

Wyatt Orifice Flow Products  
Machined and Fabricated Primary Elements



## FEATURES:

- **Reliable Performance**
- **Regulatory Acceptance**
- **Low Installed Cost**
- **Flexible Designs**
- **Short Laying Length**

## Description

Differential producers, specifically orifice plates, are used in flow measurement due to their simplicity, ease of installation, tolerance to extreme atmospheric and process conditions, and predictable and reliable performance. Orifice plates are the most common method of differential pressure flow measurement and are used in various industries, particularly in the hydrocarbon market. Because of their long history and dominance in flow measurement, orifice plate designs and installation requirements have been well documented by national and international standards organizations. Orifices have found use in restriction and anti-cavitation applications as well.

## Application

Wyatt Engineering orifice plates, flanges, and metering runs are used in a wide range of applications where extremes of pressure, temperature, or the aggressive nature of the fluid being metered render other metering technologies unfeasible. Because of their reliability, low cost, and ease of installation, Wyatt orifice products are frequently used as the differential pressure device for the measurement of the flow of fluids, especially for clear water, steam, air, petrochemical, and most gases. Typical applications range from potable water, cooling water, process water, steam, air flow for fine bubble aeration, combustion air, and natural and process gases.

## Documented Accuracy

Wyatt Engineering also provides application guidance to support the proper use of its equipment: We address the use of flange, corner, and pipe taps; the use of metering runs with integral flow straighteners; and the use of alternate orifice plate geometries.

Unlike most providers of orifice products, Wyatt Engineering has extensive flow calibration data that reflects experience and depth of knowledge. Industry, national, and international codes can provide guidance to manufacturers, but only successful test results can assure the flow measurement results that are necessary in today's market.



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## Accuracy

The uncertainty associated with the use of orifice meters is a function of pipe Reynolds number, beta ratio ( $d/D$ ), tapping arrangement, line size, and piping configuration, so contact Wyatt Engineering for further information. If lower uncertainty is desired, orifice flow meters can be flow calibrated to provide a flow measurement uncertainty of  $\pm 0.25\%$ .

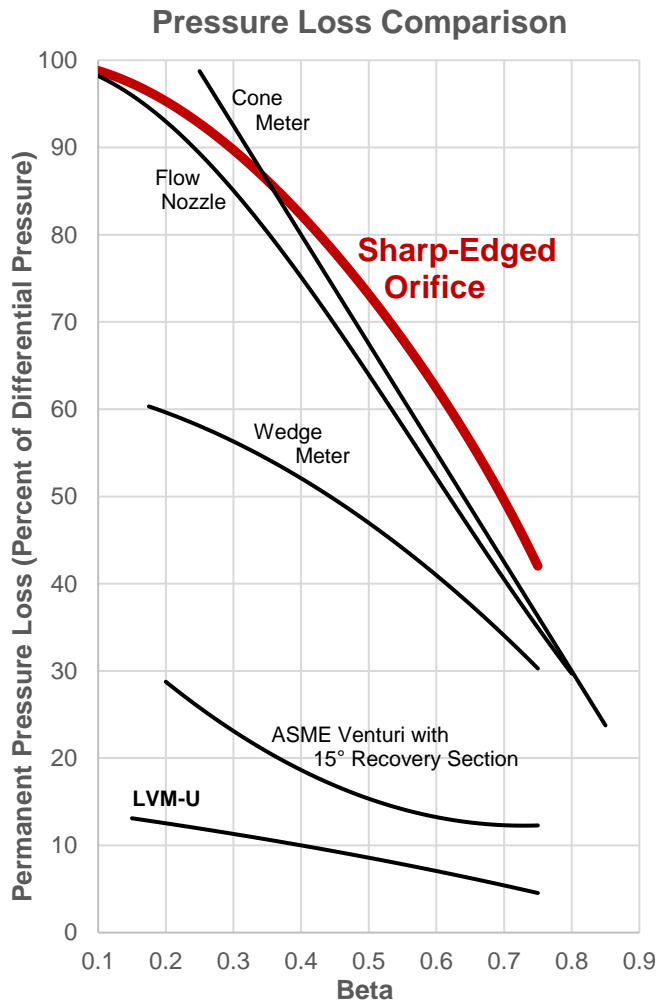


Figure 1

## Pressure Loss

The permanent pressure loss of orifice plates, expressed as a percentage of the differential pressure produced, is somewhat higher than other differential producing primary elements. Refer to Figure 1, above.

