only; except in cases where winterizing is required.
7. Insulation is not required where the meter is above the orifice and the pots are installed at the taps; except in cases where winterizing is required.
8. It is important to connect leads to the appropriate bottom or end connections, as illustrated, to provide the proper seal.
9. Where redundant impulse line blocks are not required, a single tube-fitting type bypass valve may be used.

REMOTELY MOUNTED FLOWMETERS FOR STEAM OR CONDENSABLE SERVICE

Fig. 5

4.3.4 Seals, condensate pots, and knockout pots

In some services it is necessary to protect certain types of meters from the process fluid or to reduce potential errors caused by water or vapor in a meter lead . Seal chambers should be installed if these conditions are present, according to IPS-E-IN-210 "Instrument Protection".

In steam service, a means must be provided to maintain an equal liquid head on each side of the meter. A means should also be provided to permit prefilling the leads with the condensate to protect the instrument from excessive temperature during startup. Generally, the 20-millimeter (¾-inch) filling tee suffices as an adequate condensate chamber, especially for low-displacement type meters.

However, larger conventional condensate chambers may be preferred. When used, the long axis of the filling tee should be installed horizontally to provide the largest liquid-vapor interface and the least level change with volumetric displacement. Various examples are shown in Fig. 5.

4.3.5 Purging

Purging is needed to prevent the plugging of meter leads under the following conditions:

1) The flowing fluid contains solids.
2) The flowing fluid is either corrosive to meter parts or highly viscous.
3) The meter or meter piping cannot tolerate water or condensate.

The purge should be introduced as close to the transmitter as practical. The purge flow must be restricted so that it is uniform on both sides of the meter and does not cause a false differential. Restriction orifices, purge rotameters (preferably armored type,) needle valves, or drilled gate valves are commonly used to control the volume of purge fluid. The drilled gate valve is desirable if frequent blowing back is required, The purge fluid should be clean and compatible with the process fluid. For additional information, see IPS-E-IN-210 "Instrument Protection".

4.4 Senior (Retractable) Orifice Fitting

a) Remove all foreign matter such as dirt, sediment or scale form fitting surfaces, connections and internal cavities which may have collected between factory inspection and delivery. Gasket the line flanges and install or weld the fitting in line, making sure flow arrow cast on body corresponds to flow direction.

b) Install Bleeder Valve and Grease Gun to connections provided on fitting.

c) After installation, remove Drain Plugs and Check for any foreign matter that may have become trapped in fitting cavities, Install full-opening valves for blow-down operation.

d) Generally manufacturer installation instructions shall be considered strictly.

5. VARIABLE AREA METERS

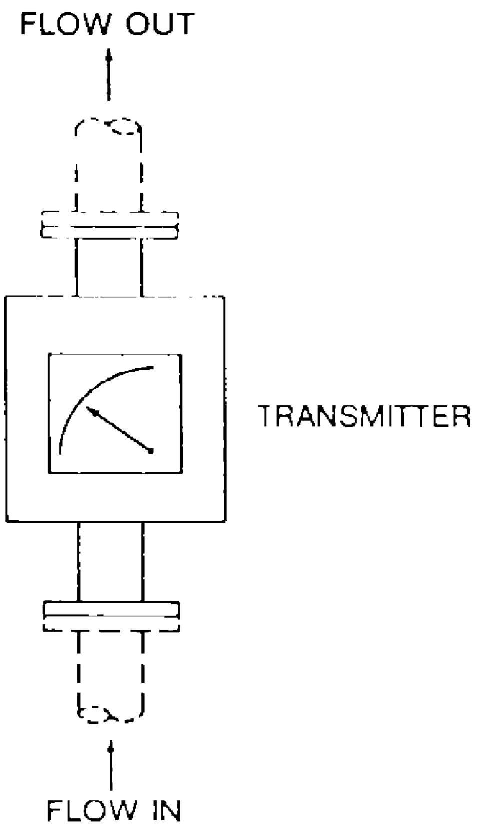
5.1 Location and Mounting

The meter should be installed in location that is free from vibration and where sufficient clearance is available for occasional float removal for service or inspection if applicable. The meter location should be visible and readily accessible for operation and maintenance. In general, when a meter is to be used in regulating service, it should be placed as close as possible to the throttling point, preferably with the valve located at the outlet fitting.

Rotameters must always be mounted vertically, with the outlet connection at the top of the meter and the inlet connection at the bottom.

5.2 Main Line Piping

Most variable area flow measurement is practically independent of upstream piping arrangements[1]. Elbows, globe or throttling valves, and other fittings have no effect on measurement accuracy if they are not closer than 5 diameters upstream of the meter. Typically with 0 (no clearance) diameters upstream, the inaccuracy will not exceed 5 percent .



THROUGH-FIOW TYPE ROTAMETER

Fig. 6

(1) Spink, L.K., principles and practice of flow meter engineering, ninthe edition, 1967.

When connections are interchangeable (for vertical or horizontal connections), horizontal connections are recommended, if at all practicable, in the overall piping arrangement. Horizontal connections permit the use of the plugged vertical openings as convenient cleanout ports. The design of most rotameters permits the end fitting to be rotated in 90-degree increments allowing a convenient variety of connection arrangements. Rotameter piping connections are shown in Detail A of Fig. 7, see also the attached typical drawing 16.

All piping should be properly supported to prevent sagging caused by the weight of the meter. Care must be taken so that the piping arrangement does not impose any strain on the meter body.

5.3 By-Pass Piping

Block and bypass valves, such as shown in Detail B of Fig. 7 should be provided where operating conditions do not tolerate shutdown while servicing the meter. See also the attached typical drawing 16.

The bypass line and valves should be the same size as the main line. Block valves, (gate valves) should be installed upstream and downstream of the rotameter. A drain valve should be installed between the inlet block valve and the meter. A typical bypass arrangement is shown in Detail B of Fig. 7 see also the attached typical drawing 16.

When a rotameter installation includes a bypass, care must be taken to ensure that the bypass valve is tightly closed when the rotameter is in service. Only the downstream block valve may be used for throttling when flashing might be encountered.

5.4 Strainers

In smaller line sizes, it is sometimes advisable to locate a strainer upstream of the meter to prevent the float from being jammed with foreign material. This will also prevent the indicatig scale on glass tube meters from being made illegible.

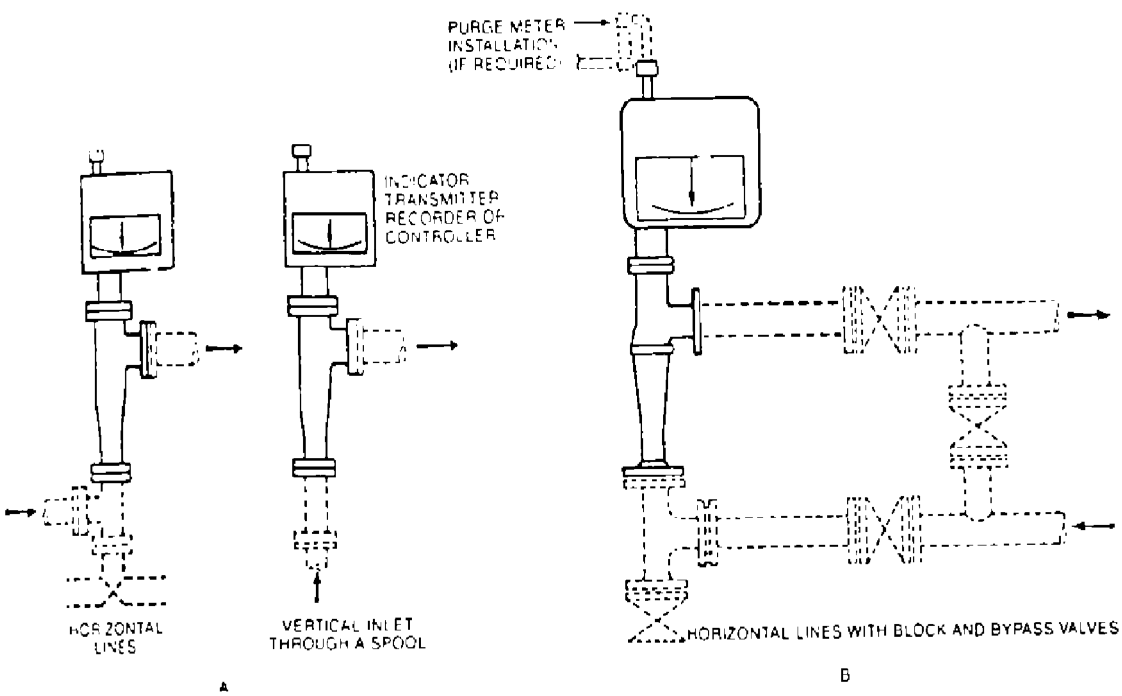
5.5 Purge Fluid

In installations where purging is necessary, the purge fluid may be injected at the top of the extension tube, as shown in Detail B of Fig. 7 or at other connections provided in the instrument . Where the main-line pressure or purge fluid supply pressure may vary over short periods of time, it is advisable to use the purge rotameter differential regulator combination for automatic control of the purge rate of flow (see IPS-E-IN-210). Consult the manufacturer's instruction bulletin for purge rate.

5.6 Start-up

When the meter is put into operation, the valve should be opened slowly to prevent flow surges, which might damage the float or other meter components. If the meter is purged, the purge flow must be started first.

Generally, no field calibration of rotameters is possible.



ROTAMETER PIPING CONNECTIONS

Fig. 7

6. TARGET FLOW METERS

6.1 Location and Mounting

The target flowmeter can be installed in either horizontal or vertical lines, It should be located where it is accessible from grade, a platform, or a ladder.

The target flowmeter is line-mounted. It must be oriented with the directional arrow in accordance with flow direction. For better cooling on hot horizontal lines, the meter should be mounted with the head to the bottom or side. All piping should be sufficiently supported to prevent undue stress.

6.2 Main Line Piping

Standard orifice meter piping practice should be followed using meter run values of minimum 0.70 d/D. This Standard practice includes the optional use of straightening vanes, where necessary, to reduce the run of straight pipe. (See Details 1 to 13 in Fig. 1 and Table 1).

6.3 By-Pass Piping

Bypass piping is usually recommended on continuous service or in services requiring zero adjustment or calibration. Upstream and downstream block valves should be line size and located in accordance with orifice meter practices.

6.4 Strainers

Strainers are not normally required or recommended for target meter service.

6.5 Electrical Installation

Installations should be made in accordance with the manufacturer's recommendations (see IPS-E-IN-190) "Transmission Systems".

6.6 Start-up and Calibration

On new installations, care must be used to assure that the process line is free of large foreign matters that might damage the meter at initial startup.

The target flowmeter may be adjusted to zero by stopping all flow in the line, usually by bypassing, and adjusting the output to correspond to zero flow. Range adjustment is normally accomplished by removing the meter from the line and applying weights to the force bar in accordance with the manufacturer's instructions.

7. TURBINE METERS

7.1 Location and Mounting

The turbine meter is installed directly in the process line using flanged, or screwed connections. The line should be relatively free of vibration. If the meter includes an integrally mounted, direct-reading register, it should be positioned so that it can be easily read and maintained.

Turbine flowmeters are generally installed in horizontal lines. Some designs may be installed vertically, but calibrations for that position may be necessary. In some meter designs, special thrust bearings must be specified for vertical mountings to prevent excessive wear. It is usually necessary to specify the position for which the meter is to be calibrated.

7.2 Main Line Piping

Accuracy and repeatability of turbine meters are especially dependent upon upstream and downstream piping arrangements. In addition to sufficient upstream and downstream straight runs, flow straightening is normally required if the very high potential accuracy of a turbine meter is to be achieved [3]*. See Fig 8 and 9.

