ORIFICE MTERE

BASIC SELECTION & DESIGN CONSIDERATIONS

METER SELECTION PHILOSOPHY

- ⌘Reliability/ Repeatability
- ⌘Rangeability
- ⌘Versatility
- ⌘Economics
  - ⌘Installation Cost
  - ⌘Maintenance cost
- ⌘Easily Replaceable
- ⌘Range modification
- ⌘Space Occupation

Why Orifice Meter

- Least Expensive.
- Easiest to Change.
- Locally Resizable.

Why Orifice Meter (Continued)

METER	ERROR
•Single Orifice Meter	2%
•Dual Orifice Meter	0.75%
•Mag Flow meters	1%
•Positive displacement meter	0.25%

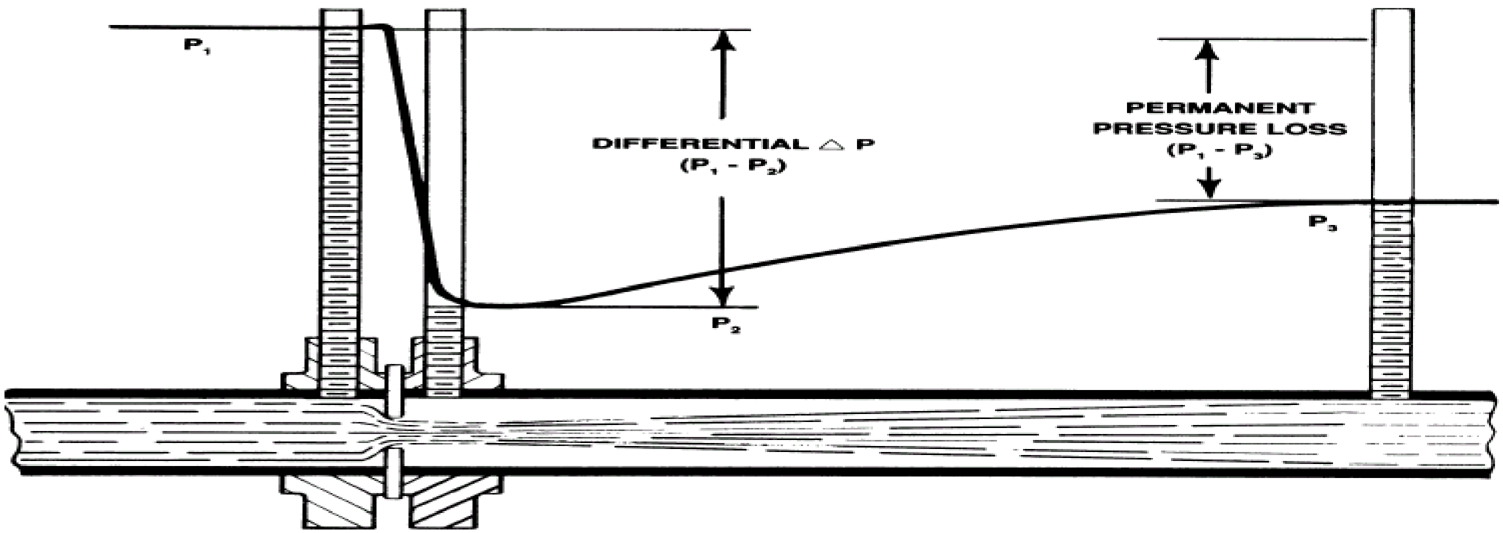
Therefore it is by far the most common sensing element used.

What is an Orifice Meter?

An orifice Meter is a conduit and a restriction to create pressure drop.

How does it work?

