# MATERIAL AND EQUIPMENT STANDARD

# FOR

# FLOW INSTRUMENTS

## FIRST EDITION

## JANUARY 2013

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**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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## 1. SCOPE

This Standard presents general and minimum requirements for material and quality control of different types of flow measurement instruments, such as: orifice plates, flow transmitters, variable area meters, turbine meters, positive displacement 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.

**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. 10 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.

**AGA (AMERICAN GAS ASSOCIATION)**

| | |
|---|---|
| AGA 3 | “Concentric, Square-Edged Orifice Meters, Natural Gas Applications" |
| AGA 7 | “Measurement of Fuel Gas by Turbine Meters” |
| AGA 8 | “Compressibility Factors of Natural Gas and other Related Hydrocarbon Gases” |
| AGA 9 | “Measurement of Gas by Multipath Ultrasonic Meters” |
| AGA 11 | “Use of Abrasive Grain for Anti-Slip and Floor Reinforcing” |

**ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)**

| | |
|---|---|
| B 2.1 | “Pipe Threads” |
| B 16.5 | “Steel Pipe Flanges and Flanged Fittings” |
| B 16.34 | “Valves, Hydrostatic Testing of Control” |
| B 31 | “Code for Pressure Piping” |

**API (AMERICAN PETROLEUM INSTITUTE)**

| | |
|---|---|
| TR 20.01 | “Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations” |
| RP 550 | “Manual on Installation of Refinery Instruments and Control Systems” |

| | |
|---|---|
| API 551 | "Process Measurement Instrumentation" |
| 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" |

**ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)**

| | |
|---|---|
| MFC-3M | "Measurement of Fluid Flow in Pipes using Orifice, Nozzle, and Venturi" |
| 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" |

**NEMA (NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION)**

| | |
|---|---|
| 250 | "Enclosures for Electrical Equipments (1000 V.MAX.)" |

**IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)**

| | |
|---|---|
| 60529 | "Degrees of Protection Provided by Enclosures (IP Code)" |

**IPS (IRANIAN PETROLEUM STANDARDS)**

| | |
|---|---|
| IPS-E-GN-100 | "Engineering Standard for Units" |
| IPS-E-IN-100 | "Engineering Standard for General Instrumentation" |
| IPS-E-IN-130 | "Engineering Standard for Flow Instruments" |
| IPS-C-IN-130 | "Construction and Installation Standard for Flow Instruments" |
| IPS-G-IN-210 | "General Standard for Instrument Protection" |
| IPS-E-IN-240 | "Engineering Standard for Measurement of Liquid Hydrocarbons (Custody Transfer)" |

## 3. UNITS

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

## 4. DIFFERENTIAL PRESSURE PRIMARY ELEMENTS

### 4.1 Thin-Plate Orifices

#### 4.1.1 Concentric orifice plates

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 Figure 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 degrees or less 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 Figure 1.

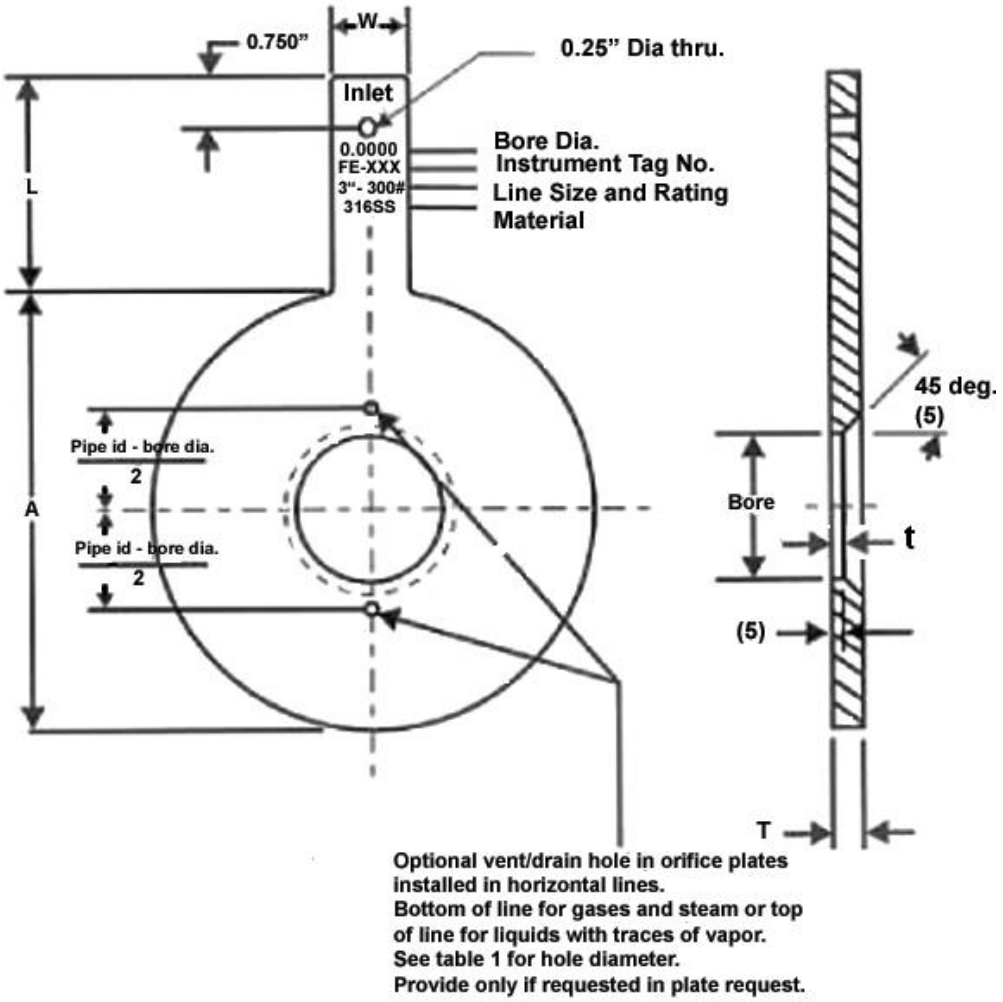
Bores must be round and concentric. Practical tolerances for orifice diameters, as given in MPMS Chapter 14.3, are shown in Table 1.

The upstream edge of a 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 Figure 1. Detailed tolerances are discussed in MPMS Chapter 14.3 and American Society of Mechanical Engineers publications. Refer to: 2.1, ASME Standards and 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.

**TABLE 1- PRACTICAL TOLERANCES FOR ORIFICE BORE**

| ORIFICE SIZE, d | | TOLERANCE PLUS OR MINUS PER inch AND mm OF DIAMETER | |
|---|---|---|---|
| Inch | mm | mm | Inch |
| 0.250 | 6.350 | 0.00762 | 0.0003 |
| 0.375 | 9.525 | 0.01016 | 0.0004 |
| 0.500 | 12.700 | 0.0127 | 0.0005 |
| 0.625 | 15.875 | 0.0127 | 0.0005 |
| 0.750 | 19.050 | 0.0127 | 0.0005 |
| 0.875 | 22.225 | 0.0127 | 0.0005 |
| 1.000 | 25.400 | 0.0127 | 0.0005 |
| over 1.000 | over 25.400 | 0.0127 | 0.0005 |




**ORIFICE PLATE OUTSIDE DIAMETERS TO FIT ANSI SERVICE RATED FLANGE UNIONS**

| NOMINAL PIPE SIZE DN | T | t | CLASS 300 | 600 | 900 | 1500 | 2500 | TAB L | TAB 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:**

**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 inches, +0 millimeters, -0.08 millimeters (-1/32 inch).**

**3) For orifice plate outside diameters in flange sizes and ratings not listed above, refer to gasket OD dimensions given under Figure 3, Table 1, Appendix E in ANSI B 16.5, 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 0.010 per inch (.25 millimeters) 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 0.0025 inch (0.06 millimeter). The cumulative out-of-flatness for two mating surfaces shall not exceed 0.0040 inch (0.1 millimeter).**

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. See also the attached typical drawings on pages 37 through 40.

### 4.1.2 Other orifice plates

For other types of orifice plates, such as eccentric and segmental orifice plates, refer to typical drawings - attached here with this standard, on pages 41 through 43.

### 4.2 Flow Nozzles

- All flow nozzles shall be made in accordance with ASME codes, including ASME MFC-3M, ANSI B31 and other, related standards.

- Normally stainless steel flow nozzles shall be used, to lessen the effect of corrosion on the highly polished throats.

- Chrome molybdenum steel flow nozzles shall be used for applications under sustained temperatures as high as 565°C (1050° F).

- Other types of material shall be used for special applications, after approval of the user.

### 4.3 Venturi Tubes

- Venturi tubes shall be manufactured in accordance with ASME standard MFC-3M.

- Normally the material used is stainless steel, unless other- wise specified, for special applications.

- Normally these tubes are fabricated from rolled plate, with flanged ends.

- Throat may be fabricated from heavier stock and bored to size.

- 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.

- Entire inside shall have suitable coating according to the required application.

## 5. DIFFERENTIAL PRESSURE PRIMERY ELEMENTS ACCESSORIES

### 5.1 Meter Run Tubes (Pipes)

- Meter tubes shall be fabricated according to MPMS Chapter 14.3 (AGA report No. 3) and ASME fluid meters.

- Meter tubes, incorporating orifice fittings or flanges and the orifice plate are accurately designed and manufactured to exacting requirements. Each tube shall be expertly finished to give the highest degree of repeatability and the lowest maintenance.

- Metering runs for orifices shall be 50 mm (2 in.) or larger.

- Meter run pipe or tubing shall be carefully selected for uniform, but unpolished, internal surface free of striations and grooves. It shall be also selected for roundness, for concentricity of inside and outside diameters, and for conformance with published diameters.

### 5.2 Senior (Retractive) Orifice Fitting

- The senior orifice fitting is composed of two independent compartments separated by a hardened stainless steel slide valve. Slide valve cannot be closed unless orifice is concentric to bore of fitting. Plate carrier is raised and lowered by double rack and pinion mechanism with power applied through speed wrench. All parts, including the essential slide valve assembly, can be replaced or repaired without removing fitting from line.