## Beta Ratio

Wyatt Engineering can furnish orifice meters with a wide range of diameter ratios ( $d/D$ ). By custom designing a meter for your application's flow conditions, Wyatt can provide an accurate and reliable primary element.

## Process & Environmental Conditions

Wyatt orifice plates, fittings, and meter runs can be fabricated for virtually any set of process or ambient conditions. We design to ASME B31.1, 31.3, 31.8, or other standards, as needed. A temperature range of  $-250\text{ }^{\circ}\text{C}$  to  $+650\text{ }^{\circ}\text{C}$  ( $-425\text{ }^{\circ}\text{F}$  to  $+1200\text{ }^{\circ}\text{F}$ ) and pressures from vacuum service to 35 MPa (5100 PSIG) can be accommodated.

## Piping Requirements

Wyatt Engineering orifice flow meters can be mounted horizontally, vertically, or at an angle. Contact Wyatt Engineering for recommended upstream and downstream piping and installation requirements.

## Wyatt Orifice Flanges

Orifice plates produce differential pressures, and properly manufactured orifice flanges are necessary to turn those differential pressures into a flow measurement. All Wyatt orifice flanges are manufactured in accordance with the appropriate ANSI/ASME, API, and AGA standards. Wyatt orifice flanges can be made of carbon steel, stainless steel, and Cr-Mo alloys; other materials are also available.

**Flange Ratings** from ANSI 150-lb raised-face to 2500-RTJ are available. Other flange types and ratings are also available.

**Flange Bore Diameters** are custom for your application, and **Surface Finishes** are to the tolerances given in industrial, national, and international codes and standards.

**Pressure Taps:** Typically, 1/2" NPT, but other sizes and designs (socket-weld, flanged, etc.) are available. Tap hole centerlines are positioned to accommodate common compressed gasket thicknesses, and piezometer hole edges are sharp and free from burrs.

**Gaskets:** Precision-cut gaskets are furnished with all Wyatt orifice flange sets. For RTJ flanges, Wyatt provides integral plate holders for the pressure-retaining ring.

## Flange Options

**Jack Screws** that allow for easier separation of the orifice flanges are our most-common option.

**Alignment Pins** that help assure proper alignment of the orifice plate with the flange bores can be furnished also.

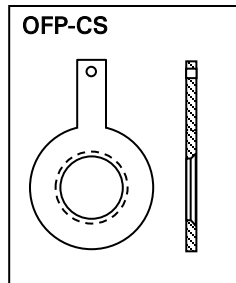
**Offset Tap Holes** can be provided to provide greater clearance for transmitter impulse piping.

**Corner-Tap Orifice Flanges** are also available. Corner tap flanges are used to measure fluids and gases in a variety of applications where economical and accurate orifice flow measurement is needed.

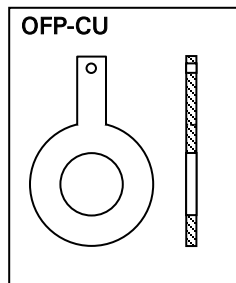
**Integral Orifice Meter Flanges and Meter Runs** are options that eliminate the need for and cost for secondary piping. Typical line sizes range from 1/2" to 4" (12 mm to 100 mm), though larger line sizes are available.

# Orifice Specifications

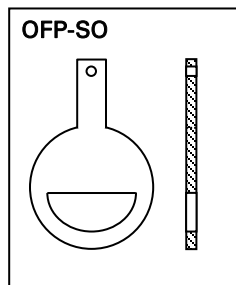
**OFF-CS:** The standard **Concentric Sharp-Edged Orifice** plate is bored and beveled to a 45° angle. Wyatt Engineering's flow test data, as well as the requirements of North American and international standards, indicate the cylindrical bore thickness must be limited to a range of 0.5% to 2.0% of the adjacent pipe inside diameter.



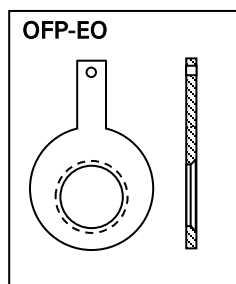
**OFF-CU:** Unlike the standard concentric plate, the **Concentric Unbeveled Orifice** plate can be used for bidirectional flow measurement. This design is sometimes employed to limit flow rates and mitigate cavitation in control valves and other equipment, but is not as precise as the concentric sharp-edged orifice.