Where optimum performance of flow measurement is required, means must be provided for automatic removal of air or gas which may be in the process stream. Gas entrainment can cause errors in repeatability and accuracy of the meter.

Turbine meters should be installed so that they have a positive head of liquid upstream. This head should be equivalent to at least twice the anticipated pressure drop through the meter. To minimize cavitation problems in vacuum service or when operating with liquefied gases, a back pressure regulator should be provided downstream to maintain an adequate back pressure for proper operation of the meter [3]*.

Care should be exercised in installation of flanged meters to ensure that the pipeline gaskets do not interfere with the flow pattern by protruding into flow stream.

7.3 By-pass Piping

The need for bypass piping is determined by the application. It may be necessary to isolate or disassemble the flowmeter for maintenance purposes. In continuous service applications, where shutdown is considered undesirable, block and by-pass valves must be provided to permit process operation while the meter is being serviced. Some of the conditions that may necessitate disassembly of the meter are damage caused by foreign material, wear, or a build-up of solids. If by-passed, the meter should be in the main run and the block valves should be line size and placed at least 10 diameters upstream and 5 diameters downstream of the meter [3]*. The by-pass valves must be capable of positive shutoff to prevent measurement errors.

7.4 Strainers

Generally, all turbine meter installations require strainers to prevent foreign matter from blocking or partially blocking the flow passages or lodging between the rotor and meter body. The strainer must be capable of removing particles of a size that might damage the rotor and bearings (see Table 2). The strainer should be located at least 10 pipe diameters upstream if a flow straightener is used [3]*. Limitations on strainer mesh may be dependent on process applications in which the pressure drop due to excessive strainer plugging must be considered.

TABLE 2 - TYPICAL SCREEN SIZE FOR LIGHT-HYDROCARBONS

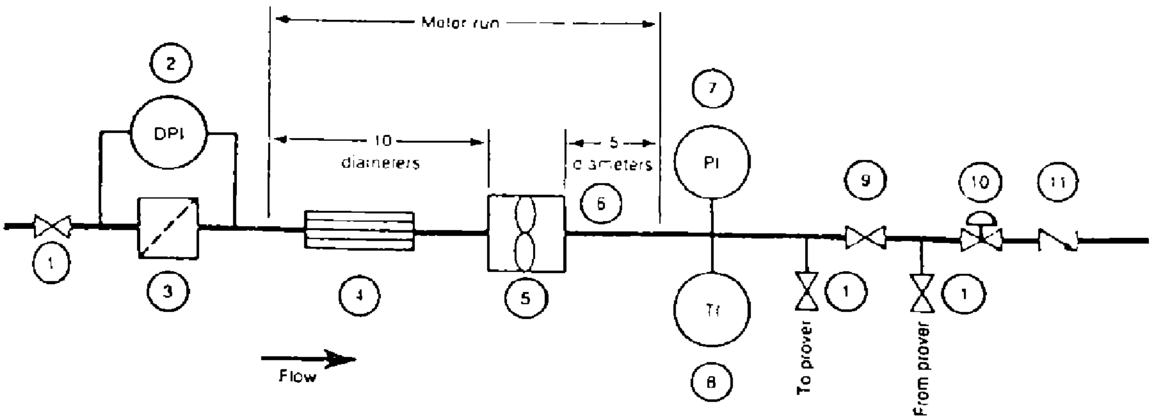
METER SIZE		
INCHES	MILLIMETERS	MESH
3/8 or smaller	10 or smaller	200
½ - ¾	12-20	150
1 -3	25-75	80
Larger than 3	Larger than 75	60

7.5 Electrical Installation

Generally, the signal from a turbine meter is low-level and of the pulse type, which makes it especially susceptible to noise pickup. Shielding of signal wires is mandatory to eliminate spurious counts. If the transmission distance is more than 3 meters (l0 ft) and a low-level signal is used to achieve greater rangeability, a preamplifier may be required.

High-level signals may often be transmitted as much as 150 meters (500 feet). Consult the manufacturer's instruction bulletin for details. (Refer to IPS-E-IN-190 "Transmission Systems").

*** Bracketed numbers indicate references to be found in para: 2.**



1) Block valve, if required.

2) Differential pressure device if required.

3) Filter, strainer, and/or vapor eliminator (if required) for each meter or whole station.

4) Straightener assembly per Fig. 9.

5) Turbine meter.

6) Straight pipe.

7) Pressure measurement device.

8) Temperature measurement device.

9) Positive shutoff double block-and-bleed valve.

10) Control valve, if required.

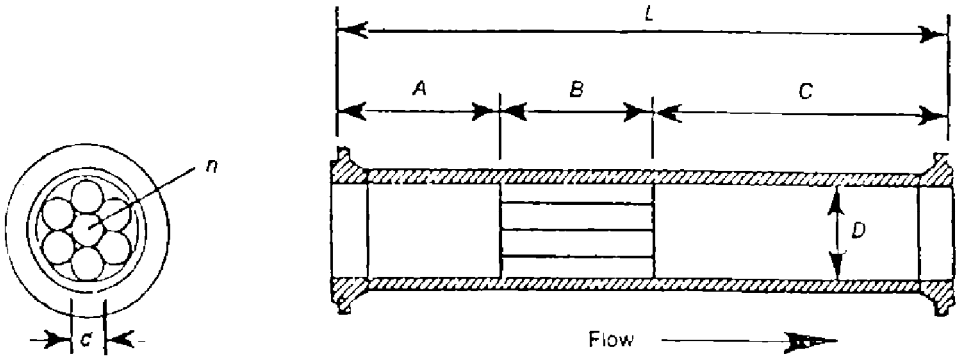
11) Check valve, if required.

Note:

All sections of line that may be blocked, between valves should have provisions for pressure relief (preferably not installed between the meter and the prover).

SCHEMATIC DIAGRAM OF A TURBINE METER

Fig. 8



L = Overall length of straightener assembly (≥ 10D).
A = Length of upstream plenum (2D-3D).
B = Length of tube or vane-type straightening element(2D-3D).
C = Length of downstream plenum (≥ 5D).
D = Nominal diameter of meter.
n = Number of individual tubes or vanes (≥ 4).
d = Nominal diameter of individual tubes (B/d ≥ 10).

Note:

This figure shows assemblies installed upstream of the meter, Downstream of the meter. 5D minimum of straight should be used.

EXAMPLE OF FLOW-CONDITIONING ASSEMBLY WITH STRAIGHTENING ELEMENTS

Fig. 9

7.6 Start-up and Calibration

Care must be used to prevent damage to the meter at initial startup. It should be placed in service only after the process line has been flushed and hydrostatically tested. If strainers are used, they should be cleaned after flushing and periodically during operation.

Plugged strainers may break loose and sweep downstream, demolishing the meter internals. Flow should be introduced slowly to the meter to prevent damage to the impeller blades as a result of sudden hydraulic impact or overspeed.

The calibration factor expressed in electrical pulses generated per unit volume of throughput is normally called a K (meter) factor. The K factor, which may be dependent on fluid conditions, is determined when the flowmeter is calibrated and is inherent in that particular meter. Generally, the K factors of meters vary even within the same size. This can be attributed to the different hydraulic characteristics of each individual meter. No adjustment may be made to the primary sensor [3]*.

For more details refer to: IPS-E-IN-240 "Custody Transfer".

*** Bracketed numbers indicate references to be found in para: 2.**

8. MAGNETIC FLOW METERS (MAGMETERS)

8.1 Location and Mounting

Considerable care must be exercised when installing the flowmeter primary in the pipeline. Special attention must be given to prevent damage to the liner and to ensure proper grounding requirements are met. The manufacturer's installation recommendations should be followed. The transmitter is built on a rugged piece of pipe, but it should be handled as a precision instrument.

The transmitter should be accessible from grade or from a platform with enough space around it so that at least the top housing could be removed if necessary. At the very minimum, sufficient access room should be available to remove any inspection plates.

If the transmitter is to be underground or in a pit that might become water flooded, provision should be made to prevent it from being submerged, unless the meter is equipped with a special housing to permit operation while submerged. Submersion should be avoided if possible.

The magnetic flow transmitter tube may be installed in any position (vertical, horizontal, or at an angle), but it must run full of liquid to ensure accurate measurement, If mounted vertically, flow should be from bottom to top to assure a filled pipe. When mounted horizontally, the electrode axis should not be in a vertical plane. A small chain of bubbles moving along the top of the flow line could prevent the top electrode from contacting the liquid.

Vertical mounting with a straight run on the inlet side and upward flow is recommended if an abrasive slurry is being measured. This arrangement distributes wear evenly.

8.2 Piping

Transmitter tubes are made of nonmagnetic materials, such as stainless steel, nickel chromium iron alloy (for example, Inconel), or fiberglass pipe. The nonmetallic tubes are used unlined, but the metal tubes are lined with a nonconducting material such as fluorocarbon,rubber,synthetic rubber, polyurethane, or glass to prevent short-circuiting the signal. Each transmitter assembly has definite operating condition limitations. Major limitations that should be considered are pressure, temperature, and corrosive and erosive properties. The operating conditions must not exceed the limits for the particular transmitter construction as outlined in the manufacturer's specifications.

When piping, the following precautions should be observed:

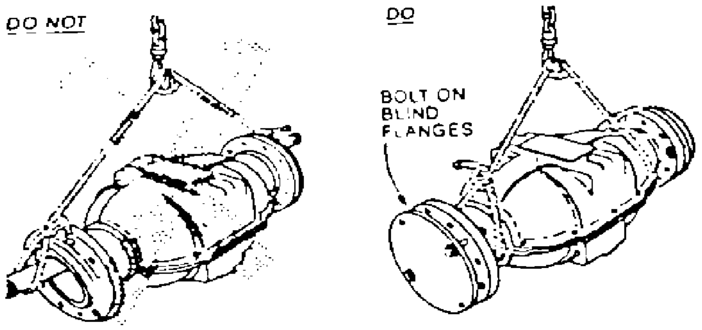
1) Care should be used in lifting the transmitter to avoid liner damage (see Fig. 10). If the liner is damaged, it should be replaced or repaired before installation, using an approved procedure.

2) The protective end covers should be kept over the flange faces until final installation.

3) During installation, care should be exercised to prevent overheating by exposing the magnetic flowmeter tube or liner to nearby heat sources (for example, welding).

4) If a metal tube magnetic flowmeter has its liner brought out over the flange faces, the liner should not be forced between adjacent flanges. Rather, a gasket of material compatible with the process should be inserted between the adjacent pipe flange and the magnetic flowmeter flange.

It is further recommended that a pipe spool installed on each end fitting of the magnetic flowmeter while it is out of the pipeline to minimize the possibility of damage to the meter pipe and flange liner during mounting.



HANDLING A MAGNETIC FLOWMETER

Fig. 10

5) To avoid liner damage on new piping installations, it is desirable to bolt the adjoining pipe fitting or valves to the transmitter before installing it in the line.

If this is not possible, it should be bolted in continuity from upstream to downstream piping. If piping is already installed, it is advisable to remove one or both adjoining pipe sections. In installations where there are no block valves or bypasses, it may be desirable to make up and install a flanged spool piece on each end of the transmitter.

6) Normally magmeters up to 300 mm (12 inches) in size require no support other than that required for an equal length of pipe, unless required for maintenance. The magmeter should not be used to support the adjacent piping. For larger sizes, depending upon size, construction, and the manufacturer's recommendations, a support structure may be necessary.

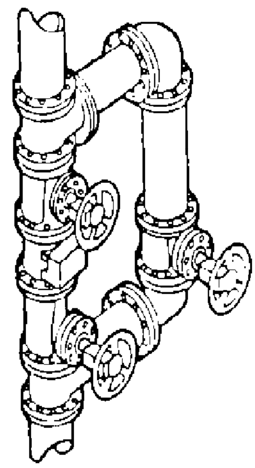
7) The piping should be designed for sufficient flexibility to prevent excessive forces from being transmitted to the electrically insulated flange faces. Particular attention should be paid to installations in vertical lines to ensure that the excessive weight of the transmitter or piping is not applied to the flange facing.

