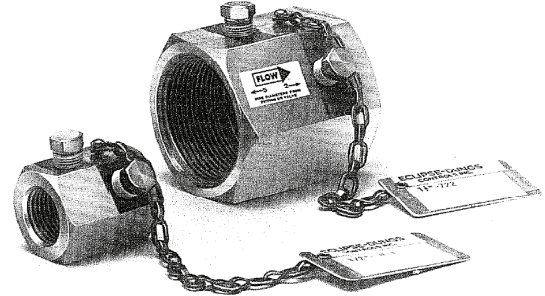


SBO and CO Gas Orifices Installation and Selection Manual

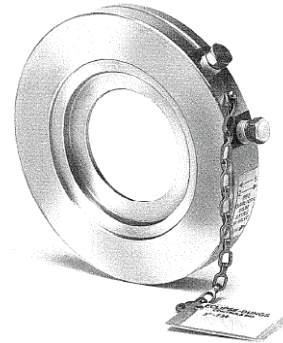
Screwed Brass Orifices (SBO) 1/2 - 2" NPT; rated 250 PSI

- Low cost metering device permits accurate setting of burner air and gas flow for optimum efficiency.
- +/- 1% accuracy depending on location, measurement accuracy and proper use of correction factors.
- One piece machined brass connection
- Includes brass hex-head screws to plug holes when measurements are not being taken.
- Metal tag chained to orifice clearly shows orifice pipe size and part number
- For temperatures up to 300 deg F.
- 1/8" NPT pressure taps.



Carbon Steel Orifices (CO) 2 1/2 - 24"; rated 250 PSI

- Low cost metering device permits accurate setting of burner air and gas flow for optimum efficiency.
- Can be socket-welded to pipes or mounted between flanges (Karl Dungs does not sell mating flanges).
- +/- 1% accuracy depending on location, measurement accuracy and proper use of correction factors.
- One piece zinc-plated, carbon steel.
- Includes brass hex-head screws to plug holes when measurements are not being taken.
- Metal tag chained to orifice clearly shows orifice pipe size and part number
- For temperatures up to 1200 deg F.
- 1/8" NPT pressure taps.



ATTENTION

- Read these instructions carefully.
- Failure to follow them and/or improper installation may cause explosion, property damage and injuries.
- Installation must be done with the supervision of a licensed burner technician.
- Check the ratings in the specifications to make sure that they are suitable for your application.
- Never perform work if gas pressure or power is applied, or in the presence of an open flame.
- Once installed, perform a complete checkout including leak testing.
- The system must be installed, used, and maintained to meet all applicable national and local code requirements such as but not limited to NFPA 70, NFPA 86, CSD-1, ANSI Z21.13, UL 795, NFPA 85, or CSA B149.3.

Sizing an Orifice

- Use the tables on pages 2 and 3 for sizing a threaded orifice. Use the tables on page 4 and 5 for sizing a flanged, carbon steel orifice.
- The tables show the air flow in SCFH in hundreds and the corresponding pressure drop in In. W.C.
- Select the orifice by either pressure drop or by flow. Apply correction factors where needed.

SCREWED BRASS ORIFICES (SBO)