- All senior orifice fittings shall be designed and manufactured to meet latest ANSI / API / AGA recommendations, and in strict accordance with latest ASTM specifications.

**- Meter Taps**

All orifice fittings shall be provided with two sets of "flange taps" located in accordance with latest MPMS Chapter 14.3 (AGA report No. 3) recommendations.

**- Flange Tap Specifications**

Flange tap meter connections shall be ½ " NPT. Internal tap hole sizes shall follow latest MPMS Chapter 14.3 (AGA report No. 3) recommendations. Internal edges of tap holes shall be free from burrs and square edged.

**- Line Bore Tolerances**

Shall be according to MPMS Chapter 14.3 (AGA report No. 3)

**- Operating Shafts**

On sizes 50 mm (2 inch) to 350 mm (14 inch) inclusive, single operating shafts shall be provided on left or right side of fitting when looking downstream. On sizes 400 mm (16 inch) and larger, operating shafts shall be provided on both sides of fitting.

**- Indicator Plate**

This plate shall be provided, to show clearly the direction of the open and close position of the slide valve.

**- Operating Wrench**

A speed wrench shall be provided with each fitting for quick operation of the shaft and pinions.

**- Hydrostatic Testing**

All senior orifice fittings shall be hydrostatically tested in accordance with ANSI B16.34.

**- Plate Alignment**

The plate carriers in all senior fittings shall be centered using a fixed three point positioning system, to assures concentricity within the fitting in accordance with the latest MPMS Chapter 14.3 (AGA report No. 3).

**- Fitting Style**

Normally shall be raised face flanged unless, otherwise specified. ANSI class, shall be as specified.

**- Internal Trim Material**

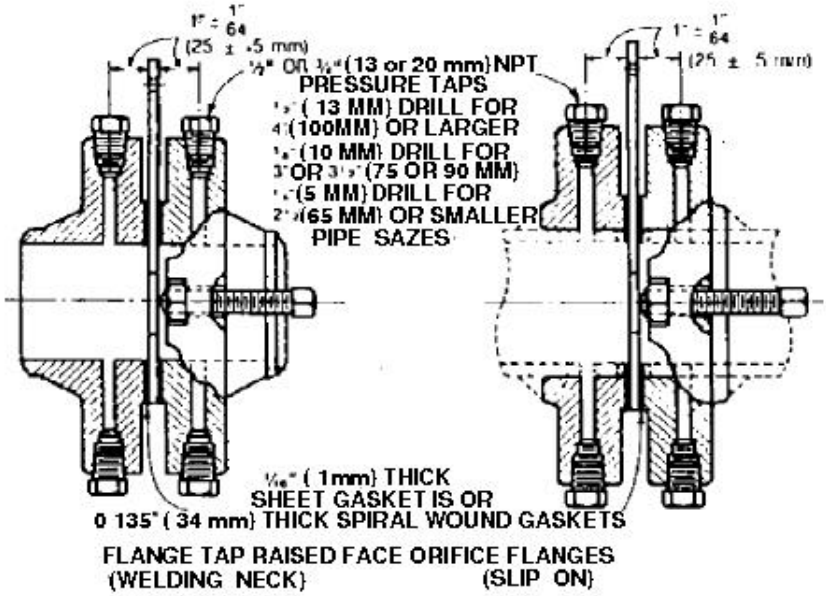
Shall be suitable to process fluid. Manufacture standard shall be accepted after agreement of the user.

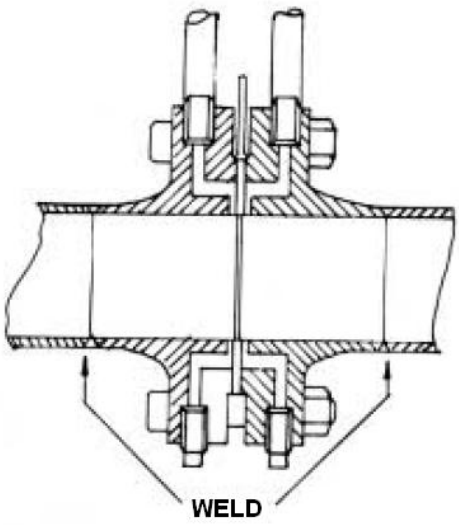
**- Orifice Plate Seal Material**

Manufacturer standard shall be accepted after agreement of the user.

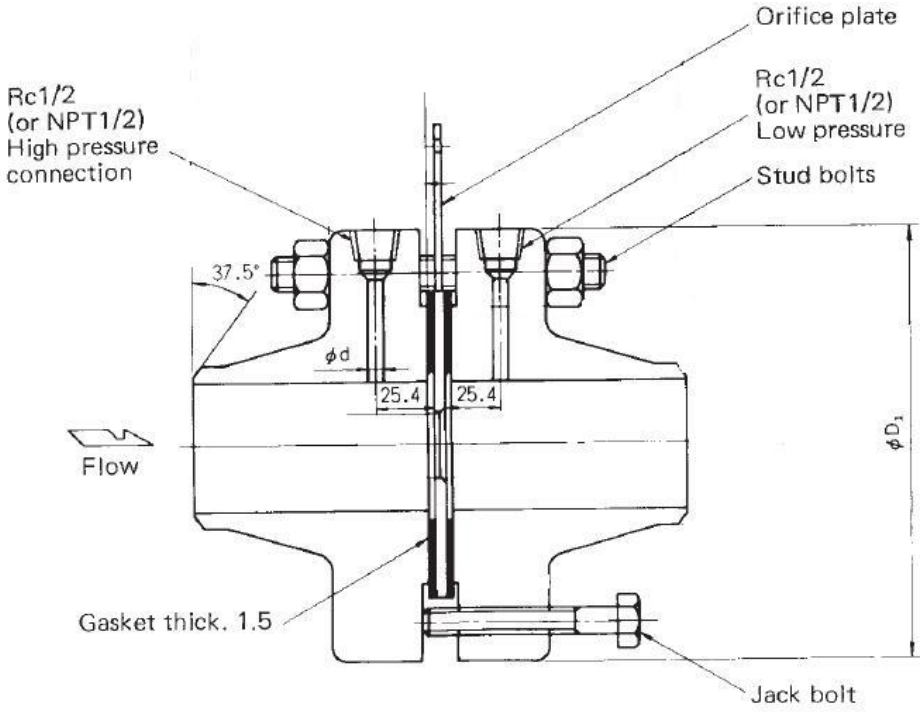
### 5.3 Orifice Flanges

Orifice flanges with flange taps, as shown in Fig. 2, are recommended. These flanges have a minimum thickness of 40 mm (1½ inches). In the smaller sizes, they are thicker than the standard class 300 flange. Each tap should be positioned 25 mm (1 inch) from the nearest face of the orifice plate. It is important to allow for compressed gasket thickness.




**CORNER TAP FLANGES**




**Welding Neck Type**

**ORIFICE FLANGES**

**Fig. 2**

**Note:**
**To provide adequate clearance in 40 millimeters (1-½-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.**

## 6. DIFFERENTIAL PRESSURE FLOW TRANSMITTERS AND VALVE MANIFOLDS

### 6.1 Pneumatic Transmitters

**- General**

These transmitters shall be force balance, mercury less, differential pressure type, blind transmitters, capable of transmitting 0.2-1 barg, signal proportional to the differential pressure.

**a) Functional Specifications**

**- Service**

Liquid, gas, steam and vapor applications.

**- Output**

0.2-1 barg, pnenumetic signal, proportional to the differential pressure.

**- Air Supply**

1.4 barg

**- Zero Elevation and Suppression**

As specified in related data sheets.

**- Over Range Protection**

Shall be same as body rating, in either direction.

**- Temperature Limits**

-30°C to +120°C at cell body

-30°C to +82°C ambient at transmitter

-30°C to 82°C storage

**b) Performance Specifications**

**- Accuracy:**

Better than 1%

**- Range**

Shall be as specified in related data sheets.

**- Span:**

Fully adjustable

**c) Physical Specifications**

**- Supply and Output Connections:**

Screwed ¼ in. NPT (FEM).

**- Process Connection**

Screwed ½ in. ANSI B2.1 NPT (FEM), unless otherwise flange type is specified.

**- Body Material**

Carbon steel, with SST. internal trim, unless otherwise specified.

**- Body, Plug and Process Connections**

316 SST.

**- Body Rating**

Shall be suitable to the maximum static pressure.

**- Differential Diaphragm (Capsule) Material**

316 SST, unless otherwise specified.

**- Vent and Drain**

Screwed and plugged ¼ in. NPT

**- Gaskets**

Teflon (glass filled) at process, Buna-N, at seal.

**- Cover**

Cast aluminum, unless otherwise specified, dust and weather proof (IP-class, shall be as specified in data sheet).

**- Mounting**

Yoke and bracket for 50 mm (2 in.) stand pipe, vertical.

**- Sealed Chamber**

Refer to IPS-G-IN-210 "instrument protection".

## 6.2 Electronic Transmitters

**- General**

These transmitters shall be of different types of sensors such as:

Capacitance, resonance wire, strain gage ..... etc, solid state electronic, differential pressure indicating transmitters, capable of transmitting a 4 to 20 mA output signal, via a 2-wire system, proportional to the differential pressure.

### a) Functional Specifications

**- Service**

Liquid, gas, steam, and vapor applications

**- Output**

Two-wire 4-20 mA (for 0-100% span and direct action).

**- Power Supply**

Nominal, 24 d.c, unless otherwise specified.

**- Hazardous Area Classification**

Normally shall be intrinsically safe and weather proof (IP 65), unless otherwise is specified. Approval of well-known certifying authorities such as BASEEFA, FM, PTB, UL ..... etc, is required.

**- Zero Elevation and Suppression**

Shall be provided, if specified in related data sheets.

**- Over Range Protection**

Shall be same as body rating in either direction.

**- Temperature Limits**

-30°C to +120°C at cell body

-30°C to +82°C ambient at transmitter

-30°C to +82°C storage

**- Humidity:**

0-100% RH.

**b) Performance Specifications**

**- Accuracy**

±0.25 of calibrated span, or better.