8) Several different types of flange connections are used. The general rule for all types is to make sure that the flange and its adjacent mating flange are properly aligned and that the bolts are tightened evenly.

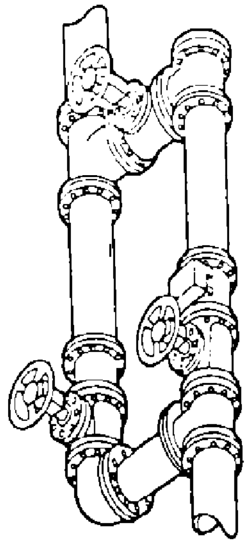
8.3 By-pass Piping

For applications that require frequent cleaning of the flow lines, the magmeter can be installed with block valves and a bypass valve to permit access to the tube interior without shutting down the process. Possible piping arrangements are shown in Figure 11. The bypass valve should be capable of positive shutoff to prevent measurement errors and wide opening. It should not be used as a throttling valve.

To permit checking the meter for zero flow, it is necessary to install the magmeter so that flow can be stopped with a full tube. For most continuous processes this will require a block and bypass arrangement. Certain magnetic flowmeters do not require zero adjustment.



A NORMAL BYPASS INSTALLATION



A BYPASS INSTALLATION WITH CLEAN-OUT TEE

BY-PASS PIPING WITH MAGMETER

Fig. 11

8.4 Electrical Installation

Power should be supplied at a voltage and frequency within the tolerance specified by the manufacturer.

Special low-capacitance cable is used to carry the generated signal from the transmitter to the receiver. It must not be installed close to the power cable or in the same conduit as the power supply. The manufacturer's recommendations should be observed. See IPS-E-IN-190 transmission systems.

Piping should always be grounded. The importance of proper grounding cannot be overemphasized. It is necessary for personnel safety and for satisfactory flow measurement.

The manufacturer's instructions on grounding and jumper arrangement should be followed carefully. A continuous electrical contact to the same ground potential is necessary between the flowing liquid, the piping, and the magnetic flowmeter. This continuous contact is especially important if the conductivity of the liquid is low. How this contact is achieved depends upon the magmeter construction and whether adjacent piping is unlined metal, lined metal, or nonmetallic. Jumpers from the meter body to the piping are always required. If the meter is installed in nonmetallic piping, it is always necessary to make a grounding connection to the liquid. This connection is achieved by means of a metallic grounding ring between the flanges, unless internal grounding has been provided in the transmitter. This grounding connection is extremely important and must be done as recommended if the system is to operate properly.

Most magmeters have their signal and power connections enclosed in splashproof or explosionproof housings. The connections must be sealed in accordance with manufacturer's instructions. Great care must be exercised in this area.

8.5 Start-up and Calibration

No special procedures need be observed during startup since the meter is obstructionless. There are often electrical ad-

9. POSITIVE DISPLACEMENT METERS

9.1 Location and Mounting

Positive displacement meters are installed directly in the process piping. Since they are often unbalanced, they can be a source of piping vibration. Adequate foundations should be provided. Refer to the manufacturer's recommendations.

Positive displacement meters are normally installed in horizontal lines, although certain types are specifically designed for vertical lines. The meter register and ticket printer should be positioned for easy reading.

Adequate back pressure is required to eliminate the possibility of vapor release.

Flow conditioning is not required for displacement meters.

9.2 Main Line Piping

Meters should be installed so that the meter case or body does not carry piping strain. The piping should be arranged so that the meter is always full of liquid. For continuous process services, a bypass may be provided around at positive displacement meter. For custody transfer, bypasses are not provided.

Positive displacement meters should always be installed with an adequate strainer to prevent foreign matter from damaging the meter or causing excessive wear. Follow the meter manufacturer's recommendation on mesh size. Where excessive amounts of debris are entrained in the fluid, strainer pressure drop should be monitored. Otherwise, basket rupture can occur, resulting in meter damage. The best positive displacement meter installation is one designed to avoid air or vapor in the piping. Otherwise, an air eliminator should be provided. Note, however, that air eliminators often leak or have inadequate capacity to protect the meter from slugs of air or vapor. See Fig. 12.

9.3 Limitations

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.

9.4 Start-up and Calibration

a) Start-up

Positive displacement meters are often damaged or destroyed during the initial startup. The manufacturer's instructions should be followed during startup, as well as the following general guidelines:

1) Positive displacement meters should be installed in the line only after the piping has been flushed and hydrostatically tested.

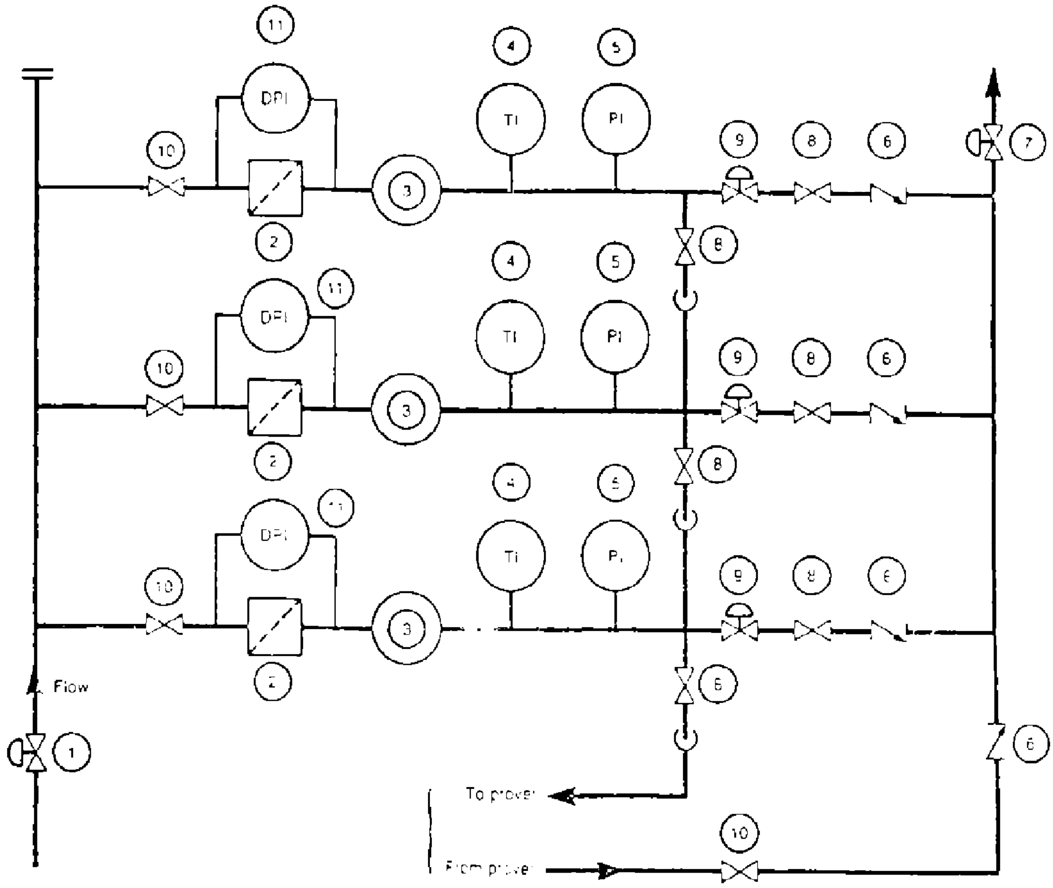
2) The meter strainer basket should be installed after the piping has been flushed. Strainer pressure drop should be monitored and strainers should be cleaned as required.

3) Extreme care must be taken to vent air from the piping. Flow should be introduced slowly to prevent hydraulic shock. The meter should be "broken in" by running at reduced flow.

4) Custody transfer meters must be proved initially and at regular intervals [4]*.

b) Calibration

For custody transfer service, the piping should be designed to allow for easy meter proving. For more information concerning custody transfer, see: IPS-E-IN-240.



1) Pressure-reducing valvemanual or automatic, if required.
2) Filter, strainer, and/or vapor eliminator
(if required) for each meter or whole station.
3) Displacement meter.
4) Temperature measurement device.
5) Pressure measurement device.
6) Check valve, if required.
7) Control valve, if required.
8) Positive-shutoff double block-and-bleed valves.
9) Flow control valve, if required.
10) Block valve, if require.
11) Differential pressure device, if required.

Note:

All sections of the line that may be blocked between valves shall have provisions for pressure relief (preferably not to be installed between the meter and the prover).

TYPICAL SCHEMATIC ARRANGEMENT OF METER STATION WITH THREE DISPLACEMENT METERS

Fig. 12

*** Bracketed numbers indicate references to be found in para: 2.**

10. VORTEX SHEDDING FLOW METERS

10.1 Installation

Vortex meters are installed directly in the process piping and are normally supported by the piping. They may usually be installed in any orientation.

A meter should be installed so that the meter body is not subjected to piping strain. In liquid applications, the piping should be arranged so that the meter is kept full.

Block and bypass valves may be provided when operating conditions do not permit shutdown.

10.2 Start-up and Calibration

Vortex meters are sometimes damaged during startup of new installations due to debris in the line. The line should be flushed and hydrostatically tested before the meter is installed.

Since velocity profile is critical, it is imperative that gaskets do not protrude into the flow stream when flanged meters are installed.

Field calibration of vortex meters is usually unnecessary, except for electrically spanning the converter or adjusting the scaling factor on a pulse-output type. For this adjustment refer to manufacturer's instructions.

11. MASS FLOWMETERS CORIOLIS FLOWMETER

11.1 General

Before initial installation, be sure that the transmitter and the sensor (flow tube) serial numbers match; the transmitter and sensor are calibrated at the factory as a matched set. For multiple sensor installations, do not exchange sensors and transmitters. To use an unmatched replacement transmitter (same model) with an existing sensor, the previous transmitter calibration and configuration settings must be matched on the replacement transmitter.

Use pipe clamps upstream and downstream close to the sensor and provide a stable, rigid mounting to ensure proper performance of the sensor.

Locate the sensor unit at least 0.6 m (2 feet) from any large transformer or motor. The mass flowmeter employs magnetic fields in its operation, therefore, do not mount the sensor near a large, interfering electromagnetic field. Also, do not drape sensor-to-transmitter interconnecting cable over equipment which project a magnetic field, such as electric motors.

In most cases, vibrations in a process plant are not a problem, however, care should be exercised in selecting the sensor's installation location.

Locate the sensor such that it remains full, or, if the process line needs to be purged, locate the sensor so it can be completely emptied of fluid. Keeping the sensor full will help prevent slug flow problems. To prevent gas accumulation within the sensor in a liquid application, avoid locating the sensor in a high point in the process piping.

The sensor measures accurately regardless of flow direction. For proper output display, set the transmitter flow direction as described in the appropriate transmitter instruction manual. The normal flow direction is marked with an arrow on the sensor housing as shown in Fig. 14.

11.2 Mounting

Large size sensors which installed directly in-line with the process piping should be installed at least 3 times the process fitting face-to-face width from each other if used in series. (see Fig. 2). Small size sensors require mounting and should be installed at least 2 meter (3 feet) from each other if used in series. Install pipe clamps on process piping between sensors which are installed in series. Proper distance between sensors and use of pipe clamps with sensors mounted in series will minimize "crosstalk" problems. Crosstalk is when sensor tube-related vibrations are conducted through the process piping between sensors. These vibrations can make it very difficult to adjust the zero flow setting (i.e.,unstable zero).

Avoid carrying or handling the sensors by their case since this may bend or twist the case and lead to interference with the vibrating sensor tubes.