Pipe Size NPT	Model Number	Pressure Drop ("W.C.)									
		1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1/2"	SBO-G-3	0.33	0.46	0.56	0.65	0.73	0.80	0.86	0.92	0.98	1.03
1/2"	SBO-H-1	0.54	0.76	0.94	1.08	1.21	1.32	1.43	1.53	1.62	1.71
1/2"	SBO-I-5	0.87	1.22	1.50	1.73	1.93	3.12	2.29	2.45	2.60	2.74
1/2"	SBO-J-7	2.14	3.02	3.70	4.27	4.77	5.23	5.65	6.04	6.41	6.75
1/2"	SBO-F-1	3.60	5.09	6.24	7.20	8.05	8.82	9.52	10.18	10.80	11.38
3/4"	SBO-K-1	0.16	0.22	0.27	0.31	0.35	0.38	0.41	0.44	0.47	0.49
3/4"	SBO-J-3	0.31	0.44	0.54	0.62	0.69	0.76	0.82	0.88	0.93	0.98
3/4"	SBO-A-1	0.52	0.73	0.89	1.03	1.15	1.26	1.36	1.46	1.55	1.63
3/4"	SBO-B-5	0.82	1.15	1.41	1.63	1.82	2.00	2.16	2.31	2.45	2.58
3/4"	SBO-C-3	1.19	1.68	2.06	2.38	2.66	2.91	3.15	3.37	3.57	3.76
3/4"	SBO-D-7	1.65	2.33	2.86	3.30	3.69	4.04	4.37	4.67	4.95	5.22
1"	SBO-X-1	1.59	2.25	2.75	3.18	3.56	3.89	4.21	4.50	4.77	5.03
1"	SBO-B-9	2.75	3.88	4.75	5.49	6.14	6.72	7.26	7.76	8.24	8.68
1"	SBO-C-5	3.85	4.92	6.03	6.96	7.78	8.52	9.21	9.84	10.44	11.00
1"	SBO-D-11	4.50	6.36	7.78	9.00	10.06	11.02	11.91	12.73	13.50	14.23
1"	SBO-E-3	5.76	8.15	9.89	11.52	12.88	14.11	15.24	16.29	17.28	18.21
1"	SBO-F-13	7.20	10.18	12.47	14.40	16.10	17.64	19.05	20.36	21.60	22.77
1-1/4"	SBO-396	2.90	4.09	5.01	5.79	6.47	7.09	7.66	8.19	8.69	9.15
1-1/4"	SBO-478	4.38	6.19	7.59	8.76	9.79	10.73	11.59	12.39	13.14	13.85
1-1/4"	SBO-585	7.00	9.90	12.12	14.00	15.65	17.15	18.52	19.80	21.00	22.14
1-1/4"	SBO-667	10.30	14.57	17.84	20.60	23.03	25.23	27.25	29.13	30.90	32.57
1-1/2"	SBO-440	3.55	5.02	6.15	7.10	7.94	8.70	9.39	10.04	10.64	11.23
1-1/2"	SBO-559	8.06	11.40	13.96	16.12	18.02	19.74	21.32	22.80	24.18	25.49
1-1/2"	SBO-628	10.84	15.33	18.78	21.68	24.24	26.55	28.68	30.66	32.52	34.28
1-1/2"	SBO-658	13.80	19.52	23.90	27.60	30.86	33.80	36.51	39.03	41.40	43.64
1-1/2"	SBO-722	16.80	23.76	29.10	33.60	37.57	41.15	44.45	47.52	50.40	53.13
2"	SBO-369	6.50	9.19	11.26	13.00	14.53	15.92	17.20	18.38	19.50	20.55
2"	SBO-448	7.94	11.23	13.75	15.88	17.75	19.45	21.01	22.46	23.82	25.11
2"	SBO-551	12.59	17.80	21.80	25.17	28.14	30.83	33.30	35.60	37.76	39.80
2"	SBO-621	16.89	23.88	29.25	33.77	37.76	41.36	44.67	47.76	50.66	53.40
2"	SBO-677	23.50	33.23	40.70	47.00	52.55	57.56	62.18	66.47	70.50	74.31

Flows for all are air (1.0 S.G.) at 60 degrees F. sea level (14.7 PSI) with a supply pressure to the orifice of 1 PSIG. See CORRECTION FACTOR CALCULATION on page 5 for other pressures and temperatures.

SCREWED BRASS ORIFICES (SBO)