**- Range**

As specified in related data sheets.

**- Span**

Fully adjustable

**- Stability**

±0.25% of upper range limit for six months.

**- Vibration Effect**

±0.05% of upper range limit per g up to 200 Hz in any axis.

**- RFI Effects**

Shall be tested from 20 to 1000 MHz and for field strength up to 30 v/m.

**c) Physical Specifications**

**- Electrical Connection**

M 20 × 1.5

**- Electrical Terminals**

Shall be in isolated compartment

**- Process Connection**

½ NPT, unless otherwise flange-type is specified.

**- Body and Process Connections Material**

316 SST (wetted parts), unless otherwise specified.

**- Body Material**

Carbon steel (non-wetted part), unless otherwise specified.

**- Body Rating**

Shall be suitable to the specified range.

**- Differential Diaphragm (Capsule)**

316 SST, unless otherwise specified.

**- Drain Vent Valves**

316 SST, unless otherwise specified

**- Process Flanges**

Plated carbon steel or 316 SST, unless otherwise specified.

**- Gaskets**

Teflon, at diaphragm and seal.

**- Amplifier Housing**

Die-cast aluminum with cadmium or baked vinyl finish, dust and weather proof (IP 65).

**- Mounting**

Yoke and bracket for 50 mm (2 in) stand pipe vertical.

**- Calibration Facility**

Built-in test jack.

**- Sealed Chamber**

Refer to IPS-G-IN-210 "Instrument Protection".

## 6.3 Micro Processor-Based "SMART" Transmitters (Intelligent Transmitters)

**- General**

These transmitters are micro processor-based devices, capable of transmitting a 4-20 mA analogue and, digital signal, super imposed on 4-20 mA signal via a 2-Wire system, proportional to the differential pressure.

### a) Functional Specifications

**- Service**

Liquid, gas, steam and vapor applications.

**- Outputs**

Two-wire 4-20 mA, user-selectable for linear or square root output and digital signal superimposed on 4-20 mA signal.

**- Power Supply**

24 V d.c., unless otherwise specified.

**- Hazardous Area Classification**

Normally shall be intrinsically safe and weather proof (IP 65), unless otherwise is specified. Approval of well-known certifying authorities such as BASEEFA, FM, PTB, UL ..... etc, is required.

**- Zero Elevation and Suppression**

Shall be provided, if specified in related data sheets.

**- Overload Protection**

Shall be same as body rating in either direction.

**- Temperature Limit**

-30 to +120°C at cell body

-30 to +82°C ambient at transmitter

-30 to 82°C storage

**- Failure Alarm**

If self-diagnostics detect a major transmitter failure, the analogue signal will be driven either below 4 mA or above 20 mA to alert the user (high or low alarm signal is user-selectable by internal jumper).

**- Humidity Limits**

0-100%RH.

**b) Performance Specifications**

**- Accuracy**

Better than ±0.1% of calibrated span for analogue signal, ±0.07% of calibrated span for digital signal.

**- Range**

As specified in related data sheets.

**- Stability**

±0.1% of upper range limit for 6 months.

**- Vibration Effect**

±0,05% of upper range limit per g up to 200 Hz in any axis.

**- RFI Effects**

Shall be tested from 20 to 1000 MHz and for field strength up to 30v/m .

**c) Physical Specifications**

**- Electrical Connection**

M20 × 1.5

**- Electrical Terminals**

Shall be in isolated compartment

**- Process Connection**

½ in. NPT, unless otherwise flange-type is specified.

**- Process-Wetted Parts**

* Differential Diaphragms (Capsule)

316 SST, unless otherwise specified

* Drain / Vent Valves

316 SST, unless otherwise specified

* Process Flanges

Plated carbon steel or 316 SST, unless otherwise specified.

* Wetted O-Rings

Glass-filled teflon.

**- Non-Wetted Parts**

* Electronic Housing

Low-copper aluminum, NEMA4X, or IEC code IP 65.

* Bolts

Plated carbon steel ASTM A449, Grade 5.

* Fill Fluid

Silicon oil, or manufacturer standard.

* Paint

As specified.

* Cover O-Rings

Buna-N

**- Mounting**

Yoke and bracket for 50 mm (2 in.) stand pipe vertical.

**- Calibration Facility**

Test and calibration shall be performed by portable 2-wire digital output calibrator (HHT-hand held terminal), which can be connected to any point of the loop, without disconnecting the output signal. This HHT can be connected to the output terminals of the transmitter directly.

### 6.4 Valve Manifolds

**- General**

3 or 5 valve block manifold for use with differential pressure instruments (transmitters).

**- Materials**

Stainless Steel, unless otherwise specified.

**- Bore**

5 mm min. dia.

**- Spindle Packing**

P.T.F.E., unless otherwise specified.

**- Working Pressure**

As specified in related data sheets.

**- Working Temperature**

As specified in related data sheets.

**- Process Connection**

screwed ½ in. ANSI B2.1 NPT.

## 7. VARIABLE AREA METERS (ROTAMETERS) (V.A)

### 7.1 Glass Tube Rotameters

**- General**

These type of rotameters consists of a tapered metering glass tube and a float which is free to move up and down inside it. Flow rate is indicated by the position of the float on the graduated scale.

**- Rangeability**

1:10 or better.

**- Repeatability**

≤0.25% of full scale.

**- Accuracy**

±1.0% of Max. flow, or better.

**- Scale Length**

Manufacturer standard shall be accepted.

**- Scale Graduation**

As specified in related data sheets.

**- Working Temperature and Pressure**

As specified in related data sheets.

**- Connections**

Screwed or flanged to ANSI RF, as specified in related data sheets.

**- Metering Tube Material**

Borosilicate glass

**- Tube Adapter**

316 SST, unless otherwise specified.

**- Float**

316 SST, unless otherwise specified.

**- Fittings**

316 SST, unless otherwise specified.

**- O-Rings**

Buna-N, unless otherwise specified.

**- Housing**

304 SST, unless otherwise specified.

**- Flanges**

Steel, zinc plated, unless otherwise specified.

**- Window**

Safety glass.

**- Mounting**

Normally shall be process line mounting.

**- Guide Rod**

To be provided, if required.

**- Min. and/or Max. Alarm**

As specified in related data sheets.

**- Allowable Pressure Drop**

Shall be as low as possible.

### 7.2 Metal Tube Rotameters (Armored V.A Flowmeters)

**- General**

These type of rotameters consist of a tapered metering metal tube, rate is indicated by an isolated indicator-which is magnetically coupled with the float-on graduated scale.

**- Rangeability**

1:10 or better.

**- Repeatability**

≤0.25% of full scale.

**- Accuracy**

±1.6% of full scale or better.

**- Scale Length**

Normally shall be 100 mm.

**- Scale Graduation**

As specified in related data sheets.

**- Operating Temperature and Pressure**

As specified in related data sheets.

**- Allowable Ambient Temperature**

-30 to +85°C

**- Housing (Enclosure) Protection**

Normally shall be IP 65.

**- Connections**

Normally shall be flanged ANSI RF, unless otherwise specified

- Meter Tube Material: 316 S.S unless otherwise specified
- Float Material: 316 S.S unless otherwise specified
- Reducer: 316 S.S unless otherwise specified
- Fittings: 316 S.S unless otherwise specified
- Flanges: 316 S.S unless otherwise specified
- Spacer: 316 S.S unless otherwise specified

**- Base Plate**

Normally is Aluminum anodized.

**- Housing**

Normally is Aluminum, epoxy painted, unless otherwise specified.

**- Window**

Safety glass.

**- Gasket**

Buna-N.

**- Clamp**

Stainless steel.

**- Min. and/or Max. Alarm**

As specified in related data sheets.

**- Allowable Pressure Drop**

Shall be as low as possible.

## 8. TARGET FLOW METERS

### 8.1 General

The target flow meter is comprised of a flow element (primary device) and a force-balance transmitter (secondary device). The primary device contains a disc-shaped target located in the fluid stream on the axial center line of the pipe, forming an annular orifice. The target is fixed to lever (lower force bar) which transfers the force exerted on the target to the secondary device, located on the top of the primary device. The force exerted on the target by the fluid is proportional to the square of the fluid velocity, and therefore, to the square of the flow rate. The integral force-balance transmitter converts this force into either a pneumetic output signal of 0.2-1.0 barg (3-15 psig), or an electronic output signal of 4-20 mA d.c.

**- Body Material**

Normally is a casting made from ASTM A351 Grade CF-8M stainless steel (cast 316 SS)

**- Target and Lower Force Bar**

Normally shall be 316 SS, unless otherwise is specified.

- ¼" NPT plug with a vent screw in the body extension shall be provided, for line fluid venting or flushing.
- The body shall be mounted between ANSI RF flanges

**- Accuracy**

Shall be ±2% or better.

**- Ambient Temperature Limitation**

-30 to +85°C

**- Relative Humidity**

0-100%

**- Air Supply Pressure and Connection Size (for Pneumatic Transmitters)**

1.4 barg, ¼" NPTF.

**- Supply Voltage (for Electronic Transmitters)**

Shall be 24 V d.c., unless otherwise specified.

**8.2 Pneumatic Transmitters Materials**

**- Base Plate**

Normally is stainless steel and mounts to the top surface of the primary device.

**- Cover**

Normally is a high impact, glass-filled polycarbonate

**- Gasket**

Normally is silicone rubber and cork composition.

**- Enclosure Type**

IEC-IP 53 (NEMA 3) as minimum.

**- Signal Connection Size**

¼" NPTF

**8.3 Electronic Transmitters Materials**

**- Base Assembly**

Normally is cast Aluminum, and mounts to a top surface of the primary device.

**- Force Bar Assembly**

Normally is 316 SS.

**- Gasket**

Normally is silicone elastomer.

**- Cover**

Normally is cast Aluminum.

**- O-Ring**

Normally is Buna-N.

**- Enclosure Type**

IEC IP 65 (NEMA 4)

**- Hazardous Area Classification**

As specified in related data sheets and to be certified from acceptable authorization bodies such as BASEEFA, FM, UL, PTB etc.