Mount the small size sensor units on a flat, rigid, stable base, such as a concrete wall or floor. Secure all four mounting legs to the same surface. Separate or jointed surfaces may move relative to one another due to thermal expansion/contraction and settling. This could cause an unacceptable zero shift in the flowmeter. The more solid and inflexible the surface, the better the mount. (See Fig. 13)

If a solid, rigid surface is not available, the sensor should be mounted to a steel plate. A slightly smaller steel plate will be necessary to accommodate sensors with flange fittings.

Do not mount more than one sensor on the same steel plate.

When the sensor is bolted to the mounting, make sure the surface is reasonably flat. Use washers and apply equal torque to the mounting bolts to establish a firm mount. If this is not done, forces will twist the sensor housing, potentially resulting in zero instability.

If the sensor is used in a high vibration environment, the sensor must always be placed on a steel plate (as described above) which is mounted with vibration absorbers (see Fig. 15). Also, use at least 15 cm (6 inches) of flexible piping and install pipe clamps at the inlet and outlet (see Fig. 15). Use several centimeters (inches) of rigid pipe between flexible piping and the process connections and install pipe clamps on the rigid pipe close to the process connections.

A stress-free installation is important when connecting process fittings and process piping.

Exercise care to minimize stress placed on the process connections. Properly align the process piping with the flanges to minimize stress. Also, valves or pumps in the process line near the sensor require their own supports; do not allow the sensor mount on process connections to support pumps and valves.

Do not attach pipe supports to the sensor flange connections.

Systems where the sensor is normally full, but occasionally acquires gas vapors in the piping in the form of slugs, may require special monitoring. Typically, when a slug of gas moves through a pipe, a quantity of liquid accompanies the slug. The recommended system orientation depends upon whether the application is for loading and unloading or for a slug flow problem.

If the application exhibits slug flow, the sensor should be mounted with the tubes down (see Fig. 16) or in a vertical line (see Fig. 18). This should prevent slugs of air from being trapped in the sensor tubes. Slug flow will affect sensor performance by creating an imbalance between sensor flow tubes and, therefore, an inaccurate flow-rate reading. However, the flow metering system will recover as soon as the sensor tubes are full again.

In loading/unloading applications, the sensor is typically empty on start-up, a batch is run, and the sensor is purged of liquid at the end of the run. In these applications, the sensor should be mounted either in the flag position or with the tubes up (see Figs. 17 and 18). A check valve located downstream of the flow sensor is recommended to prevent fluid from draining back into the sensor and being measured twice during unloading. The check valve should be mounted as close to the sensor as possible.

In some instances the piping will not be completely purged of fluid. A flag mount or, mounting with the tubes up prevents any liquid left in the pipe from draining into the flow sensor. This type of mount will ensure that the sensor is empty after the pipeline is purged. If fluid is allowed to drain back into the sensor, the effective specific gravity of the liquid and air in the tubes could fall into the normal operating range. This could result in the sensor exhibiting erroneous flow counts.

11.3 Start Up

The performance of the sensor is very dependent upon the installation. Each application will require good engineering judgment in order to perform well. A start-up technique that has worked well for loading and unloading applications is described below:

1) Mount shut-off valves upstream and downstream of the sensor.

2) Close the upstream valve.

3) Partially open the downstream valve.

4) Slowly open the upstream valve to force the air out and slowly fill the sensor. This will minimize the amount of fluid missed on start-up.

5) Once the flow metering system begins counting in a normal manner, slowly open the downstream valve until it is fully open. The amount of time required before the downstream valve can be fully opened is typically less than 2 minutes, however, the timing will depend upon the particular application.

A portion of the fluid flow may not be counted during loading/unloading. The amount of fluid not counted will depend upon the piping arrangement, meter location, fluid properties, flow rate, and purging method. However, if the start-up and purge operation is always performed in the same manner, the amount of fluid not measured by the sensor can be characterized.

11.4 Mechanical Connections

Observe good piping practices during sensor installation. For best results, provide pipe supports near the fluid fittings. Do not attach pipe supports to the sensor flange connections. Install inlet and outlet piping using appropriate anchors, guides, expansion joints, hangers, or other mechanical support systems.

For the sensors which install directly in-line, place pipe supports as close to the sensor's process connections as possible(on the process piping side). Pipe supports or clamps installed close to the sensor should be mounted to the same attachment surface. Install pipe supports on process piping between sensors which are installed in series. Proper distance between sensors and use of pipe supports with sensors mounted in series will minimize "crosstalk" problems.

Crosstalk is when sensor tube-related vibrations are conducted through the process piping between sensors. These vibrations can make it very difficult to adjust the zero flow setting (i.e., unstable zero).

Pipe supports should support the process piping. Never use the sensor to support process piping-the sensor is supported from the pipe supports.

In high vibration areas, it is recommended that vibration isolationtype pipe supports should be used. Alternatively, flexible piping could be used for process fitting connection to minimize vibration transmission into the sensor.

Normal vibrations in the piping do not generally present a problem, but clamping of process piping as previously described can help dampen out any potentially interfering vibrations.

In some installations, it may be desirable to install a bypass loop to isolate the sensor from the process flow stream. Sensor isolation will allow for meter proving or removal if necessary. Install the inlet and outlet valves so that their added weight does not impinge on the process connections.

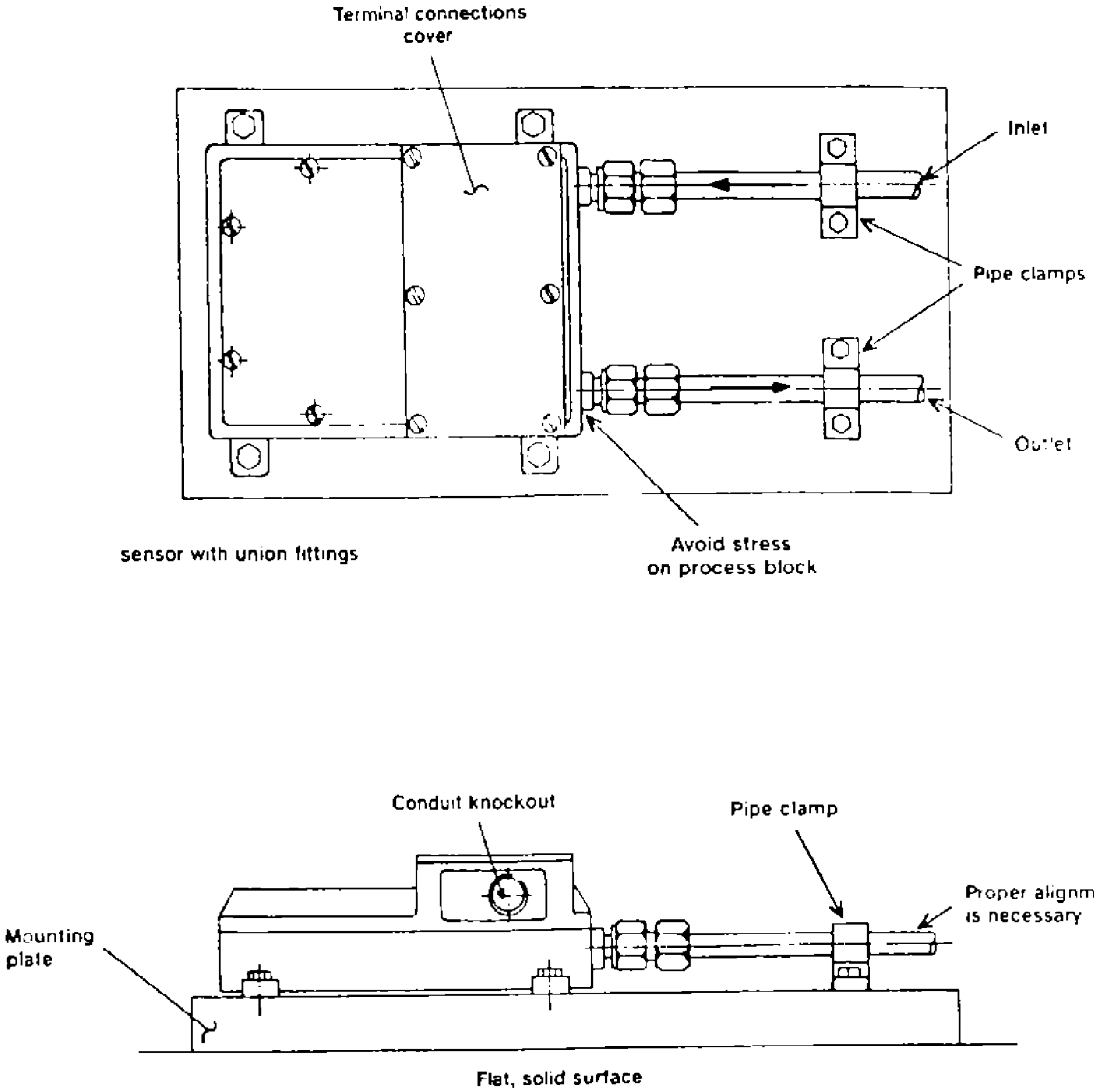
Minimizing pipe stress on the sensor process connections, both axial and lateral, is important. Gaskets should always be used, therefore, alignment of piping is crucial.

If the sensor operates at more than 28°C (50°F) above ambient temperature, check the coupling or bolts after the first cool-down period. Also, recheck the fitting if a leak occurs during operation at elevated temperatures.

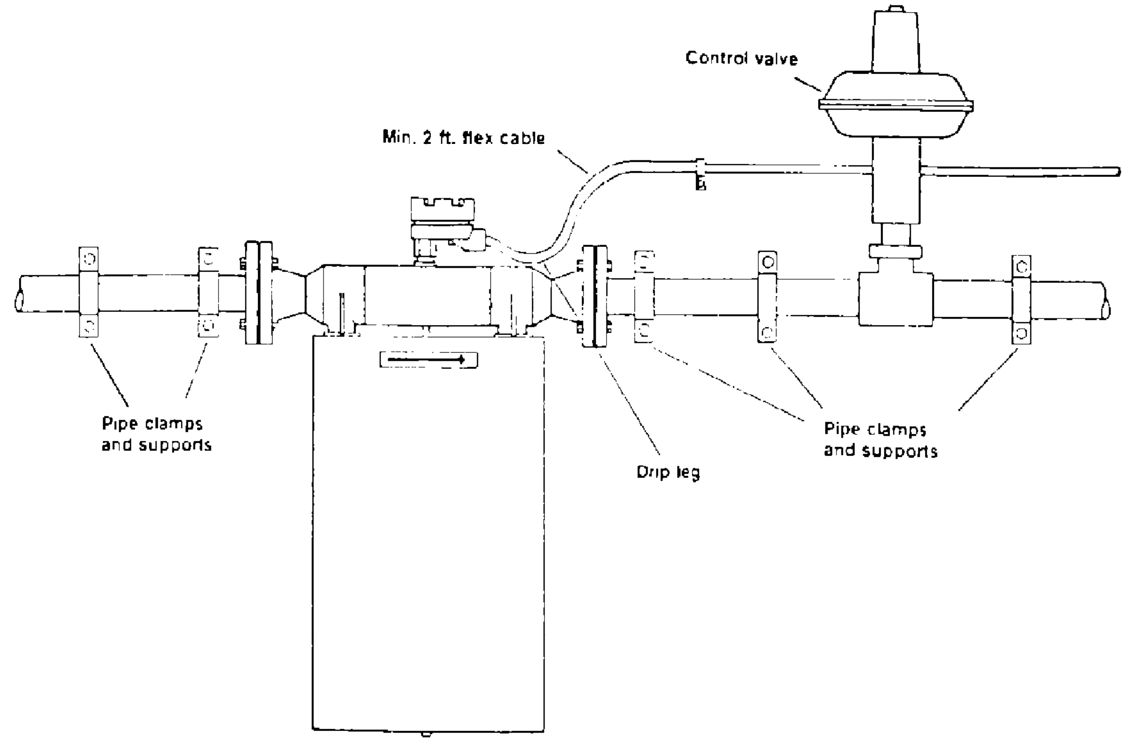
Ensure that the process piping is electrically grounded. If not, use the sensor grounding connections.