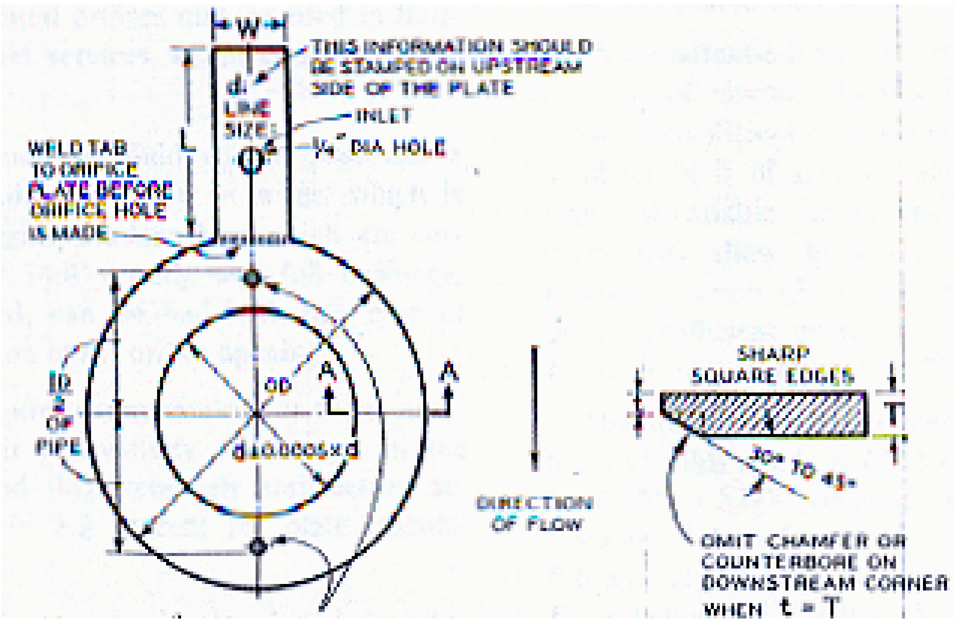
As the fluid approaches the orifice plate, the pressure increases slightly and then drops suddenly as the orifice plate is passed.



CONCENTRIC ORIFICE PLATE SPECIFICATIONS

- **Material of construction**

SS-304, SS-316, or some special material



- **Orifice plate Edge Thickness**

D/50, d/8, (D-d)/8

- **The Upstream edge of Orifice**

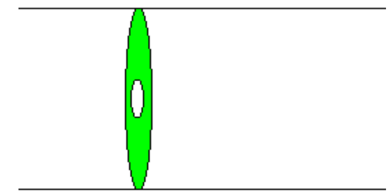
Square & Sharp

- **Weep holes Provision**

To remove moisture from wet steam, wet gas, or to remove non-condensables from liquid stream

TYPES OF ORIFICE PLATE

A. The Thin Plate, Concentric Orifice

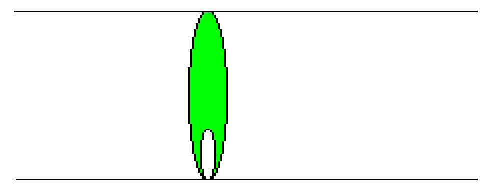


•Reliable measurement.

•The upstream edge of the orifice must be sharp and square.

• Minimum plate thickness based on pipe I.D., orifice bore, etc. is standardized.

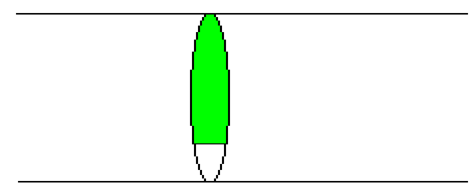
B. Eccentric Orifice Plates



⌘Round opening (bore) tangent to the inside wall of the pipe.

⌘Used to measure fluids which carry a small amount of non-abrasive solids, or gases with small amounts of liquid.

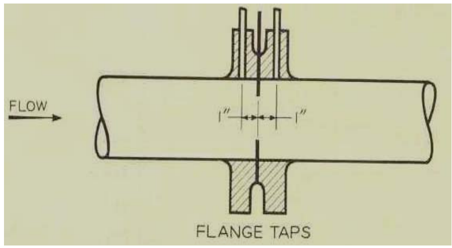
C. Segmental Orifice Plates



⌘Used for measuring liquids or gases which carry non-abrasive impurities such as light slurries or exceptionally dirty gases.