Pipe Size NPT	Model Number	Pressure Drop ("W.C.)					Beta Ratio	Head Loss	Bore Diameter (in) +/- 0.001"
		12.0	14.0	16.0	18.0	20.0			
1/2"	SBO-G-3	1.13	1.22	1.30	1.38	1.45	0.301	89%	0.151
1/2"	SBO-H-1	1.87	2.02	2.16	2.29	2.41	0.402	87%	0.201
1/2"	SBO-I-5	3.00	3.24	3.46	3.67	3.86	0.500	85%	0.250
1/2"	SBO-J-7	7.40	7.99	8.54	9.06	9.55	0.703	73%	0.352
1/2"	SBO-F-1	12.47	13.47	14.40	15.27	16.10	0.804	63%	0.402
3/4"	SBO-K-1	0.54	0.58	0.62	0.66	0.69	0.152	90%	0.114
3/4"	SBO-J-3	1.07	1.16	1.24	1.32	1.39	0.227	90%	0.170
3/4"	SBO-A-1	1.78	1.93	2.06	2.18	2.30	0.300	89%	0.225
3/4"	SBO-B-5	2.82	3.05	2.26	3.46	3.64	0.380	87%	0.285
3/4"	SBO-C-3	4.12	4.45	4.76	5.05	5.32	0.455	85%	0.341
3/4"	SBO-D-7	5.72	6.17	6.60	7.00	7.38	0.531	83%	0.398
1"	SBO-X-1	5.51	5.95	6.36	6.75	7.11	0.417	80%	0.417
1"	SBO-B-9	9.51	10.27	10.98	11.65	12.28	0.536	79%	0.536
1"	SBO-C-5	12.06	13.02	13.92	14.76	15.56	0.596	76%	0.596
1"	SBO-D-11	15.59	16.84	18.00	19.09	20.12	0.655	73%	0.655
1"	SBO-E-3	19.95	21.55	23.04	24.44	25.76	0.715	65%	0.715
1"	SBO-F-13	24.94	26.94	28.80	30.55	32.20	0.775	58%	0.775
1-1/4"	SBO-396	10.03	10.83	11.58	12.28	12.95	0.430	82%	0.538
1-1/4"	SBO-478	15.17	16.39	17.52	18.58	19.59	0.520	76%	0.650
1-1/4"	SBO-585	24.25	26.19	28.00	29.70	31.30	0.634	65%	0.793
1-1/4"	SBO-667	35.68	38.54	41.20	43.70	46.06	0.725	55%	0.906
1-1/2"	SBO-440	12.30	13.28	14.20	15.06	15.88	0.410	78%	0.615
1-1/2"	SBO-559	27.92	30.16	32.24	34.20	36.05	0.602	67%	0.903
1-1/2"	SBO-628	37.55	40.56	46.36	45.99	48.48	0.677	58%	1.016
1-1/2"	SBO-658	47.80	51.63	55.20	58.55	61.72	0.738	47%	1.107
1-1/2"	SBO-722	58.20	62.86	67.20	71.28	75.13	0.776	42%	1.164
2"	SBO-369	22.52	24.32	26.00	27.58	29.07	0.392	84%	0.784
2"	SBO-448	27.50	29.71	31.76	33.69	35.51	0.479	78%	0.958
2"	SBO-551	43.60	47.09	50.34	53.39	26.28	0.590	68%	1.180
2"	SBO-621	58.49	63.18	67.54	71.64	75.51	0.665	60%	1.330
2"	SBO-677	21.41	87.93	94.00	99.40	105.10	0.725	48%	1.450

Flow CFH of Air in Hundreds

$$\text{Beta} = \frac{\text{Bore Diameter}}{\text{Pipe OD}}$$

Head loss is the pressure loss caused by the orifice as a percentage of the measured pressure drop. Flows for all are air (1.0 S.G.) at 60 degrees F. sea level (14.7 PSI) with a supply pressure to the orifice of 1 PSIG. See CORRECTION FACTOR CALCULATION on page 5 for other pressures and temperatures.

CARBON STEEL ORIFICES

Pressure Drop ("W.C.)