**- Electrical Connection**

M20 × 1.5

## 9. TURBINE METERS

**- General**

A turbine flow meter measures the flow of fluids by rotation of a rotor producing an alternating voltage, the frequency of which is directly proportional to the flow rate.

**- Body**

Min. A105 forged carbon steel, unless otherwise is specified in related data sheets.

**- End Connections**

Normally shall be flanged, carbon steel, unless other wise is specified.

**- Rotor Blades**

316 stainless steel, unless otherwise is specified.

**- Rotor Hanger Units**

316 stainless steel, unless otherwise is specified.

**- Rotor Spindle (if Applicable)**

Tungsten carbide.

**- Spindle Bearing Bushes**

Cemented tungsten carbide.

**- Electrical Connection**

M20 × 1.5.

**- Environmental Protection**

Shall be IEC-IP 65.

**- Pick-up Coil Output**

Normally 0.5-5 V at min./max. flow into 22k ohm load, also manufacturer standard is accepted.

**- Operating Temperature**

Normally shall be -45°C to +120°C unless otherwise is specified in related data sheets.

**- Straightening Vanes**

Normally is carbon steel.

**- Linearity**

±0.10% over normal linear working range.

**- Repeatability**

±0.02% at any point in linear flow range.

**- Response Time**

Average 25 ms for 10-90% step flow change.

**- Pressure Drop**

0.1 to 0.4 bar, at Maximum linear flow.

**- Pre-Amplifier**

Voltage shall be according to manufacturer standard.

**- Hazardous Area Classification**

As specified in data sheet, and shall be certified from acceptable authorization, such as FM, BASEEFA, UL, PTB ... etc.

**- Power Supply**

24 V d.c., unless otherwise specified.

**- Option:**

- Printer
- Preset valve
- Transmitter and receiver
- Indicator
- Strainer
- Totalizer

- Compensation
- Preset countor
- Meter prover
- Flow computer

## 10. MAGNETIC FLOW METERS

**- General**

A Magnetic flow tube is the primary in-line device of a magnetic flowmeter. It is used to measure the flow rate of electrically conductive liquids.

The flow tube produces a d.c. or a.c. millivoltage. This low-level voltage is directly proportional to velocity and translatable to volumetric flow rate. It is converted into a standard transmission signal by a magnetic flow transmitter.

**- Rangeability**

10:1 or better.

**- Accuracy**

±0.5% of full scale or better.

**- Min. Required Fluid Conductivity**

≥2 μs/cm.

**- Operating Temp. and Pressure**

As specified in data sheets.

**- Liner Material**

Normally is PTFE, ceramic, neoperene, polyutherane, unless otherwise specified.

**- Electrode Material**

Normally is AISI 316L SST.

**- Flanges**

Normally is 304 SST, ANSI RF.

**- Housing (Tube Coils)**

Steel sheet for sizes larger than 300 mm (12 in.) and low copper content cast aluminum alloy for sizes smaller than 300 mm (12 in.), shall meet IEC IP 65 requirements (NEMA 4).

**- Transmitter Mounting**

Normally shall be directly mounted on the flow tube itself, for sizes up to 300mm (12 in.).

And shall be pipe mounted on 50mm (2 in.) stand pipe, for sizes more than 300mm (12 in.).

**- Transmitter Enclosure**

Shall be IEC-IP 65 weather prooved.

**- Transmitter Housing and Cover Material**

Normally is low-copper content cast aluminum alloy, unless otherwise specified.

**- Transmitter Output Signal**

Shall be 4-20 mA d.c., unless otherwise specified.

**- Hazardous Area Classification**

As specified in related data sheets, and shall be certified from a well known authorization such as BASEEFA, FM, UL, PTB etc...

**- Power Supply**

Normally is 110 V ±10%, 50 Hz ±3 Hz, unless otherwise specified.

- Allowable Ambient temp. -40 to+85°C

- Allowable storage temp. -20 to +70°C

**- Allowable Vibration**

Less than 15 $m/s^2$ (1.5g).

**- Electrical connection**

M20 × 1.5

## 11. POSITIVE DISPLACEMENT METERS

**- General**

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

**- Linearity**

±0.2% or better

**- Repeatability**

±0.05% or better

**- Capacity**

As specified in related data sheets.

**- Working Pressure**

Normally shall be 10 barg, unless otherwise is specified in related data sheets.

**- Connections**

Shall be flanged to ANSI RF 150, unless otherwise is specified.

**- Meter Housing and Parts**

Welded Steel Construction the following material requirement should be met unless otherwise is specified:

- Meter element Housing (counter): Aluminum.
- Rotors: Heat treated aluminum.
- Rotor shafts: Ground and polished nitralloy
- Rotor Bearing: Ball bearing stainless steel.
- Counter Drive gears: Stainless steel.
- Counter Drive shaft: Stainless steel.
- Counter Drive shaft bushings: carbon filled teflon

**- Counter**

Large numerical counter with five digits (min.) resetable and seven digits non-resetable totalizers, with suitable flow units.

**- Seals**

Buna-N, unless otherwise is specified

**- Temperature Compensator**

Automatic temperature compensator with gravity selection facility.

**- Option**

The following accessories may be ordered as specified in relative data sheet.

- Printer:
- Preset valve: (flow control valve):
- Transmitter and receiver:
- Indicator:
- Pulser:
- Strainer:
- Air Eliminator:
- Air actuated check valve:
- Meter prover
- Flow computer

## 12. VORTEX SHEDDING FLOW METERS

### - General

Vortex flow meters measure the flow of fluids in pipe lines by monitoring induced vortices. Vortices are rotational flow zones similar to natural whirlpools. They transmit either a pulse signal or an electronic analog signal linearly proportional to volumetric flow rate.

The flow meter consists of a flow meter body (primary device) and an electronics housing (secondary device) mechanically connected together.

The primary device contains the vortex shedding element and sensor assembly (detector), the vortex shedding element is cast (inplace) into the flowmeter body.

The sensor assembly is located in a flow chamber directly above the shedding element. This assembly is easily removed from the top of the body without the need for removing the flowmeter from the pipe line (for noninsertion type). The secondary device houses the output module assembly, terminal block, and a flow rate indicator.

A flexible coaxial cable connects the sensor assembly to the out put module assembly.

### - Accuracy

±0.5% flow rate or better, for pulse output.

±0.7% full scale or better, for 4-20 mA analog output.

### - Repeatability

±0.2% of full scale.

### - Sensor Type

Manufacturer standard.

### - End Connection

Normally is flanged, ANSI RF, B16.5, rating shall be as specified.

### - Standard Materials, (Wetted Parts)

316 SST (body, shedding element, etc), unless otherwise specified.

### - Power Supply

Normally shall be 24 V d.c., or 110 V a.c. unless otherwise specified.

### - Output Signal

Pulse or 4-20 mA analog, as specified in related data sheets.

### - Hazardous Area Classification

As specified in related data sheets, and to be certified from acceptable authorization, such as: FM, BASEEFA, UL, PTB etc.

**- Ambient Temperature**

-30 to +85°C

**- Relative Humidity**

0 and 100% RH

**- Enclosure Protection**

Normally is IEC-IP 65 (NEMA 4)

**- Electrical Connection**

M20 × 1.5

**- Local Flow Rate Indicator**

Shall be provided, when specified.

## 13. MASS FLOW METERS

**- General**

Mass flowmeters measure fluid mass flow rate directly, not inferentially as volumetric flowmeters do. The principle of coriolis acceleration is used which allows true mass folw rate measurements of fluids to be made directly, without the need for external temperature, pressure, or specific gravity measurements. They are comprised of a sensor (flow tubes) and a signal processing transmitter.

The transmitter provides analogue (4-20 mA) and digital output signals.

**- Accuracy**

±0.2% of reading, or better.

**- End Connection**

Normally is flanged, ANSI, RF, B 16.5, rating shall be as specified.

**- Flow Tube Materials (Wetted Parts)**

316 SST, unless otherwise specified.

**- Flow Tube Enclosure Materials (Non-Wetted Parts)**

304 SST, with a mat finish seams are welded and enclosure free from water and dust retaining cavities.

**- Power Supply**

Normally shall be 24 V d.c. unless otherwise specified.

**- Output Signal**

4-20 mA, pulse, or digital signal, as specified.

**- Hazardous Area Classification**

As specified in related data sheets, and to be certified from acceptable authorization, such as : FM, UL, PTB, BASEEFA,..... etc.

**- Ambient Temperature**

-30 °C to +85 °C

**- Relative Humidity**

0 and 100% RH

**- Mechanical Vibration**

Transmitter : 5 $m/s^2$ (0.5 "g") at 5 to 200 Hz

Flowtube : 10 $m/s^2$ (1 "g") at 5 to 40 and 100 to 200 Hz

**- Transmitter Enclosure Protection**

Normally is IEC-IP 65 (NEMA 4 X )

**- Flowtube Enclosure Protection**

Hermetically sealed, welded flowtube enclosure provides ingress protection at internal pressure less than atmospheric pressure.

**- Flow Rate Indicator**

Shall be provided, when specified.

**- High Voltage Protection**

The transmitter can withstand surge voltages up to 2500 V.

**- Transmitter Mounting**

Shall be panel, pipe, or surface mounted, as specified.

## 14. DOCUMENTATION / LITERATURE

### 1) AT QUOTATION STAGE

Suppliers shall provide the following in the numbers requested at the time of quotation (minimum five hard copies and one set searchable electronic files):

**a)** Comprehensive descriptive literature.

**b)** List of recommended commissioning spares with prices.

**c)** Details of any special tools required with prices.

**2) AT ORDERING STAGE**

Suppliers shall provide the following in quantities and at times as detailed on the order, (minimum five hard copies and one set searchable electronic files):

**a)** List of recommended spares for two years continuous operation.

**b)** Illustrated comprehensive spare parts manual with part numbers suitable for warehouse stocking.

**c)** Illustrated installation and operating instructions.

**d)** Maintenance manuals.

**Note:**

**The above shall include identification of all proprietary items.**

All drawings and literature shall be in the English language and show all dimensions, capacities, etc., in metric units.