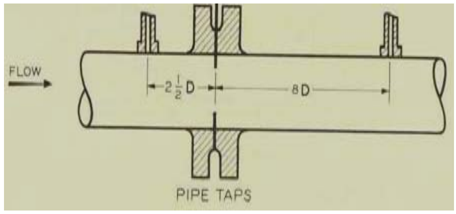
⌘Efficiency not as good as that of Concentric Plate.

METER TAP TYPE / LOCATION



a. Flange Taps

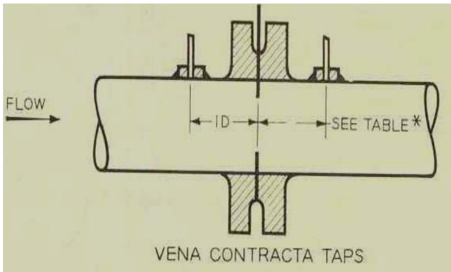
- 1” from the U/S face
- 1” from the D/S face with a + 1/64 to +1/32 tolerance.



b. Pipe Taps

- 2½ pipe diameters U/S
- 8 pipe diameters downstream

(point of maximum pressure recovery).



c. Vena-Contracta Taps

- One pipe diameter U/S
- The point of minimum pressure downstream

(vena-contracta 0.3~0.8 PD).

d. Corner Taps

- Immediately adjacent to the plate faces, U/S and D/S.
- Used in line sizes less than 2 inches

TAP LOCATION / FLOW DIRECTION

- Hold Impulse Leads to Min. Length
- 1in/ ft positive slop to avoid possible pocketing & to provide venting / drainage.
- In Vertical lines Up flow for liquids to avoid vap or Trash build up
- Install meter Below the tap for liquids and condensable vapors
- For gases install meter above the taps for avoiding the accumulation of condensable

DESIGN COSIDERATION OF ORIFICE METER

- Design Flow rate and Meter Capacity

Design flow should be above 30% and below 90% of maximum Flow.

- ß Ratio (d/D) (Range varies between 0.7 to 0.25)
- Meter dP (<1/25th of the line pressure)
- Line Size (Minimum line size of 2" is standard because of pipe roughness considerations)

Orifice Plate Coefficient of Discharge - Cd

The coefficient of discharge depends on

- ⌘Reynolds number
- ⌘Sensing tap location
- ⌘Meter tube diameter

&

- ⌘Orifice diameter etc.