Pipe Size NPT	Model Number	Pressure Drop ("W.C.)									
		1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
2-1/2"	CO-708-2.5	29.40	41.60	50.90	58.80	65.70	72.00	77.80	83.20	88.20	93.00
2-1/2"	CO-810-2.5	44.40	62.80	76.90	88.80	99.30	108.80	117.50	125.60	133.20	140.40
3"	CO-653-3	96.50	51.60	63.20	73.00	81.60	89.40	96.60	103.20	109.50	115.40
3"	CO-734-3	49.80	70.40	86.30	99.60	111.40	122.00	131.80	140.90	149.40	157.50
3"	CO-794-3	64.20	90.80	111.20	128.40	143.60	157.30	169.90	181.60	192.60	203.00
4"	CO-619-4	56.40	79.80	97.70	112.80	126.10	138.20	149.20	159.50	169.20	178.40
4"	CO-712-4	80.40	113.70	139.30	160.80	179.80	196.90	212.70	227.40	241.20	254.20
4"	CO-804-4	115.20	162.90	199.50	230.40	257.60	282.20	304.80	325.80	345.60	364.30
5"	CO-750-5	146.50	207.20	253.70	293.00	327.60	358.90	387.60	414.40	439.50	463.30
6"	CO-575-6	110.00	155.60	190.5	220.00	246.00	269.40	291.00	311.10	330.00	347.90
6"	CO-750-6	210.00	297.00	363.7	420.00	469.60	514.40	555.60	594.00	630.00	664.10
8"	CO-800-8	450.00	366.40	779.4	900.0	1,006.2	1,102.3	1,190.6	1,272.8	1,350.0	1,423.0
10"	CO-775-10	625.00	883.90	1,082.5	1,250.0	1,397.5	1,530.9	1,653.6	1,767.8	1,875.0	1,976.4
12"	CO-792-12	960.00	1,357.6	1,662.8	1,920.0	2,146.6	2,351.5	2,539.9	2,715.3	2,880.0	3,035.8
14"	CO-800-14	1,200.0	1,697.1	2,078.5	2,400.0	2,683.3	2,939.4	3,174.9	3,394.1	3,600.0	3,794.7
16"	CO-800-16	1,585.0	2,241.5	2,745.3	3,170.0	3,544.2	3,882.4	4,193.5	4,483.1	4,755.0	5,012.2
18"	CO-800-18	2,040.0	2,885.0	3,533.4	4,080.0	4,561.6	4,997.0	5,397.3	5,770.0	6,120.0	6,451.0
20"	CO-800-20	2,520.0	3,563.8	4,364.8	5,040.0	5,634.9	6,172.7	6,667.3	7,127.6	7,560.0	7,968.9
24"	CO-800-24	3,540.0	5,006.3	6,131.5	7,080.0	7,195.7	8,671.2	9,366.0	10,012.6	10,620.0	11,194.5

Flow CFH of Air in Hundreds

CARBON STEEL ORIFICES

Pressure Drop ("W.C.)

Pipe Size NPT	Model Number	Pressure Drop ("W.C.)					Beta Ratio	Head Loss	Bore Diameter (in) +/- 0.001"	
		12.0	14.0	16.0	18.0	20.0				
2-1/2"	CO-708-2.5	101.80	110.00	117.60	124.70	131.50	0.708	45%	1.750	
2-1/2"	CO-810-2.5	153.80	166.10	177.60	188.40	198.60	0.810	20%	2.000	
3"	CO-653-3	Flow CFH of Air in Hundreds	126.40	136.60	146.00	154.90	163.20	0.653	57%	2.000
3"	CO-734-3		172.50	186.30	199.20	211.30	222.70	0.734	40%	2.250
3"	CO-794-3		222.40	240.20	256.80	272.40	287.10	0.794	30%	2.437
4"	CO-619-4	195.40	211.00	225.60	239.30	252.20	0.619	60%	2.500	
4"	CO-712-4	278.50	300.80	321.60	341.10	359.60	0.712	45%	2.875	
4"	CO-804-4	399.10	431.00	400.80	488.80	515.20	0.804	22%	3.225	
5"	CO-750-5	507.50	548.20	586.00	621.50	655.20	0.750	32%	3.750	
6"	CO-575-6	381.10	411.60	440.00	466.70	491.90	0.575	66%	3.481	
6"	CO-750-6	727.50	785.70	840.00	891.00	939.10	0.750	32%	4.550	
8"	CO-800-8	1,558.8	1,683.7	1,800.0	1,909.2	2,012.5	0.800	25%	6.380	
10"	CO-775-10	2,165.1	2,338.5	2,500.0	2,651.7	2,795.1	0.775	28%	7.750	
12"	CO-792-12	3,325.5	3,592.0	3,840.0	4,072.9	4,293.3	0.792	25%	9.500	
14"	CO-800-14	4,156.9	4,490.0	4,800.0	5,091.2	5,366.6	0.800	25%	10.600	
16"	CO-800-16	5,490.6	5,930.5	6,340.0	6,724.6	7,088.3	0.800	25%	12.200	
18"	CO-800-18	7,066.8	7,633.0	8,160.0	8,655.0	9,123.2	0.800	25%	13.800	
20"	CO-800-20	8,729.5	9,429.0	10,080.0	10,690.0	11,269.8	0.800	25%	15.400	
24"	CO-800-24	12,262.9	13,245.5	14,160.0	15,018.9	15,831.4	0.800	25%	18.300	

$$\text{Beta} = \frac{\text{Bore Diameter}}{\text{Pipe OD}}$$

Head loss is the pressure loss caused by the orifice as a percentage of the measured pressure drop.