The order number shall be prominently shown on all documents. Drawings shall be properly protected and packed and reproducable copies shall be dispatched in a strong cardboard cylinder. Drawing shall be rolled not folded.

## 15. INSPECTION AND TEST

- Inspection by appointed representative shall consist of but not necessarily be confined to:

**1)** Visual and dimensional checks.

**2)** Hydraulic and functional tests where applicable.

- Certified test reports shall be provided for each instrument.

- The user reserves the right to reject individual instrument for bad workmanship or defects.

- Detailed inspection requirements are specified in IPS-E-IN-100, factory inspection for instruments and instruments systems.

## 16. PACKING AND SHIPPING

Equipment shall be carefully protected and packed to provide adequate protection during transit to destination and shall be in accordance with any special provision contained in the specification or order.

Special attention shall be given to protection against corrosion during transit.

All bright and machined parts shall be painted with a rust preventative. Ancillary items forming an integral part of the equipment should be packed preferably in a separate container if the equipment is normally cased or crated. Alternatively the ancillary items should be fixed securely to the equipment and adequate precaution taken to ensure that the items do not come loose in transit or be otherwise damaged.

Instruments having delicate movements and assembled into panels for inspection and test must be replaced in makers special shock absorbing packages for transit, all connections being marked for remounting in Iran. Such instruments to be packed in same case as associated panel, but protected by a bulkhead or equivalent packing arrangement.

## 17. GUARANTEE

Vendor shall guarantee the following when the instrument is operated in accordance with the written operating instructions.

**17.1** Designed performance and quality under conditions per specification.

**17.2** Instrument is free from fault in design, workmanship and material to fulfill satisfactorily the operating conditions specified.

**17.3** Spare parts guarantee for minimum 10 years and performance guarantee for one year after installation or 18 months after shipment whichever is closer.

| NOMINAL PIPE SIZE INCHES | ORIFICE PLATE OUTSIDE DIAMETER mm " A " ± 0.4 | | | | TAB HEIGHT mm +1 "H" -0 | | PLATE THICKNESS mm " W " |
|---|---|---|---|---|---|---|---|
| | ANSI 300 RF | ANSI 600 RF | ANSI 900 RF | ANSI 1500 RF | TO 900Lb | 1500 Lb | |
| 2 | 111.1 | 111.1 | 142.9 | 142.9 | 100 | 100 | |
| 3 | 149.2 | 149.2 | 174.6 | 174.6 | 100 | 100 | |
| 4 | 181.0 | 193.7 | 206.4 | 609.6 | 150 | 150 | |
| | | | | | | | 3.175 NOMINAL |
| 6 | 250.8 | 266.7 | 288.9 | 282.6 | 150 | 150 | |
| 8 | 308.0 | 320.7 | 358.8 | 352.4 | 150 | 150 | |
| 10 | 362.0 | 400.1 | 435.0 | 440.0 | 150 | 150 | |
| 12 | 422.3 | 457.2 | 498.5 | 520.7 | 150 | 150 | |
| 14 | 485.8 | 492.1 | 520.7 | 677.9 | 150 | 150 | |
| | | | | | | | 6.35 NOMINAL |
| 16 | 539.8 | 565.2 | 581.0 | 641.4 | 150 | 150 | |
| 18 | 596.9 | 612.8 | 638.2 | 704.9 | 150 | 150 | |
| 20 | 654.1 | 682.6 | 698.5 | 755.7 | 150 | 150 | |
| 24 | 774.7 | 790.6 | 838.2 | 901.7 | 150 | 150 | |
| | | | | | 50mm SHOULD BE ADDED TO DIMEN'S GIVEN ABOVE IF LINE IS LAGGED | | QUARTER CIRCLE PLATES DO NOT HAVE TO MEET THESE REQUIREMENTS OF " W " |

TOLERANCES:

MAXIMUM TOLERANCE FOR DIAMETER d OF ORIFICE IS ±01% OR AS DETAILED ON THE FOLLOWING TABLES.

| DIA OF ORIFICE mm. | MAX. TOLERANCE PLUS OR MINUS mm |
|---|---|
| LESS THAN 6.4 | 0.007 |
| 6.4 — 9.5 | 0.007 |
| 9.6 — 12.7 | 0.009 |
| 12.8 — 19.0 | 0.012 |
| 19.1 — 25.4 | 0.019 |
| 25.5 — 38.1 | 0.025 |
| 38.2 — 50.8 | 0.038 |
| 50.9 — 63.5 | 0.050 |
| 63.6 — 76.2 | 0.063 |
| 76.3 — 101.6 | 0.076 |
| 101.7 — 127.0 | 0.076 |
| 127.0 — OVER | 0.012PERIN. OF NOMINAL PIPE SIZE |

VENT & DRAIN HOLES:

DRILL HOLE TANGENT TO THE INSIDE SURFACE OF THE PIPE (D-G )FROM 2 ORIFICE PLATE CENTER

| ORIFICE DIA "d" mm | MAX. DIAMETER OF HOLE "G" mm |
|---|---|
| LESS THAN 25.4 | NOT USED |
| 25.4 — 88.9 | 2.4 |
| 89.0 — 127.0 | 3.2 |
| 127.1 — 171.4 | 4.8 |
| 171.5 — 212.7 | 6.4 |
| 212.8 — 254.0 | 7.9 |
| 254.1 — 295.3 | 9.5 |
| 295.4 — 336.5 | 11.1 |
| 336.6 & LARGER | 12.7 |

**TYPICAL DRAWINGS 1A**
**ORIFICE PLATE FABRICATION DATA**

**General Notes:**

1) The orifice flange bores shall match the pipe schedule or inside diameter specified.

2) Dimensions of plate shall be as per table on sheet 1 .

3) The plate, when purchased, shall be considered flat when a true straight EDGE is held against the faces of the plate along any diameter and there are no departures of more than 1mm per 100mm.

4) The tab thickness shall be equal to plate thickness, except for quarter circle orifice plates the maximum tab thickness shall be 6mm.

5) Before machining of the hole both sides of the plate shall be ground to asmooth finish.

6) The orifice plate tab when installed will be rotated θ degrees off of vertical.

The angle θ where a vent or drain hole is specified shall be in accordance with the following Table:

| Flange | | 45° | | 30° | 22.5° | 18° | 15° |
|---|---|---|---|---|---|---|---|
| ANSI RF | 300 | NOM PIPE SIZE | 2-3-4 | 6-8 | 10-12 | 14-16 | 18-20-24 |
| | 600 | | 2-3-4 | 6-8 | 10 | 12-14-16-18 | 20-24 |

7) Vent and drain holes shall be as per table on sheet 1 .

8) The upstream side of the tab shall be stamped as indicated. Lettering size to be 4.75mm.

9) After machining of the hole the upstream face of the plate exposed to the line fluid is to be carefully honed and polished without damaging the sharp edge of the orifice. The upstream face of the orifice plate shall be smooth to within 0.0003d peak to hollow height. The downstream face shall be parallel to the upstream face within 0.5 DEG.

10) At final inspection before installation into lines, the upstream EDGE of the square EDGE orifice shall be square and sharp, free from both burrs and rounding, so that when viewed without magnification light is not reflected by the corner.

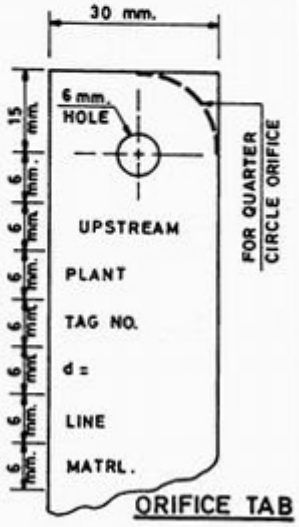
11) The edge width (W-T), of the square EDGE orifice, shall not exceed the smallest of the following values:

1/50 of the pipe diameter " D "

1/8 of the orifice diameter " d "

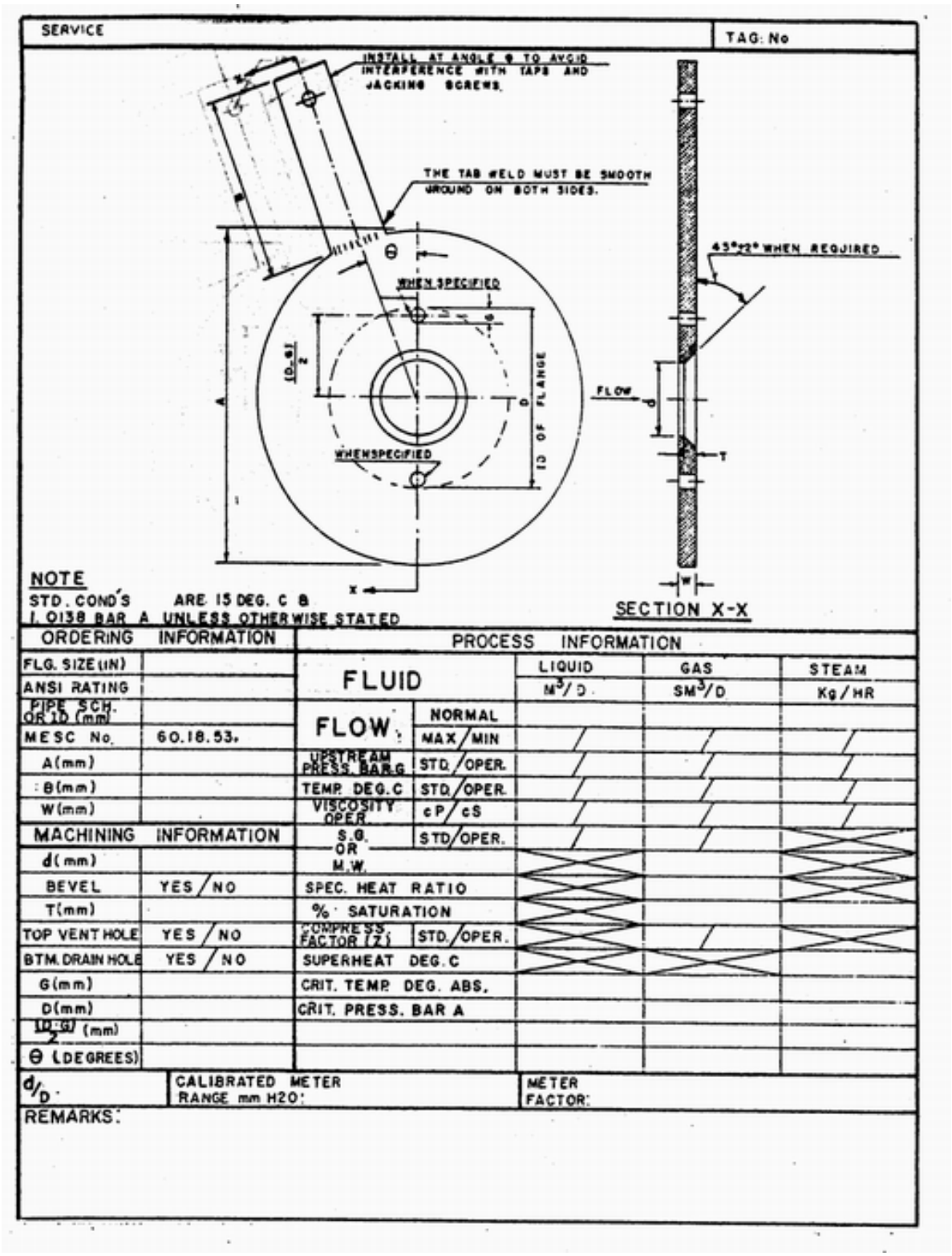
1/8 of the dam height " ( D-d ) "