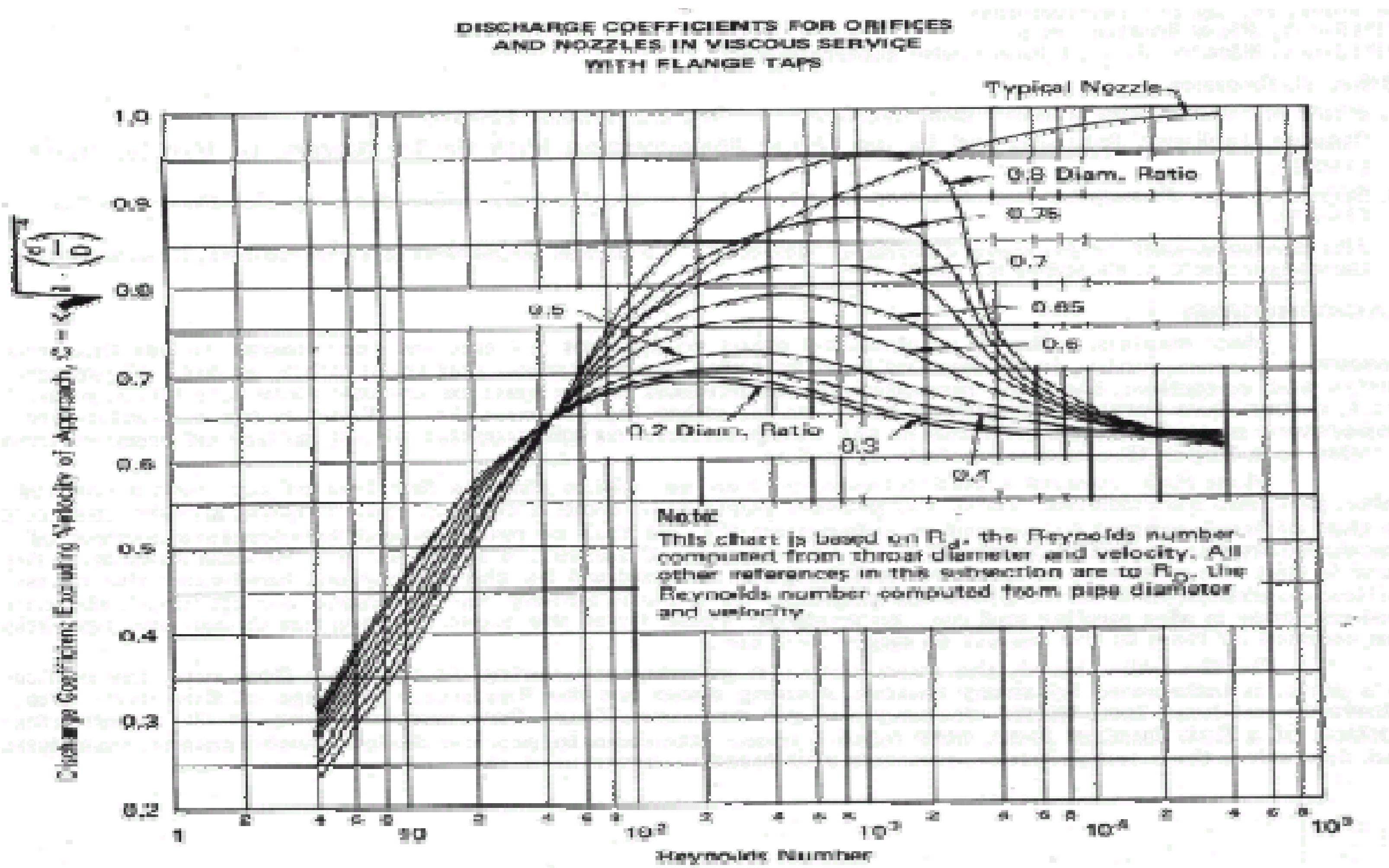
SIZING ORIFICES

Orifice Plates are sized to provide the differential of 100~200 in H2O Column at maximum Flow Rate.

Advantage:

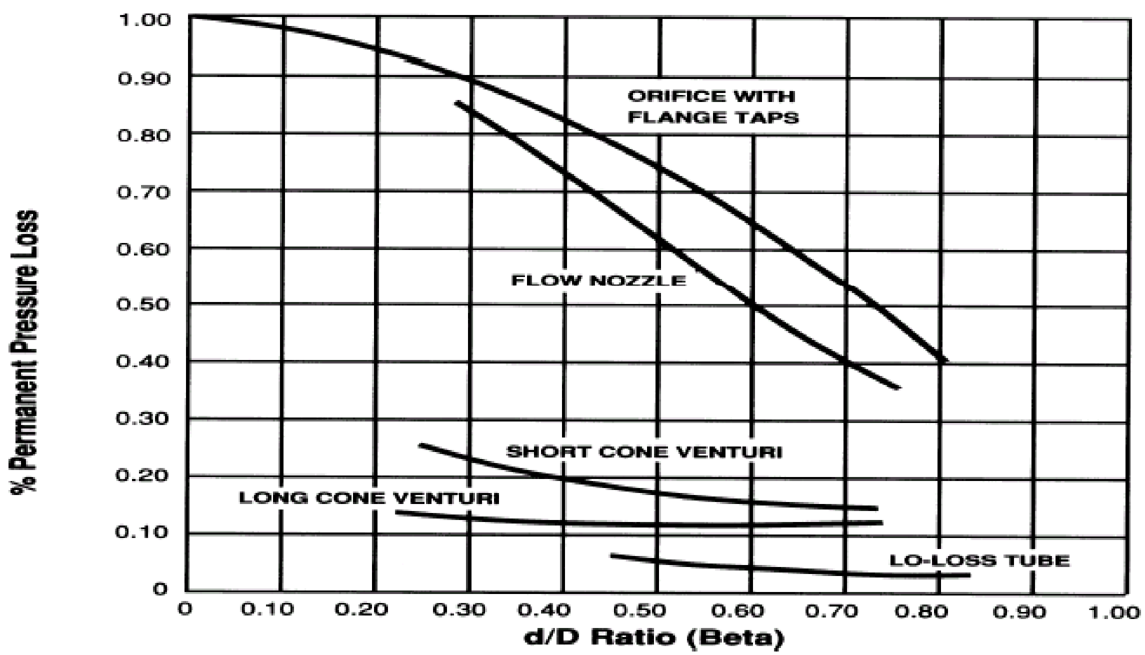
This sizing allows to change the meter range without changing the orifice plate.

Discharge Coefficient



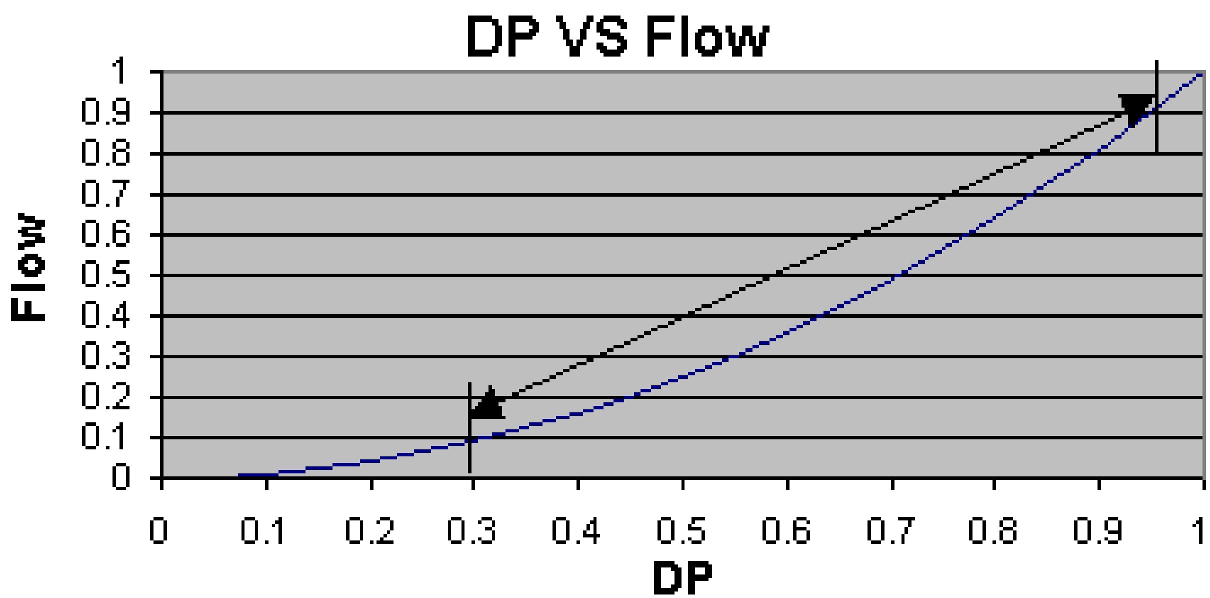
Pressure Recovery

The fraction of the orifice differential that is lost permanently depends upon **β** ratio.