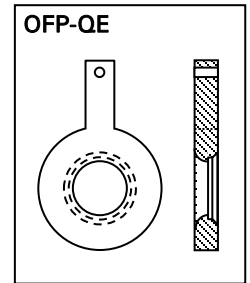
**OFF-SO:** **Segmental Orifice** plates can be used for the measurement of two-phase or multiphase flow (solids entrained in a liquid and/or gas flow stream; liquids entrained in a gas flow stream). Depending on the process flow, the segmental opening can be placed either at the crown or invert of the pipe. This is a relatively common design in the chemical, pharmaceutical, pulp and paper, and petrochemical industries.



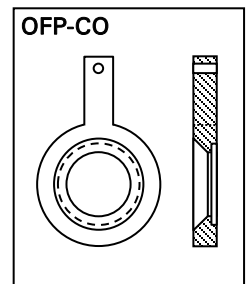
**OFF-EO:** The bores of **Eccentric Orifice** plates are not concentric with the pipe in which they are installed. The bore of the eccentric orifice is typically tangent to the inside diameter of the adjacent pipe. Like the segmental orifice plate, the bore can be placed at the top or bottom of the pipe and this design is sometimes used in the chemical, pharmaceutical, pulp and paper, and petrochemical plants. Eccentric bore orifice plates are occasionally used when the application requires a vent or drain hole, as well as a very small bore (vents and drains add to the performance uncertainty as the measurement of restriction bore decreases in diameter).



**OFF-QE:** **Quadrant Edge** orifice bore is not sharp-edged like the standard **OFF-CS**; rather, it has a radius on its leading edge. This design is for use with viscous process fluids, such as heavy crude or slurries where the pipe Reynolds number ranges from 500 to 50 000, depending on beta ratio. Since the radius of the bore's upstream edge is a function of the beta ratio, the plate thickness is usually greater than for standard concentric sharp-edged orifices.



**OFF-CO:** Like the quadrant-edge orifice plate, the **Conical Orifice** plate is designed for use with viscous fluids, but with pipe Reynolds numbers that are between 50 and 20 000. Again, this is dependent on the plate beta ratio. The bore thickness is limited by counter-boring the downstream face.



Typical materials for orifice plate construction are **304 and 316 stainless steels**, and alloys of nickel and copper. Titanium, duplex stainless steels, PVC, PTFE, alumina (ceramic), and other materials are also available.

The **thickness of an orifice plate is designed to limit plate deformation** by accounting for the magnitude of the differential pressure and other defined stresses. Only under special circumstances will the plate thickness be less than 3 mm (0.120"), nominal.

**All Wyatt Engineering orifice plates have a bevel on the downstream side** unless there is a special, defined need. Flow tests have shown that neglecting the bevel may cause errors up to 20%.

All Wyatt Engineering orifice plates are finished in accordance with the requirements of the applicable standards. Typically, the surface finish exposed to the flow is 50 µin (0.125 µm), however, special finishes are available.

**All Wyatt orifice plates come with a gasket finish**, as is required by all piping codes, unless specified otherwise.

**To measure flow rates accurately, the bore of the orifice plate must be concentric with the internal diameter of the upstream pipe.** It is also necessary that the interior of the pipe be smooth and circular in cross section. When the nominal pipe size is larger than 100 mm (4" NPS), commercial pipe, flanges, etc., are typically within tolerance limits for accurate flow measurement. Smaller line sizes require special consideration.

## Orifice Options

**Vent Holes** located at the highest elevation on the orifice plate and tangent to the pipe inside diameter can be provided to prevent gases trapped in liquid flow from being dammed up behind the orifice plate. Similarly, **Drain Holes** located at the bottom of the plate can help prevent liquids or condensates in gas or steam from being trapped behind the orifice plate.

**Special Coatings** can be applied for particularly erosive or corrosive applications, including tantalum and PTFE.

**Special Finishes** can be machined on the plate faces to cover the area between the pipe inside diameter to the outside diameter of the gasket seating surface. Special care should be taken that when specifying gasket finishes, use of thicker gaskets may be necessary that may, in turn, introduce flow measurement errors due to the larger-than-standard tap location dimensions.