A downstream shutoff valve is recommended to ensure actual zero flow when adjusting the transmitter’s zero flow setting.

In batching operations, both the flowmeter and shutoff valve should be located as close as possible to the receiving tank or vessel to minimize batching errors. Also, flexible piping between the sensor and the shutoff valve may cause batching errors’ since flex tubing may expand and contract appreciably in response to system pressure.

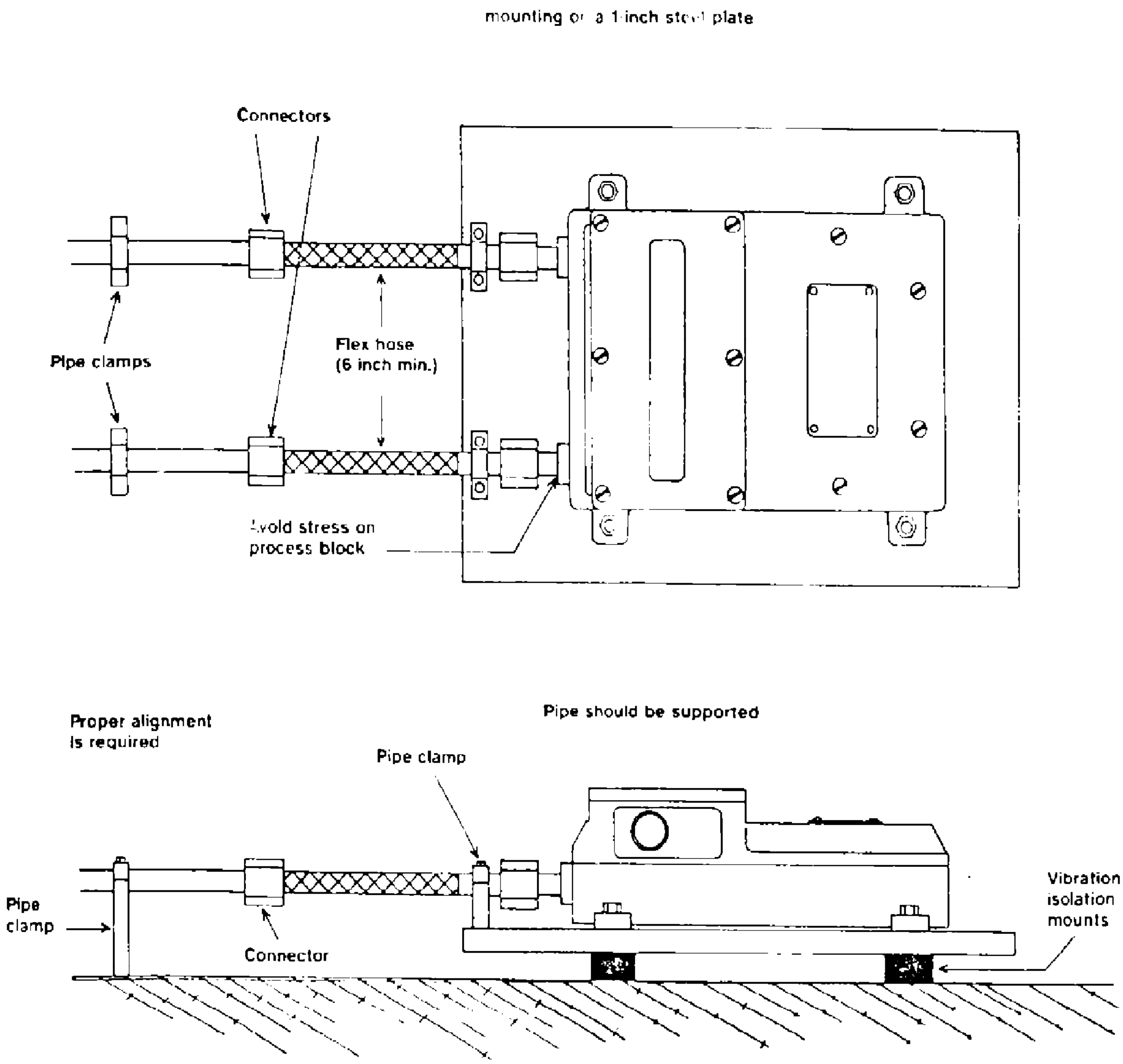


TYPICAL INSTALLATION; FOR SMALL SIZE SENSORS



TYPICAL INSTALLATION; FOR LARGE SIZE SENSORS

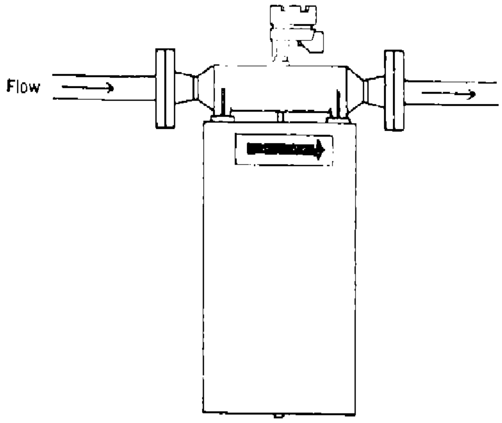
Fig. 14



TYPICAL INSTALLATION; SENSORS IN HIGH VIBRATION AREAS

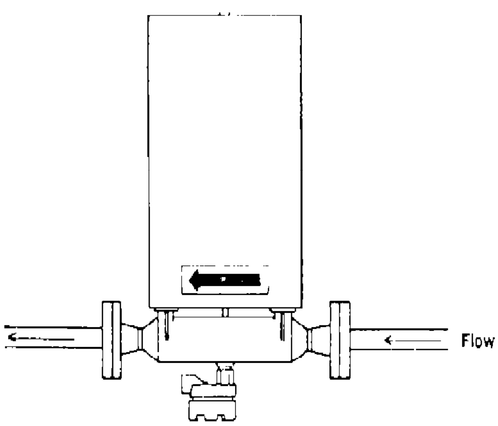
Fig. 15

RECOMMENDED ORIENTATIONS



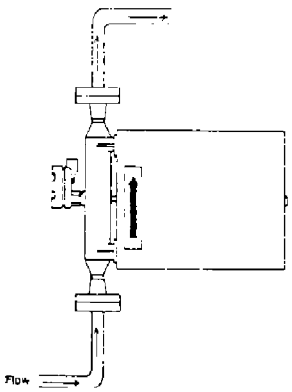
MOUNTING WITH CASE DOWN (LIQUID APPLICATION)

Fig. 16



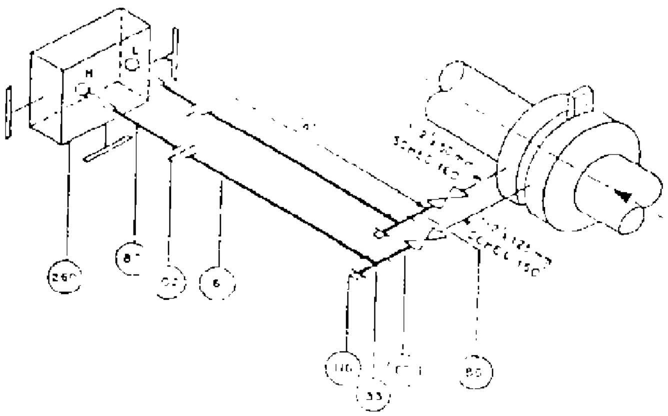
MOUNTING WITH CASE UP (GAS APPLICATIONS)

Fig. 17



MOUNTING IN A VERTICAL LINE (SLURRY OR DRAINING APPLICATIONS)

Fig. 18
TYPICAL DRAWINGS



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

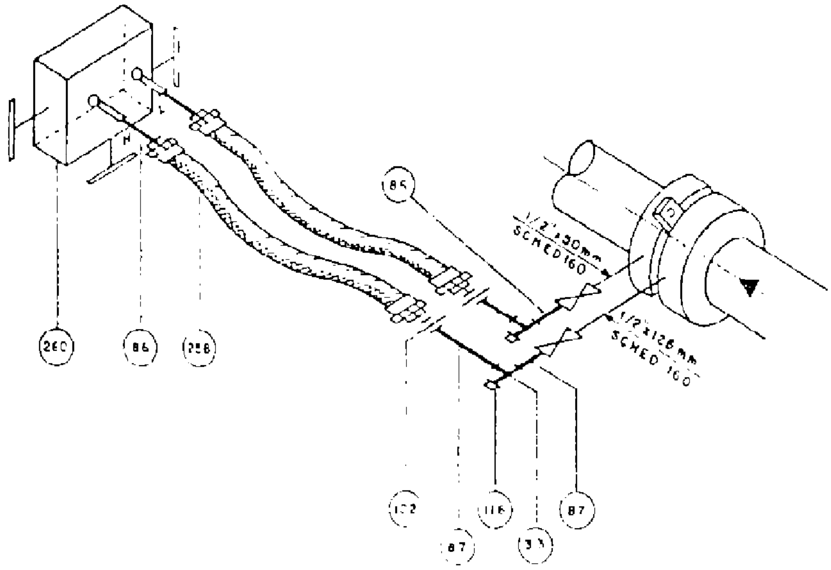
3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

4- DISTANCE "A" TO BE KEPT TO MINIMUM.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6	2 m	½"	LINE PIPE. S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL
33	2	½"	TEE, EQUAL SCRD. API CL 3000 FEM	CARBON STEEL
86	3	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH, 80	STEEL
87	1	½" × 25 mm	NIPPLE, BARREL SCRD. API SCH, 80	STEEL
102	2	½"	UNION, SCRD API CLASS 3000	CARBON STEEL
116	2	½"	PLUG, ROUND HEAD, SCRD API CL. 3000 MALE	STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

INSTALLATION OF PRESSURE PIPING
D/P CELL IN HORIZONTAL LINE WITH BLOCK MANIFOLD FOR LIQUID SERVICE

TYPICAL DRAWING 1



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

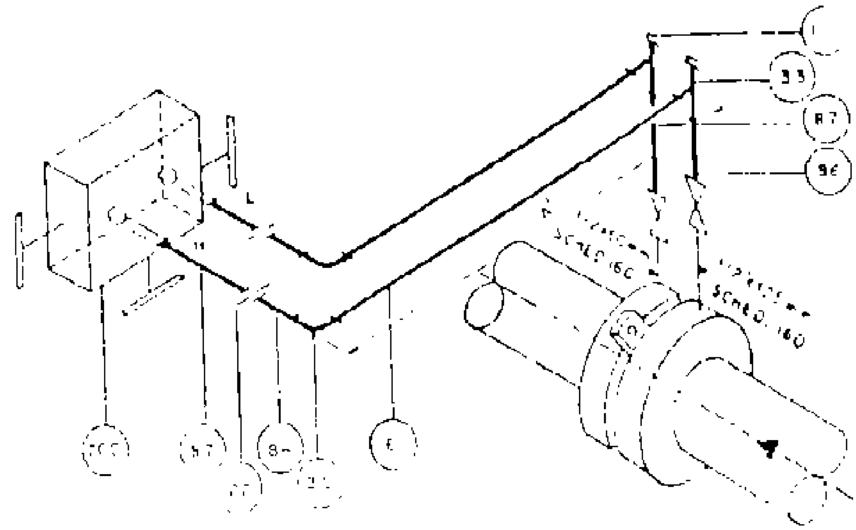
2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
33	2	½"	TEE, EQUAL, SCRD. API. CL. 3000 FEM	CARBON STEEL
86	5	½" × 50 mm	NIPPLE BARREL, SCRD. API, SCH. 80	STEEL
87	1	½" × 125 mm	NIPPLE, BARREL, SCRD. API, SCH. 80	STEEL
102	2	½"	UNION, SCRD. API. CL. 3000 FEM.	CARBON STEEL
116	2	½"	PLUG, ROUND HEAD, SCRD. API. CL. 3000 MALE	CARBON STEEL
258	2	½ × 500 mm	FLEXIBLE HOSE ASSY, CORRUGATED.	STAINLESS STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