Orifice Meter Limitations

RANGEABILITY:



Because of Sq. Root Relationship accuracy and readability become worse at decreased flow rates.

Orifice Meter Limitations CONTINUED

RANGEABILITY :

Solution:

To decrease this rangeability without loss in accuracy, two differential pressure transmitters with different ranges can be connected across Orifice Plate.

Orifice Meter Limitations CONTINUED

VARYING DISCHARGE COEFFICIENT AT LOW R_D

Below a Pipe R_D of about 20,000, the basic discharge coefficient changes markedly with R_D and hence with flow rate.

Solution:

For this reason Either

- It is not used below R_D 20,000. Or
- Specially designed to operate on flat portion of the curve (C_D VS R_D) with the realization that accuracy would somewhat reduced.

Orifice Meter Limitations CONTINUED

VARYING PROCESS CONDITIONS

As the Process flow conditions deviate from the design conditions, flow indications become inaccurate.

Solution:

To compensate this inaccuracy in the indication the correction factors are introduced into the flow measuring relation.

Correction Factors for Compressible Fluids

Pressure correction

$$Q_2 = \sqrt{\frac{P_2}{P_1}} \times Q_1$$

Temperature correction

$$Q_2 = \sqrt{\frac{T_1}{T_2}} \times Q_1$$

Molecular weight Correction

$$Q_2 = \sqrt{\frac{M_2}{M_1}} \times Q_1$$

Overall Correction

$$Q_2 = \sqrt{\frac{P_2 M_2 T_1}{P_1 M_1 T_2}} \times Q_1$$

Correction Factors for Compressible Fluids

EXAMPLES

CO_2 Flow to UR-1

Parameter	Design	Operating
Temp	95 F	95 F
Press	5 Psig	7 Psig
MW	44	43.65
Flow	510 KSCFH	533 KSCFH

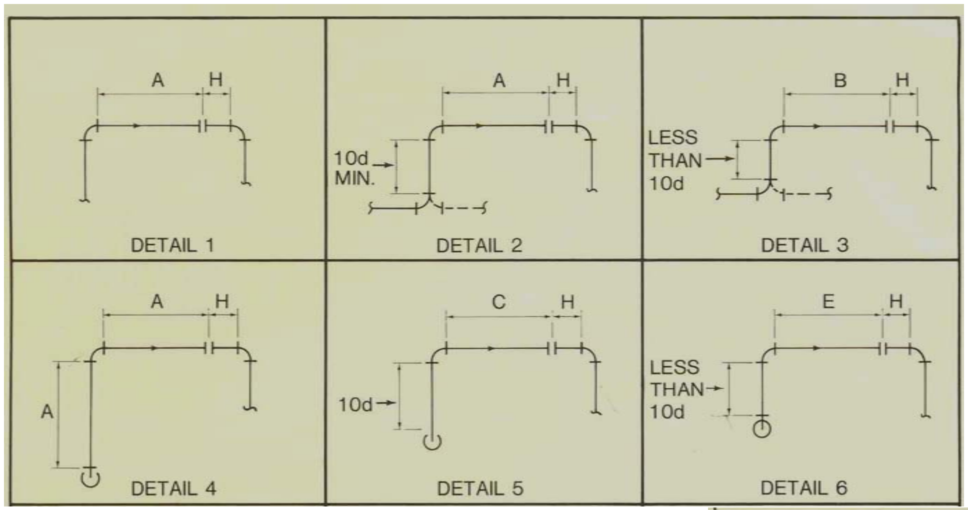
Correction Factors for Compressible Fluids