If orifice plate thickness is greater than the limitations placed on edge width, then the outlet corner of the orifice shall be bevelled at an angel of 45 degrees with respect to the face of the orifice plate.




**TYPICAL DRAWING 1B**

**ORIFICE PLATES FABRICATION DATA**



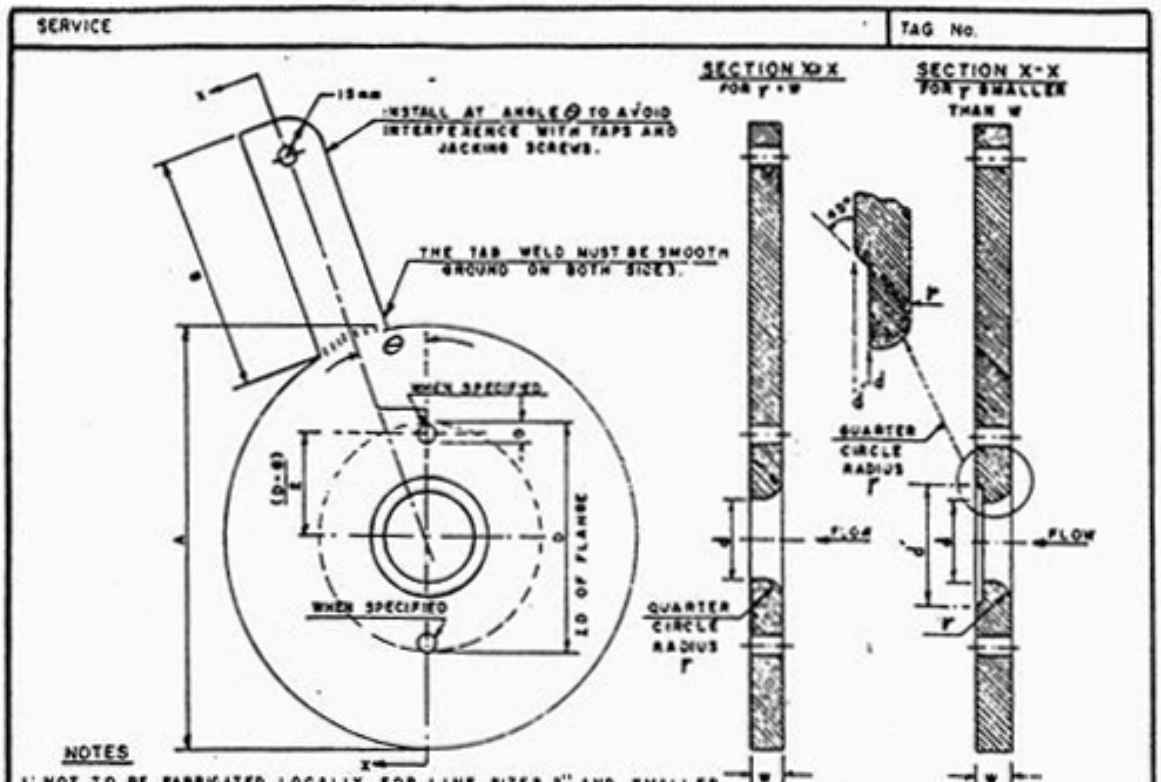

| ORDERING INFORMATION | | PROCESS INFORMATION | | | | |
|---|---|---|---|---|---|---|
| FLG. SIZE (IN) | | FLUID | | LIQUID | GAS | STEAM |
| ANSI RATING | | | | $M^3/D$. | $SM^3/D$ | Kg/HR |
| PIPE SCH. OR ID (mm) | | FLOW | NORMAL | | | |
| MESC No. | 60.18.53. | | MAX/MIN | | | |
| A(mm) | | UPSTREAM PRESS. BAR G | STD./OPER. | | | |
| B(mm) | | TEMP. DEG.C | STD./OPER. | | | |
| W(mm) | | VISCOSITY OPER. | cP/cS | | | |
| MACHINING INFORMATION | | S.G. OR M.W. | STD/OPER. | | | |
| d(mm) | | | | | | |
| BEVEL | YES/NO | SPEC. HEAT RATIO | | | | |
| T(mm) | | % SATURATION | | | | |
| TOP VENT HOLE | YES/NO | COMPRESS. FACTOR (Z) | STD./OPER. | | | |
| BTM. DRAIN HOLE | YES/NO | SUPERHEAT DEG. C | | | | |
| G(mm) | | CRIT. TEMP. DEG. ABS. | | | | |
| D(mm) | | CRIT. PRESS. BAR A | | | | |
| $\frac{ID-G}{2}$ (mm) | | | | | | |
| Θ (DEGREES) | | | | | | |

| $d/D$. | CALIBRATED METER RANGE mm H2O: | METER FACTOR: |
|---|---|---|

REMARKS:

**TYPICAL DRAWING 2**

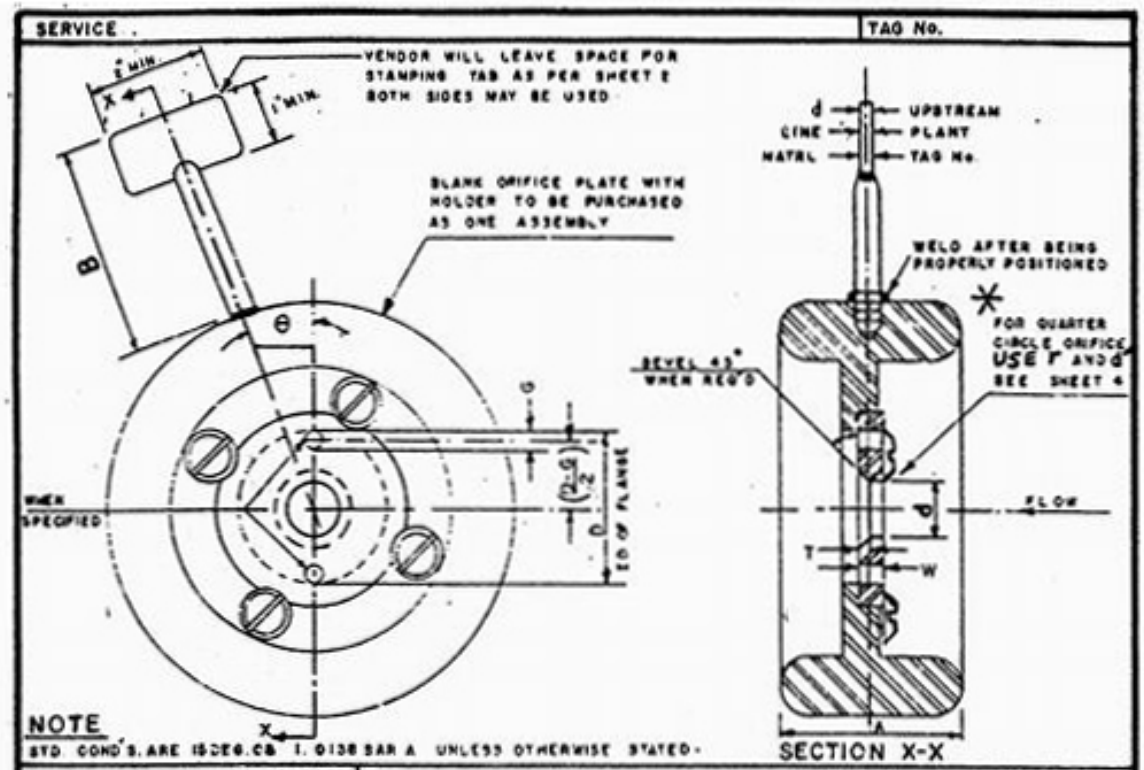
**SQUARE EDGE ORIFICE PLATE DATA AND SPECIFICATION SHEET**




| ORDERING INFORMATION | | PROCESS INFORMATION | | | | |
|---|---|---|---|---|---|---|
| FLG. SIZE (IN) | | FLUID | | LIQUID | GAS | STEAM |
| ANSI RATING | | | | $M^3/D$ | $SM^3/D$ | Kg/HR |
| PIPE SCH OR ID (mm) | | FLOW | NORMAL | | | |
| NESC No. | 60.18.53. | | MAX / MIN | / | / | / |
| A (mm) | | UPSTREAM PRESS BAR G | STD / OPER. | / | / | / |
| B (mm) | | TEMP DEG C | STD / OPER. | / | / | / |
| W (mm) | | VISCOSITY OPER. | CP / CS | / | / | / |
| MACHINING INFORMATION | | S.G. OR MW | STD / OPER | / | / | |
| d (mm) | | SPEC. HEAT RATIO | | | | |
| r (mm) | | % SATURATION | | | | |
| d' (mm) | | COMPRESS. FACTOR (Z) | STD / OPER. | | / | |
| TOP VENT HOLE | YES / NO | SUPERHEAT DEG C | | | | |
| BTM. DRAIN HOLE | YES / NO | CRIT. TEMP. DEG. ABS. | | | | |
| G (mm) | | CRIT. PRESS. BAR A | | | | |
| D (mm) | | | | | | |
| $\frac{(D-G)}{2}$ (mm) | | | | | | |
| Θ (DEGREES) | | CALIBRATED METER RANGE mm H2O : | | METER FACTOR: | | |
| REMARKS: | d/D: | | | | | |