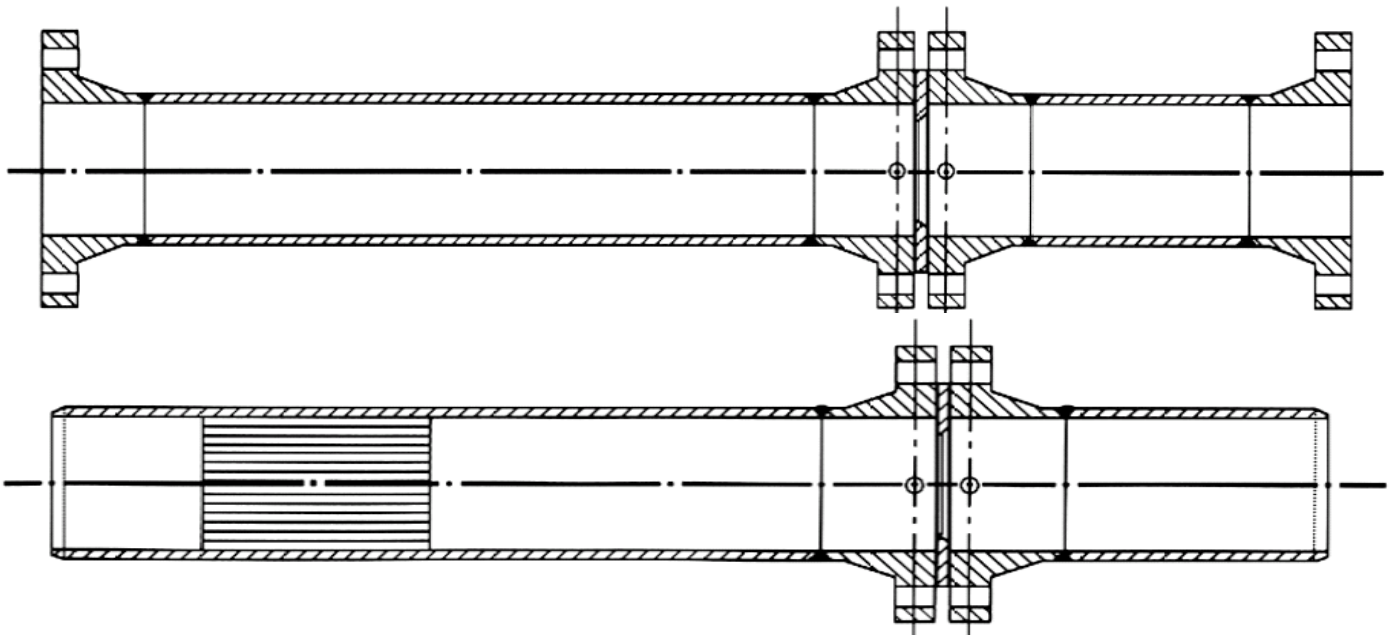
**Orifice Plate Carrier Assemblies** are available for installations where it is too costly or otherwise not practical to employ standard orifice flanges.

**Sanitary Orifice Plates, Multi-Hole Orifice Plates, and Multistage Restriction Orifice Runs** are also available.

## Wyatt Orifice Meter Runs

Wyatt Engineering provides complete **Orifice Meter Runs** that include the orifice plate, orifice flanges, upstream and downstream piping, and (if required) straightening vanes or flow conditioners. Our flow meter runs are designed to ASME B31.1 (Power Piping), B31.3 (Process Piping), or B31.8 (Gas Transmission Piping) and comply with the metering requirements of AGA 3, API 14, ASME MFC 3M, ASME MFC 14M, and/or ISO 5167. Ends of the meter run can be threaded, beveled for welding, or furnished with flanges (150-lb through 2500-lb) to suit the application requirements. Certified material and dimensional inspection reports are provided with every meter run.

For line sizes between 12 mm ( $\frac{1}{2}$ " ) and 40 mm ( $1\frac{1}{2}$ " ), Wyatt Engineering will provide its **Honed Orifice Metering Section**. Used in applications requiring high accuracy in the measurement of low flow rates, these meter runs are used most often in specialty gas and cryogenic applications. Given their size and sensitivity to corrosion, all honed orifice metering sections are fabricated of stainless steel as a standard, but other materials are available. Small line size metering runs are often provided with **Integral Orifice Meter Flanges** to simplify installation.



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