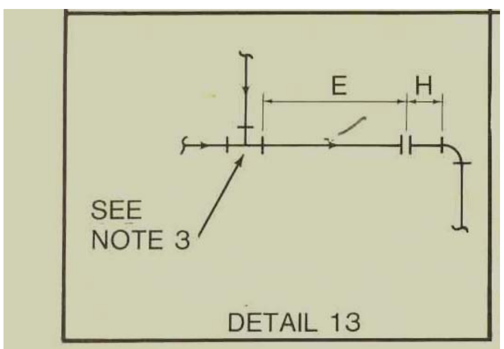
EXAMPLES

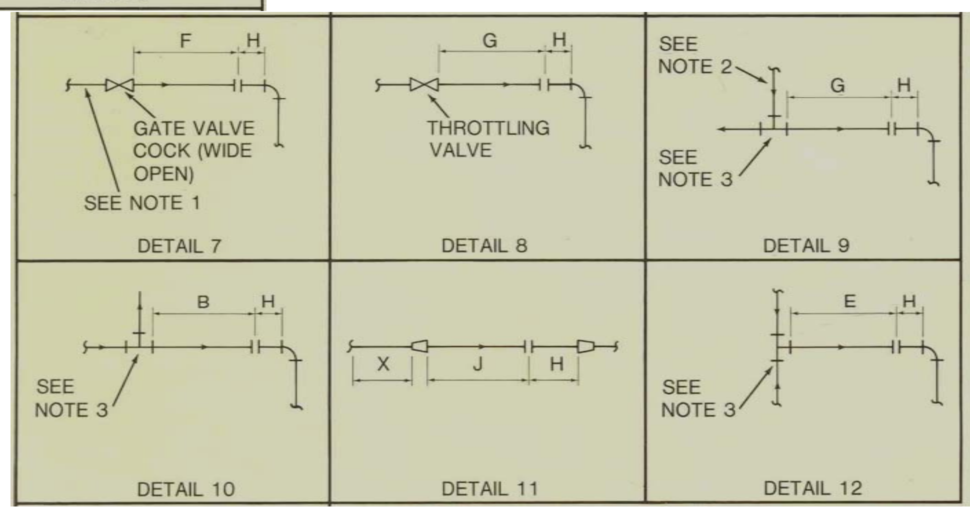
CO2 Flow to UR-2

Parameter	Design	Operating
MW	44	43.427
Flow	1280	1272

Straight Run Vs Fittings







Straight Run Vs Fittings

Table 1-2—d/D vs. Straight Run Required

d/D = Orifice ID / Actual Pipe ID (See Note 4)	Straight Run Required (Nominal Pipe Diameters) A	B	C	E	F	G	H	J
.8	20	25	33	40	14	50	5	15
.75	17	21	27	35	11	44	5	14
.7	14	19	23	31	9	39	5	13
.65	12	15	21	28	8	34	5	11
.6	10	14	19	25	8	31	5	10
.55	9	12	18	22	7	28	5	9
.5	8	10	17	21	7	25	5	8
.45	7	9	16	20	5	24	5	7
.4	7	9	15	18	5	22	5	7
.35	6	9	14	17	5	21	5	6
.3	6	9	14	16	5	20	5	6
.25	6	9	14	16	5	19	5	6

ORIFICE MTERE
CALCULATIONS

BASIC EQUATIONS

Liquid Flow>M_L=2834.53*D^2* β^2*C_d*F_a*$(Sp.g*H)^{1/2}$

Gas Flow>M_G=2834.53*D^2* β^2*C_d*F_a*Y_1*$(\rho*H)^{1/2}$

- C_d = Orifice plate coefficient of discharge
- D = Pipe ID calculated at Standard Conditions
- ρ = Density of Gas at reference conditions (Lb/Cu ft)
- H = Orifice differential pressure in inches of water at 60 degF
- $Q_{L,G}$ = Mass flow rate - Lb/hr.
- Y_1 = Expansion factor (upstream tap)
- F_a = Ratio of the Orifice bore area at operating conditions to those at 60 ^oF
- β =Ratio of Orifice Bore Dia to Pipe ID