**TYPICAL DRAWING 3**

**QUARTER CIRCLE ORIFICE PLATE DATA AND SPECIFICATION SHEET**

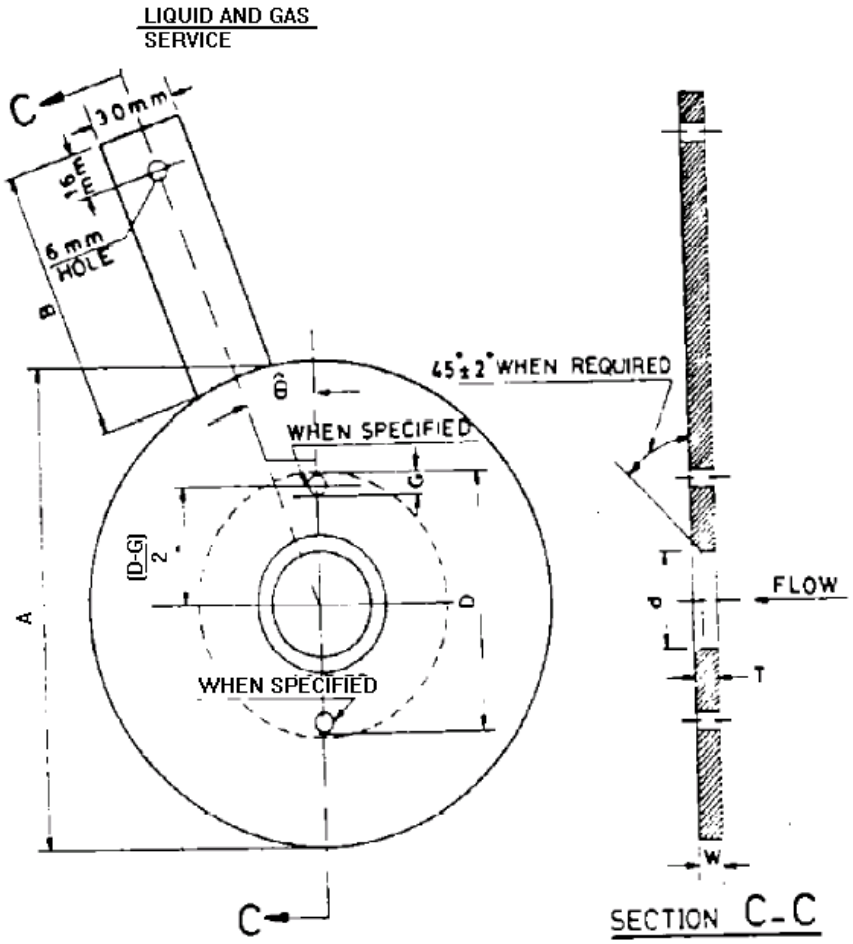



| ORDERING INFORMATION | | PROCESS INFORMATION | | | | |
|---|---|---|---|---|---|---|
| FLG. SIZE (IN) | | FLUID | | LIQUID | GAS | STEAM |
| ANSI RATING | | | | $M^3/D$ | $SM^3/D$ | Kg / HR |
| PIPE SCH. OR I.D.(mm) | | FLOW | NORMAL | | | |
| MESC No. | 60.18.53. | | MAX / MIN | / | / | / |
| A (mm) | | UPSTREAM PRESS. BARG | STD / OPER. | / | / | / |
| B (mm) | | TEMP. DEG. C | STD / OPER. | / | / | / |
| W (mm) | | VISCOSITY OPER. | CP / CS | / | / | / |
| MACHINING INFORMATION | | S.G. OR M.W. | STD / OPER | / | / | |
| d (mm) | | SPEC. HEAT RATIO | | | / | |
| * BEVEL | YES / NO | % SATURATION | | | | |
| * T (mm) | | COMPRESS. FACTOR(Z) | STD / OPER | | / | |
| TOP VENTHOLE | YES / NO | SUPERHEAT DEG. C | | | | |
| BTM. DRAINHOLE | YES / NO | CRIT. TEMP. DEG. ABS. | | | | |
| G (mm) | | CRIT. PRESS. BAR A | | | | |
| D (mm) | | | | | | |
| $\frac{D-G}{2}$ (mm) | | | | | | |
| θ (DEGREES) | | | | | | |
| d/D. | CALIBRATED METER RANGE mm H2O : | | | METER FACTOR | | |

REMARKS :

**TYPICAL DRAWING 4**

**ORIFICE PLATE AND HOLDER FOR "RTJ" FLANGES SQUARE EDGE OR QUARTER CIRCLE ORIFICE PLATE DATA AND SPECIFICATION SHEET**



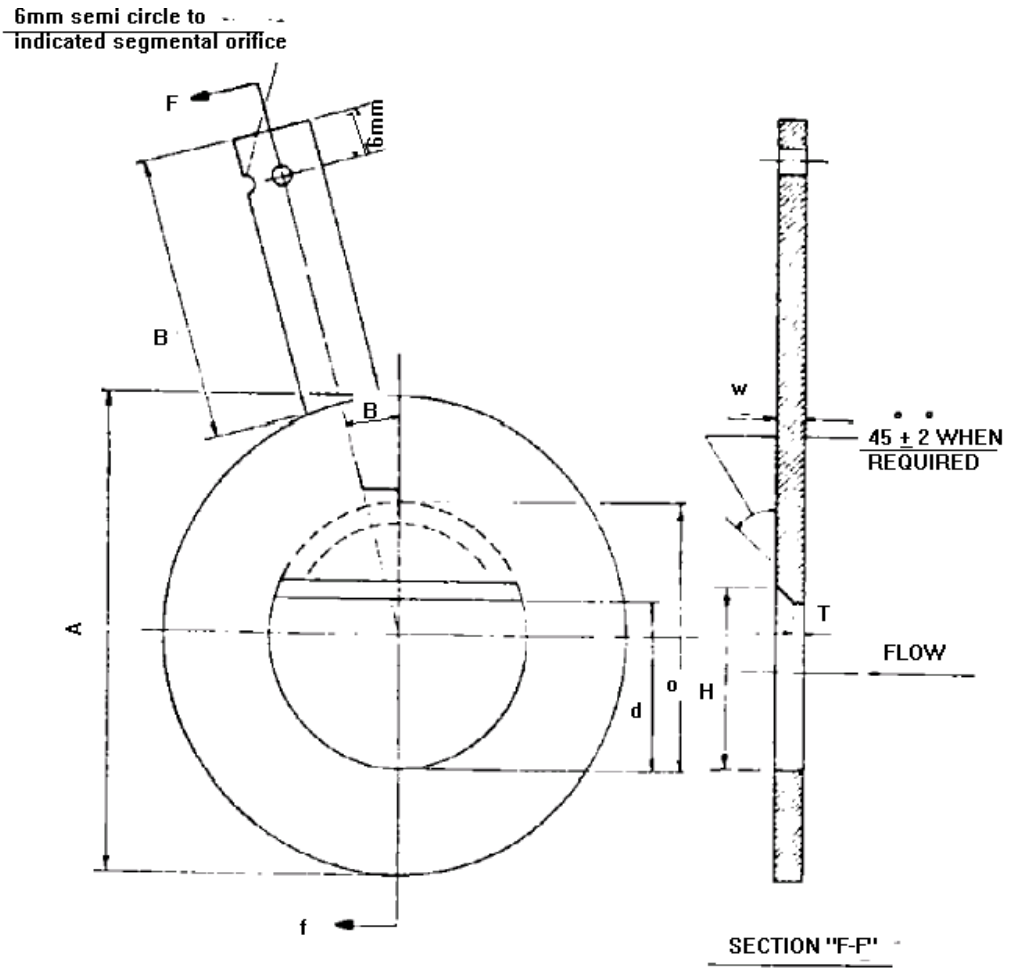

**Notes:**

**1) Install at angle è to avoid interference with taps and jacking screws.**

**2) The plate may be fabricated from one-piece of material, should the tab be welded on, however care must be taken to smooth grind the weld on both sides.**