INSTALLATION OF PRESSURE PIPING
D/P CELL IN HORIZONTAL LINE WITH BLOCK MANIFOLD LIQUID SERVICE SUBJECT TO EXTREME VIBRATION

TYPICAL DRAWING 2



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE ORIFICE

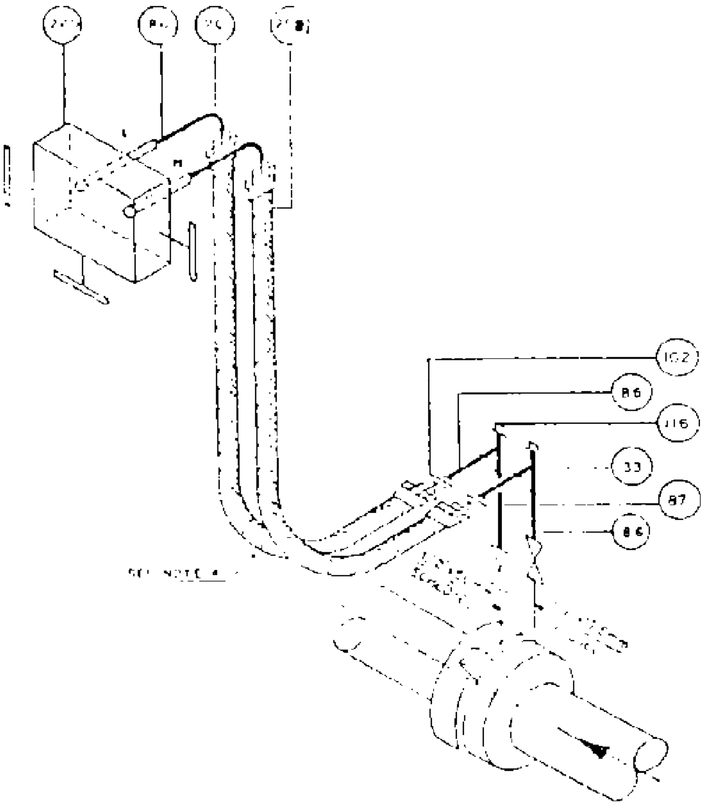
4- DISTANCE "A" TO BE KEPT TO MINIMUM.

5- ORIFICE PLATE TO BE INSTALLED WITH TAB OFFSET BY ONE BOLT CENTER LINE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL	
6	2 m	½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL	
20	2	½"	ELBOW, 90° SCRD. API CL 3000 FEM	CARBON STEEL	
33	2	½"	TEE, EQUAL SCRD. API GL. 3000 FEM	CARBON STEEL	
86	4	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
87	2	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
102	2	½"	UNION, SCRD API CLASS 3000	CARBON STEEL	
116	2	½"	PLUG, ROUND HEAD, SCRD API 3000 MALE	STEEL	
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL	

INSTALLATION OF PRESSURE PIPING
D/P CELL ABOVE ORIFICE IN HORIZONTAL LINE WITH
BLOCK MANIFOLD FOR GAS SERVICE

TYPICAL DRAWING 3



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

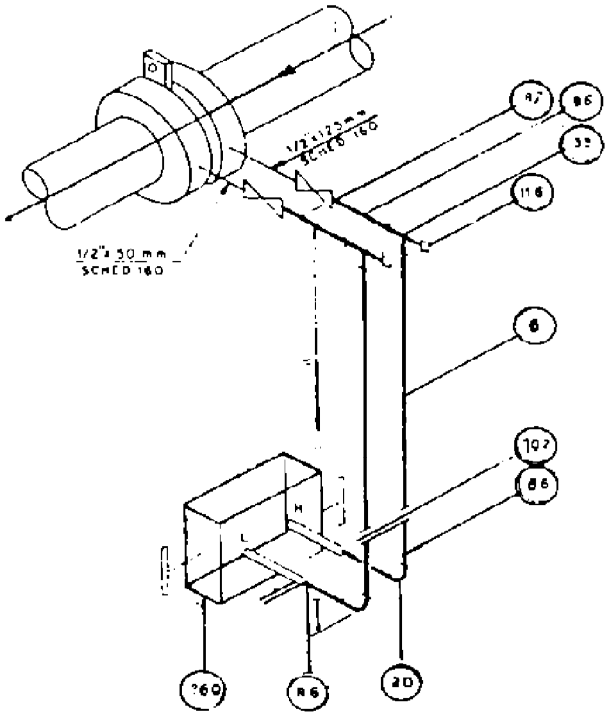
3- ORIFICE PLATE TO BE INSTALLED WITH TAB OFFSET BY ONE BOLT CENTER LINE.

4- AVOID LIQUID CONTAMINATION IN BEND OF FLEXIBLE HOSE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
20	2	½"	ELBOW, 90° SCRD. API CL 3000 FEM	GALVANIZED STEEL
33	2	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
86	5	½" × 50 mm	NIPPLE, BARREL, SCRD API, SCH. 80	STEEL
87	1	½" × 25 mm	NIPPLE, BARREL, SCRD API, SCH. 80	STEEL
102	2	½"	UNION, SCRD API CL. 3000 FEM.	CARBON STEEL
116	2	½"	PLUG, ROUND HEAD, SCRD API GL. 3000 MALE	CARBON STEEL
253	2	½" × 500 mm	FLEXIBLE HOSE ASSY, CORRUGATED	STAINLESS STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

D/P CELL WITH BLOCK MANIFOLD ABOVE ORIFICE IN HORIZONTAL LINE,

TYPICAL DRAWING 4



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

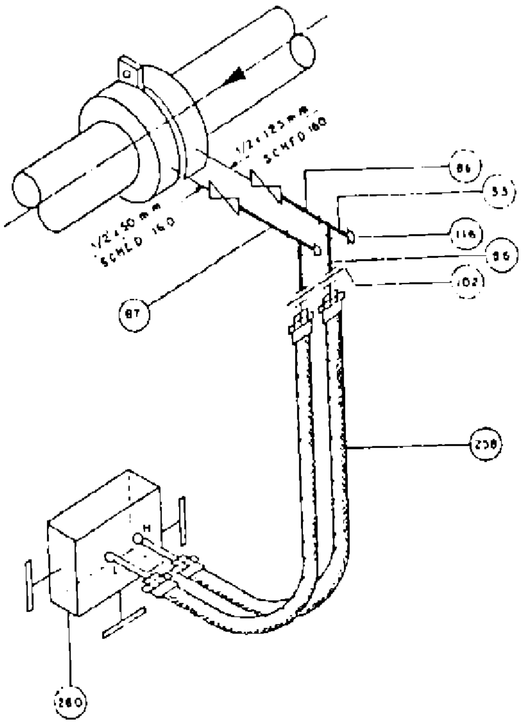
3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

4- DISTANCE "A" B" B" TO BE KEPT TO MINIMUM

ITEM REQ.	QUAN .	SIZE	DESCRIPTION	MATERIAL	
6		½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL	
20	2	½"	ELBOW, 90° SCRD. API CL 3000 FEM	CARBON STEEL	
33	2	½"	TEE, EQUAL SCRD. API GL. 3000 FEM	CARBON STEEL	
86	5	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
87	1	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
102	2	½"	UNION, SCRD. API CLASS 3000	CARBON STEEL	
116	2	½"	PLUG, ROUND HEAD, SCRD API GL. 3000 MALE	STEEL	
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL	

D/P CELL WITH BLOCK MANIFOLD BELOW ORIFICE IN HORIZONTAL LINE, FOR LIQUID SERVICE

TYPICAL DRAWING 5



TAG. No.

NOTES

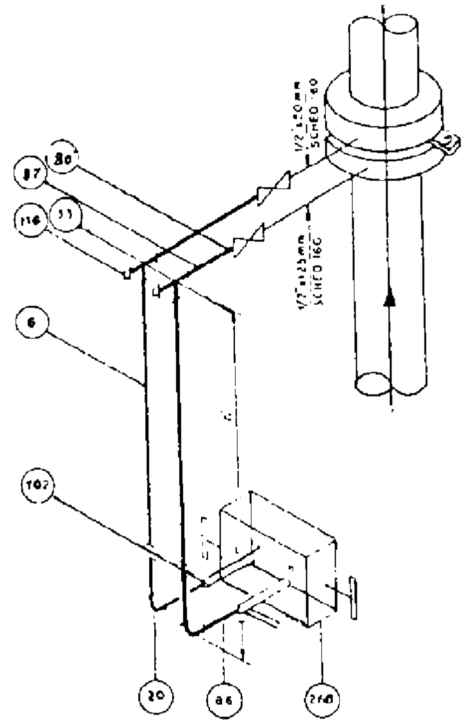
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL	
33	2	½"	TEE, EQUAL, SCRD. API CL. 3000 FEM	CARBON STEEL	
86	3	½" × 50 mm	NIPPLE, BARREL, SCRD API. SCH. 80	STEEL	
87	1	½" × 125 mm	NIPPLE, BARREL, SCRD API. SCH. 80	STEEL	
102	2	½"	UNION, SCRD. API. CL. 3000 FEM.	CARBON STEEL	
116	2	½"	PLUG, ROUND HEAD, SCRD. API. CL. 3000 MALE	CARBON STEEL	
258	1	½ × 500 mm	FLEXIBLE HOSE ASSY, CORRUGATED.	STAINLESS STEEL	
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL	

INSTALLATION OF PRESSURE PIPING
D/P CELL IN HORIZONTAL LINE WITH BLOCK MANIFOLD BELOW ORIFICE
LIQUID SERVICE SUBJECT TO EXTREME VIBRATION

TYPICAL DRAWING 6



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

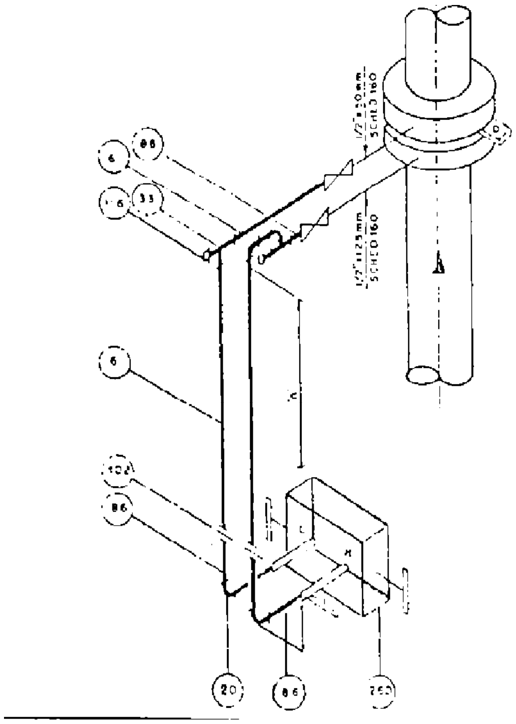
3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

4- DISTANCE "A" B" B" TO BE KEPT TO MINIMUM

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL	
6		½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL	
20	2	½"	ELBOW, 90° SCRD. API CL 3000 FEM	CARBON STEEL	
33	2	½"	TEE, EQUAL SCRD. API GL. 3000 FEM	CARBON STEEL	
86	5	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
87	1	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	
102	2	½"	UNION, SCRD. API CLASS. 3000	CARBON STEEL	
116	2	½"	PLUG, ROUND HEAD, SCRD API 3000 MALE	STEEL	
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL	