**TYPICAL DRAWING 5**

**SQUARE EDGE ORIFICE PLATE**




**Notes:**

**1) Install at angle $\theta$ to avoid interference with taps and jacking screws.**

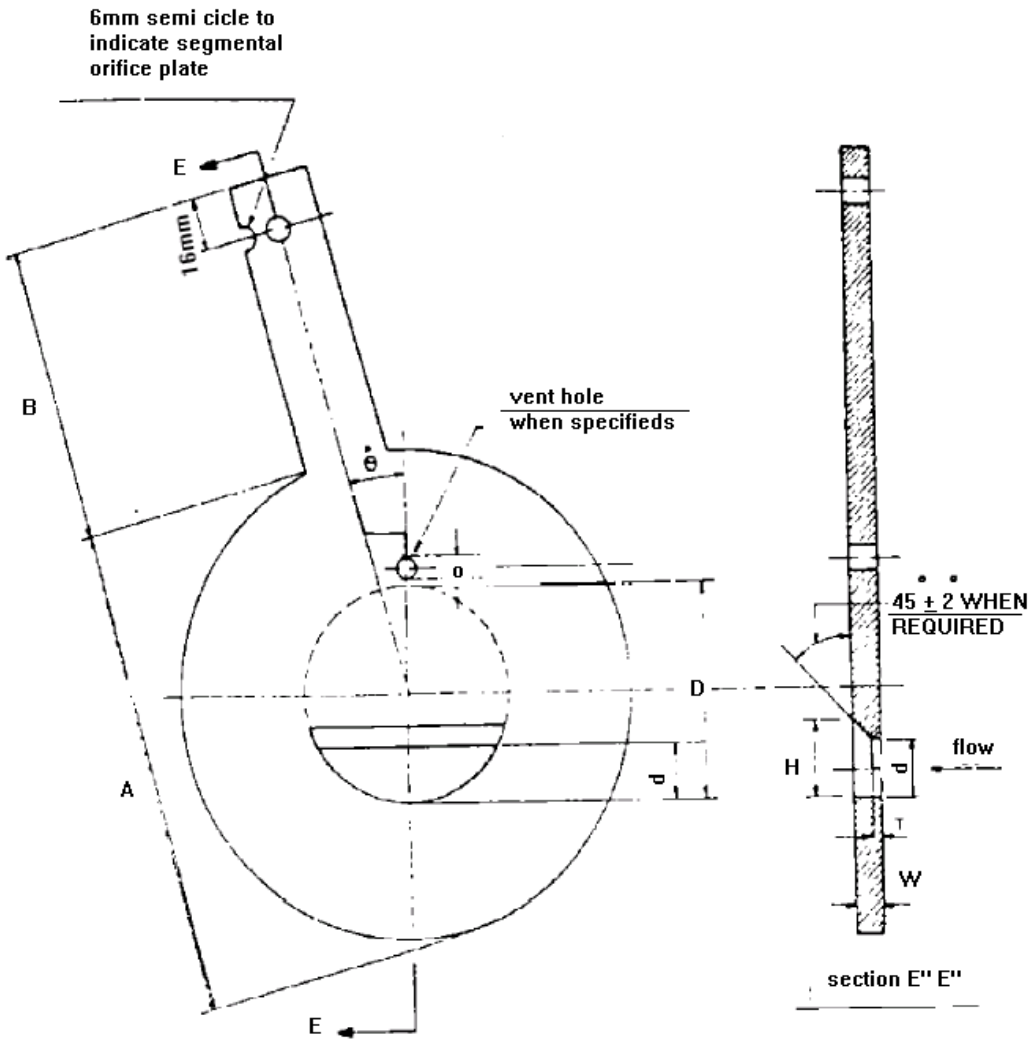
**2) The plate may be fabricated from one piece of material, should the tab welded on, however care must be taken to smooth grind the weld on both sides.**

**3) Pressure taps must be located above dam.**

**TYPICAL DRAWING 6**

**SEGMENTAL ORIFICE PLATE**

**DAM HEIGHT LESS THAN HALF INTERNAL DIA. OF PIPE**




**Notes:**

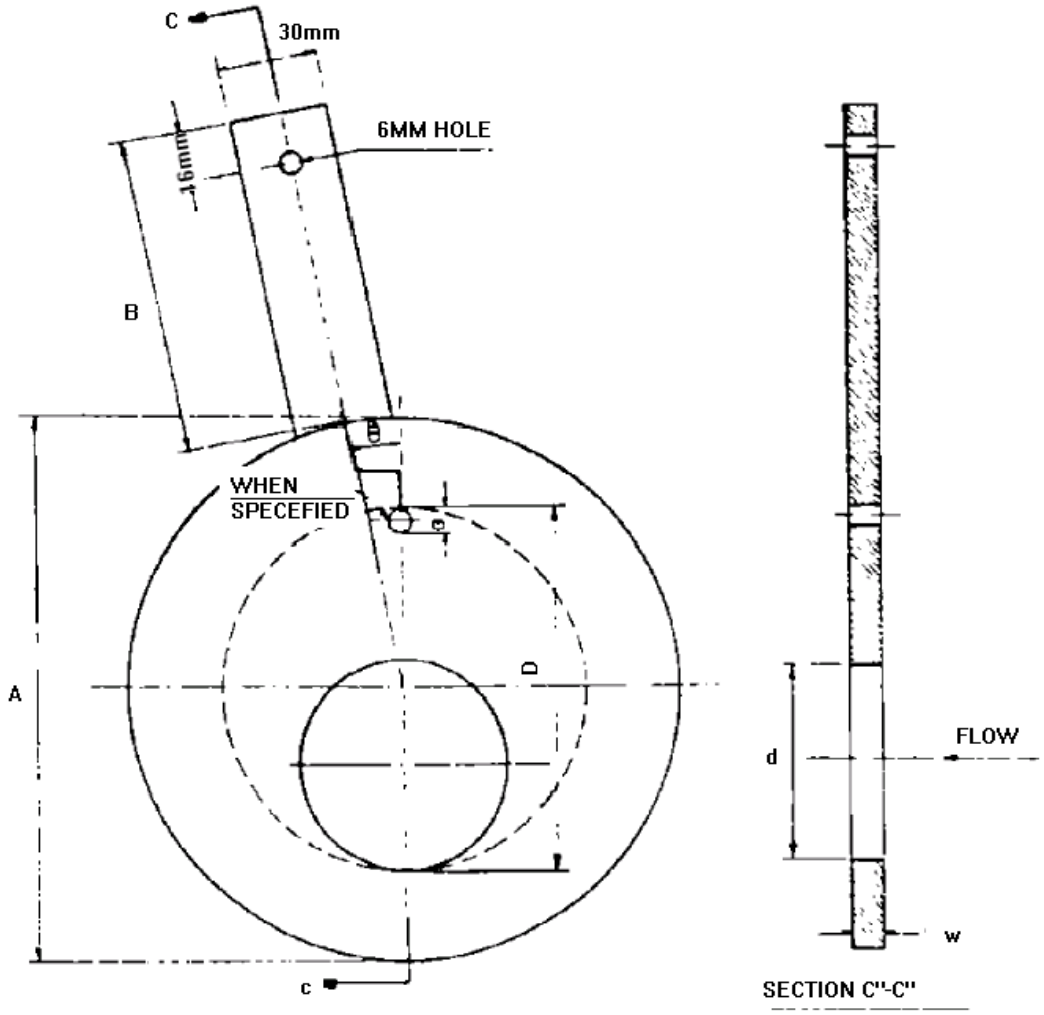
**1) Install at angel $\theta$ to avoid interference with taps and jacking screws.**

**2) The plate may be fabricated from one piece of material, should the tab be welded on, however care must be taken to smooth & grind the weld on both sides.**

**TYPICAL DRAWING 7**

**SEGMENTAL ORIFICE PLATE**

**DAM HEIGHT MORE THAN HALF INTERNAL DIA. OF PIPE**



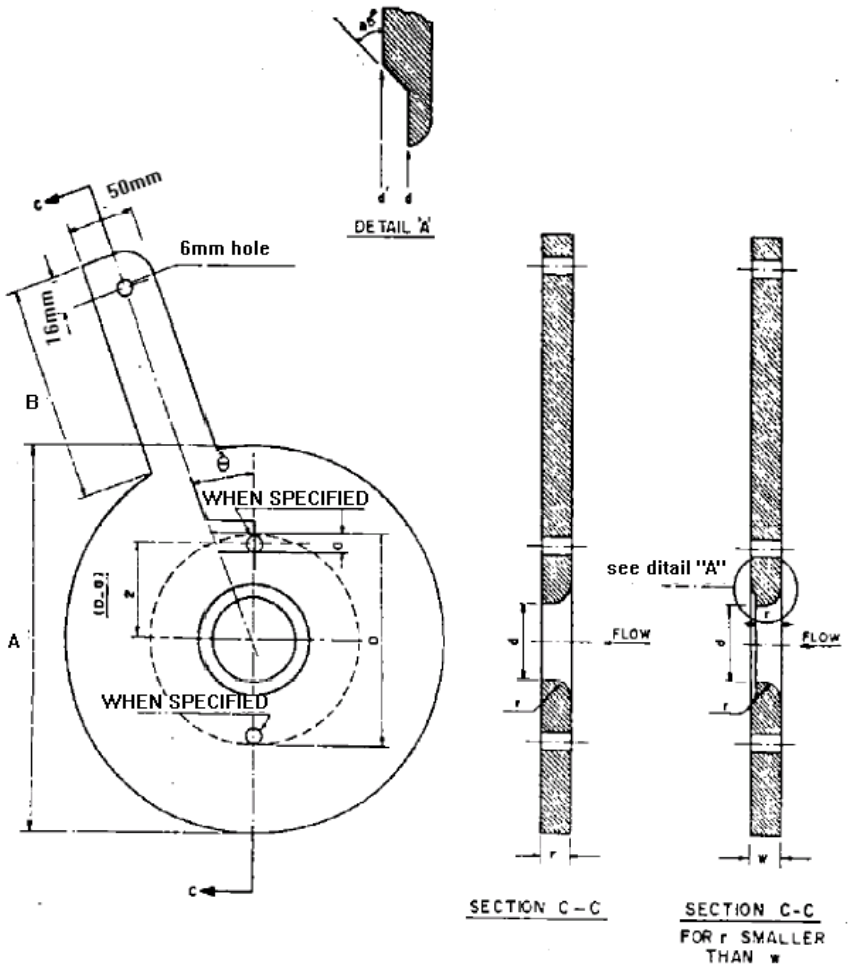

**Notes:**

**1) Install at angle è to avoid interference with taps and jacking screws.**

**2) The plate may be fabricated from one piece of material, should the tab be welded on, however care must be taken to smooth grind the weld on both sides.**

**TYPICAL DRAWINGS 8**

**ECCENTRIC ORIFICE PLATE**




**Notes:**

**1) Install at angle $\theta$ to avoid interference with taps and jacking screws.**

**2) The plate may be fabricated from one piece of material, should the tab be welded on, however care must be taken to smooth grind the weld on both sides.**

**3) Not to be fabricated locally for line sizes 2" and below.**

**4) d' shall be 1.5 times d or equal to inside pipe diameter whichever is smaller.**

**TYPICAL DRAWING 9**

**QUARTER CIRCLE ORIFICE PLATE**

## APPENDICES

## APPENDIX A

## ADDITIONAL REFERENCES

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