INSTALLATION OF PRESSURE PIPING
D/P CELL WITH BLOCK MANIFOLD BELOW ORIFICE IN VERTICAL LINE, FOR LIQUID SERVICE

TYPICAL DRAWING 7



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

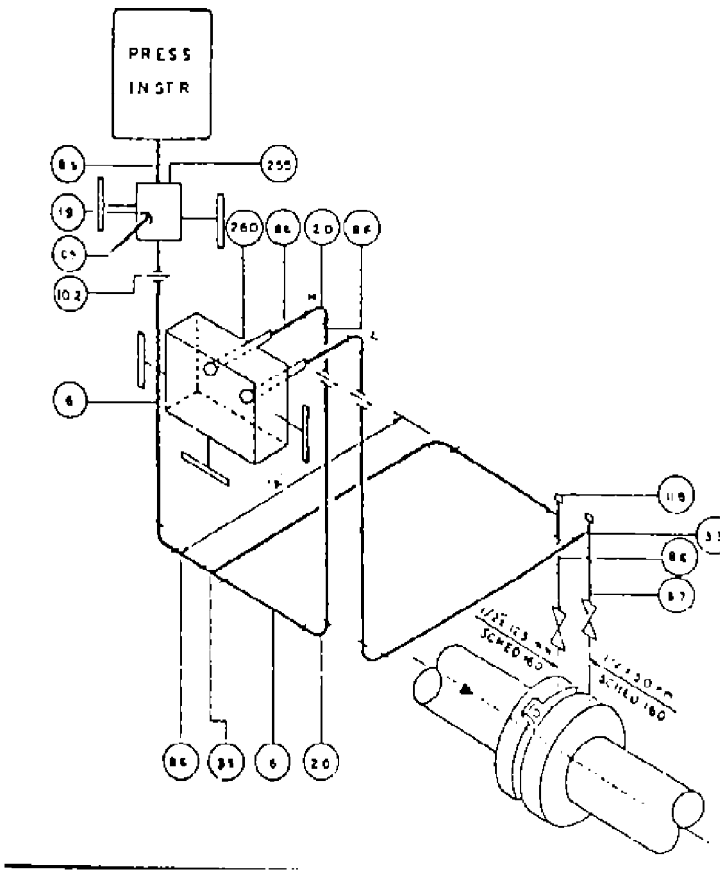
2- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

3- DISTANCE "A" TO BE KEPT TO MINIMUM.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL	
6		½"	LINE PIPE. SQ. END EXTRA STRONG W.T. 3.6	CARBON STEEL	
20	4	½"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL	
33	2	½"	TEE, EQUAL SCRD. API GL. 3000 FEM	CARBON STEEL	
86	7	½" × 50 mm	NIPPLE, BARREL SCRD API, SCH. 80	STEEL	
87	1	½" × 125 mm	NIPPLE, BARREL SCRD API, SCH. 80	STEEL	
102	2	½"	UNION, SCRD. API. CL. 3000 FEM.	CARBON STEEL	
116	2	½"	PLUG, ROUND HEAD, SCRD. API GL. 3000 MALE	STEEL	
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL	

INSTALLATION OF PRESSURE PIPING
D/P CELL WITH BLOCK, MANIFOLD BELOW ORIFICE IN VERTICAL LINE, FOR STEAM SERVICE

TYPICAL DRAWING 8



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE ORIFICE

4- DISTANCE "A" TO BE KEPT TO MINIMUM.

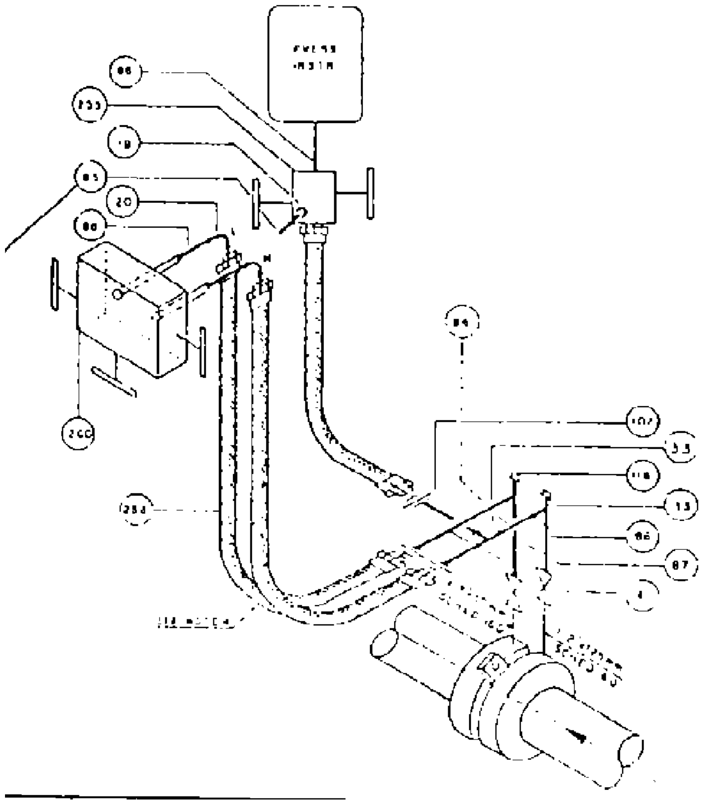
5- ORIFICE PLATE TO BE INSTALLED WITH TAB OFFSET BY ONE BOLT CENTER LINE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6	3 m	½"	LINE PIPE. S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL
19	1	¼"	ELBOW, 90° SCRD API CL. 3000 FEM	CARBON STEEL
20	6	½"	ELBOW, 90° SCRD API CL. 3000 FEM	CARBON STEEL
33	3	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
85	1	¼" × 75 mm	NIPPLE, BARREL SCRD. API. SCH. 80	STEEL
86	8	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
87	1	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
102	3	½"	UNION, SCRD API. CL 3000 FEM.	CARBON STEEL
116	2	½"	PLUG, ROUND HEAD, SCRD. API. GL. 3000 MALE	STEEL
255	1	½"	PRESSURE MANIFOLD, ½" API OR ANSI B2.1 NPT	STAINLESS STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

D/P CELL ABOVE ORIFICE IN HORIZONTAL LINE WITH BLOCK MANIFOLD

AND PRESSURE INSTRUMENT FOR GAS SERVICE

TYPICAL DRAWING 9



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

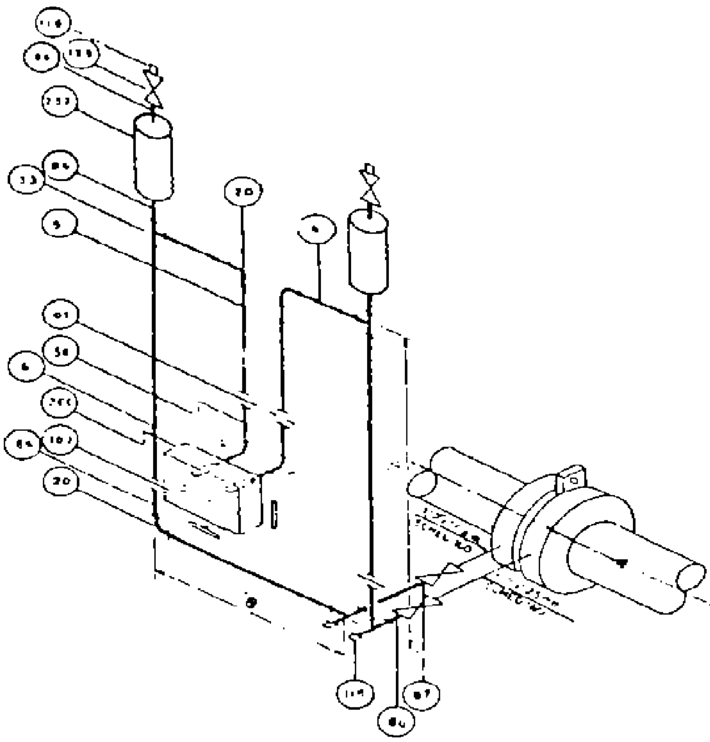
3- ORIFICE PLATE TO BE INSTALLED WITH TAB OFFSET BY ONE BOLT CENTER LINE.

4- AVOID LIQUID CONTAMINATION IN BEND OF FLEXIBLE HOSE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6	1 m	½"	LINE PIPE. SQ. END EXTRA STRONG W.T. 3.6	CARBON STEEL
19	1	¼"	ELBOW, 90° SCRD API CL. 3000 FEM	CARBON STEEL
20	2	½"	ELBOW, 90° SCRD API CL. 3000 FEM	CARBON STEEL
33	3	½"	TEE, EQUAL SCRD. API GL. 3000 FEM	CARBON STEEL
83	1	¼" × 75 mm	NIPPLE, BARREL, SCRD. API SCH. 80	STEEL
86	7	½" × 50 mm	NIPPLE, BARREL, SCRD. API SCH. 80	STEEL
87	1	½" × 125 mm	NIPPLE, BARREL, SCRD. API SCH. 80	STEEL
102	3	½"	UNION, SCRD. API CL. 3000 FEM.	CARBON STEEL
116	2	½"	PLUG, ROUND HEAD SCRD API GL. 3000 MALE	CARBON STEEL
255	1	½"	PRESSURE MANIFOLD, ½" API OR ANSI B2.1 NPT	STAINLESS STEEL
258	3	½" × 500 mm	FLEXIBLE HOSE ASSY, CORRUGATED.	STAINLESS STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

D/P CELL WITH BLOCK MANIFOLD ABOVE ORIFICE WITH PRESSURE INSTRUMENT FOR GAS SERVICE SUBJECT TO EXTREME VIBRATION

TYPICAL DRAWING 10



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

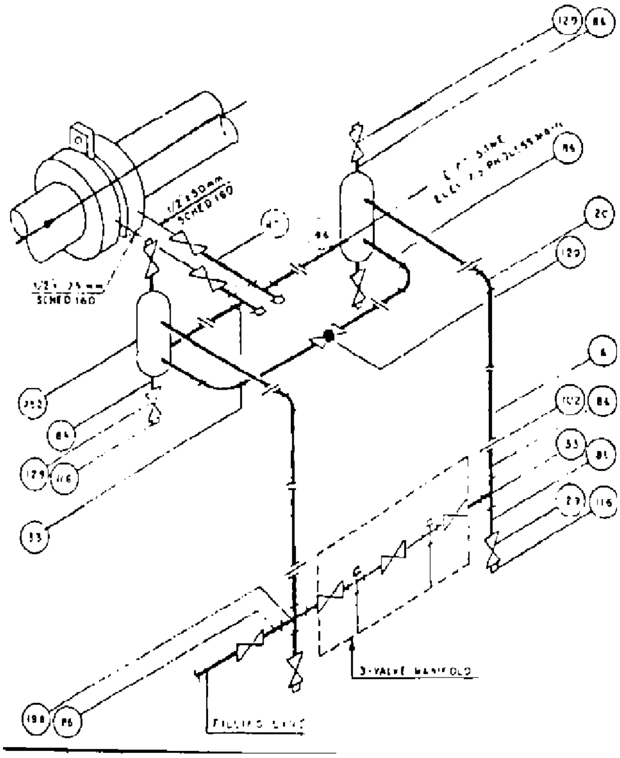
4- DISTANCE "A" B"B" TO BE KEPT TO MINIMUM.

5- THIS INSTALLATION SHALL ONE BE CONSIDERED WHEN THERE IS POSSIBILITY OF GAS/LIQUID SEPARATION AT THE D/P CELL NUMEROUS AVOID USING IT

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6	7 m	½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL
20	5	¼"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL
33	4	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
86	11	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH, 80	STEEL
87	1	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH, 80	STEEL
102	4	½"	UNION, SCRD API CLASS 3000 FEM.	CARBON STEEL
116	4	½"	PLUG, ROUND HEAD, SCRD API 3000 MALE	STEEL
129	2	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL
232	2	4"	POSTS	CARBON STEEL
260	1	½"	MANIFOLD, ½" - API OR ANSI B2.1 NPT	STAINLESS STEEL

D/P CELL WITH BLOCK MANIFOLD ABOVE ORIFICE IN HORIZONTAL LINE FOR LIQUID SERVICE USING CATCH POSTS

TYPICAL DRAWING 11



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

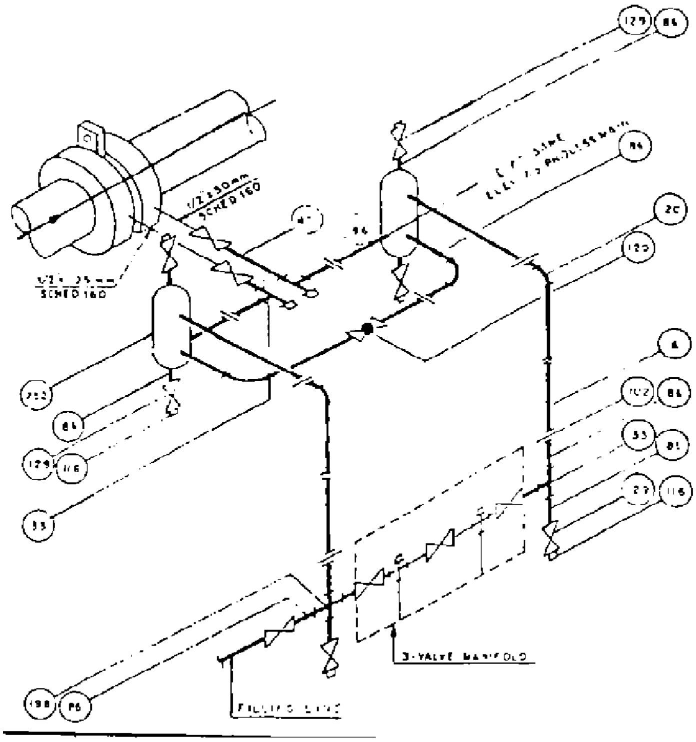
2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE INSTRUMENT

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL	
6		½"	LINE PIPE, SQ. END EXTRA STRONG W.T. 3.6	CARBON STEEL	
20	4	½"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL	
33	3	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL	
86	20	½" × 50 mm	NIPPLE, BARREL, SCRD API, SCH, 80	STEEL	
87	1	½" × 125 mm	NIPPLE, BARREL, SCRD API, SCH, 80	STEEL	
102	7	½"	UNION, SCRD API CL. 3000 FEM.	CARBON STEEL	
116	8	½"	PLUG, ROUND HEAD, SCRD. API CL. 3000 MALE	STEEL	
120	1	½"	VALVE, GLOBE SCRD. API CL. 800	CARBON STEEL	
129	7	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL	
198	1	½"	CROSS, SCRD CL. 3000 FEM.	FORGED STEEL	
252	2	6"	SCAL POST	CARBON STEEL	

INSTALLATION OF PRESSURE PIPING
METER BELOW ORIFICE SEAL LIQUID LIGHTER THAN LINE LIQUID

TYPICAL DRAWING 12



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

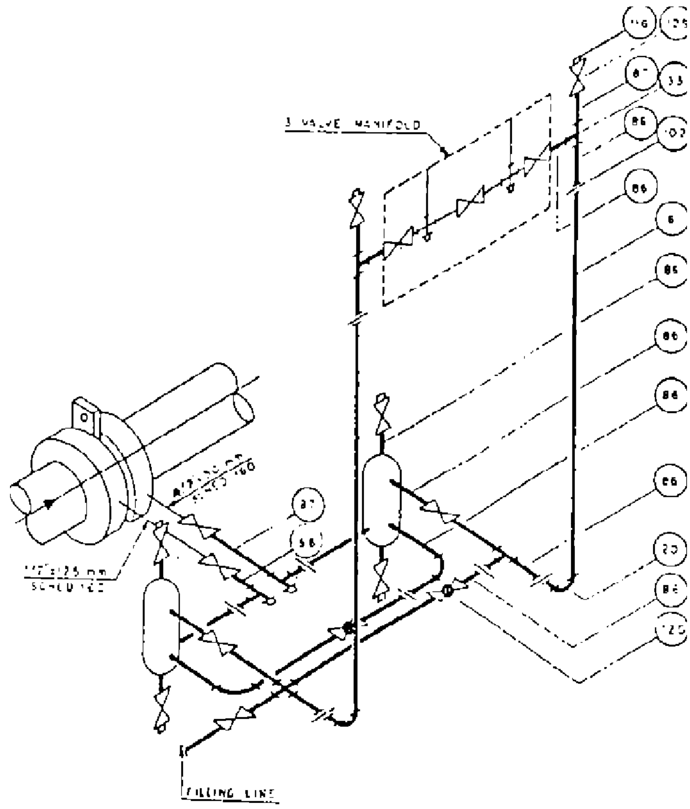
2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE ORIFICE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6		½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL
20	4	½"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL
33	3	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
86	18	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
87	3	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
102	7	½"	UNION, SCRD. API CLASS 3000	CARBON STEEL
116	8	½"	PLUG, ROUND HEAD, SCRD API CL. 3000 MALE	STEEL
120	1	½"	VALVE, GLOBE SCRD. API CL. 800	CARBON STEEL
129	7	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL
198	1	½"	CROSS, SCRD CL. 5000 FEM.	FORGED STEEL
252	2	6"	SEAL POTS	CARBON STEEL

METER BELOW ORIFICE SEAL LIQUID HEAVIER THAN LINE LIQUID

TYPICAL DRAWING 13



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

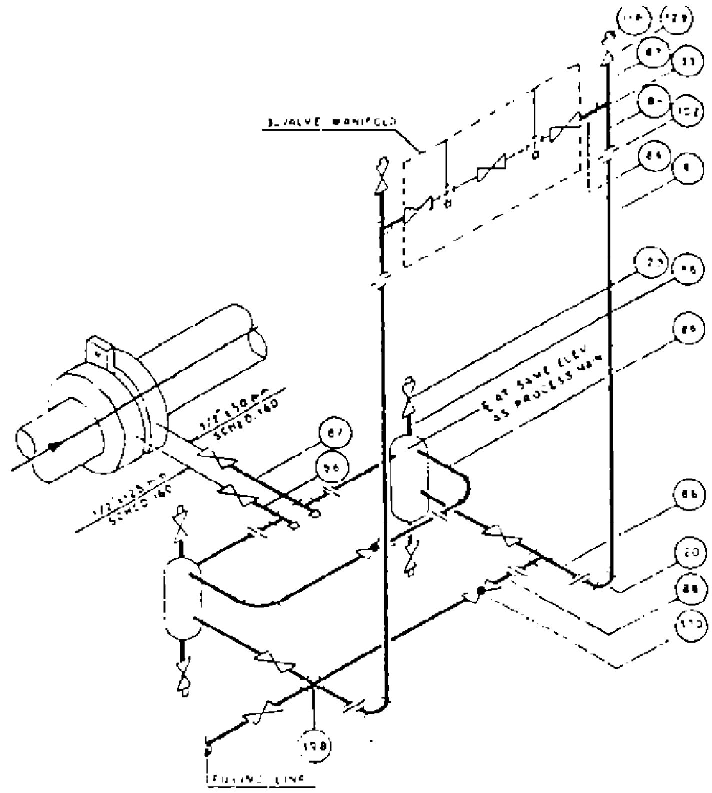
2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE ORIFICE.

ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6		½"	LINE PIPE, SQ. END EXTRA STRONG W.T. 3.6	CARBON STEEL
20	4	½"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL
33	5	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
86	26	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
87	3	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80 CL. 3000 MALE	STEEL
102	8	½"	UNION, SCRD. API CLASS 3000	CARBON STEEL
116	8	½"	PLUG, ROUND HEAD, SCRD API CL. 3000 MALE	STEEL
120	2	½"	VALVE, GLOBE SCRD. API CL. 800	CARBON STEEL
129	9	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL
198	1	½"	CROSS, SCRD CL. 5000 FEM.	FORGED STEEL
252	2	6"	SEAL POTS	CARBON STEEL

METER ABOVE ORIFICE SEAL LIQUID LIGHTER THAN LINE LIQUID

TYPICAL DRAWING 14



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DOWNSTREAM OF ORIFICE FLANGE BLOCK VALVES.

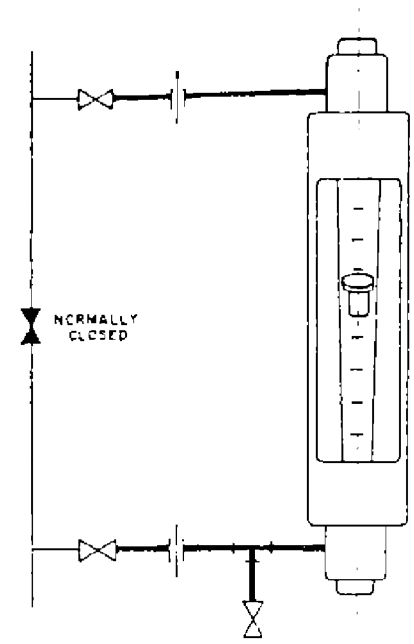
2- FOR DETAILS OF SUPPORT FOR INSTR SEE RELEVANT STD. DWG.

3- SLOPE OF PIPE RUN AT LEAST 40 mm PER METER TOWARDS THE ORIFICE.

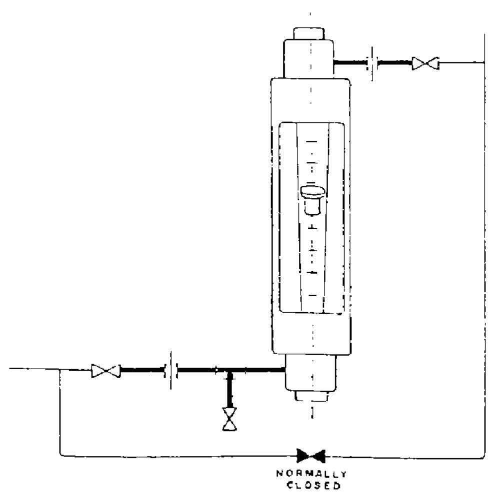
ITEM REQ.	QUAN.	SIZE	DESCRIPTION	MATERIAL
6		½"	LINE PIPE, S.Q END EXTRA STRONG W.T. 3.6	CARBON STEEL
20	4	½"	ELBOW, 90° SCRD. API CL. 3000 FEM	CARBON STEEL
33	5	½"	TEE, EQUAL, SCRD. API GL. 3000 FEM	CARBON STEEL
86	28	½" × 50 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
87	3	½" × 125 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL
102	8	½"	UNION, SCRD. API CLASS 3000	CARBON STEEL
116	8	½"	PLUG, ROUND HEAD, SCRD API 3000 MALE	STEEL
120	2	½"	VALVE, GLOBE SCRD. API CL. 800	CARBON STEEL
129	9	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL
198	1	½"	CROSS, SCRD CL. 3000 FEM.	FORGED STEEL
252	2	6"	SEAL POTS	CARBON STEEL

INSTALLATION OF PRESSURE PIPING
METER ABOVE ORIFICE SEAL LIQUID HEAVIER THAN LINE LIQUID

TYPICAL DRAWING 15



FOR VERTICAL PROCESS LINES



FOR HORIZONTAL PROCESS LINES

INSTALLATION OF VARIABLE AREA FLOWMETER

TYPICAL DRAWING 16