CORRECTION FACTOR CALCULATION

Flows in the table are for air (1.0 s.g.) at 60°F., sea level (14.7 PSIG), with a supply pressure to the orifice of 1 PSIG. To correct to other conditions, use the following formula:

Corrected Flow =

$$\text{Flow From Table} \times \sqrt{\frac{520}{460 + ^\circ\text{F}} \times \frac{1}{\text{s.g.}} \times \frac{\text{PSIA} + \text{PSIG}}{15.7}}$$

Where:

- °F = gas temp. through orifice
- s.g. = specific gravity of gas
- PSIA = barometric pressure
- PSIG - Supply pressure to orifice

Use these figure to estimate the barometric pressure at various altitudes:

Sea Level	14.7 PSIA
1000'	14.2 PSIA
2000'	13.7 PSIA
3000'	13.2 PSIA
4000'	12.7 PSIA
5000'	12.2 PSIA
6000'	11.8 PSIA
7000'	11.3 PSIA

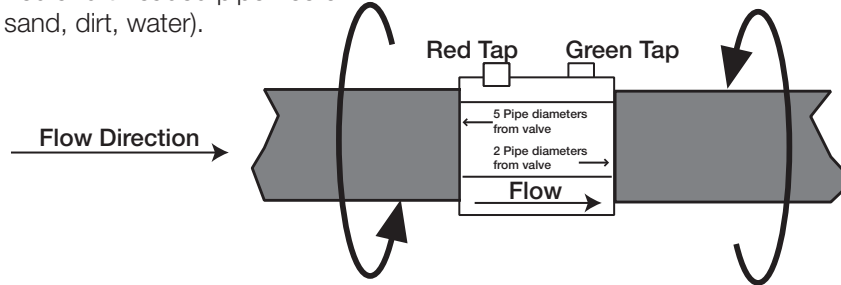
To correct for specific gravity only:

Multiple the flow from the table by:

Natural gas, 0.60 s.g.	1.29
Propane, 1.56 s.g.	0.80
Butane, 2.00 s.g.	0.71
Propane/Air, 1.29 s.g.	0.88
Coke Oven gas, 0.45 s.g.	1.49

Installation of SBO Orifices

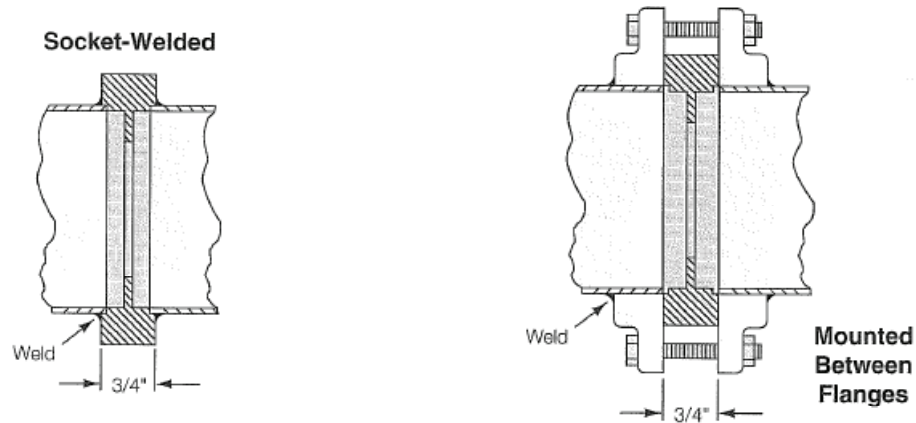
- Position the gas orifice so that that the red pressure tap is on the high pressure side.
- For maximum accuracy, laminar flow (streamline flow) is required upstream the gas orifice. There is a minimum straight run of pipe required downstream the gas orifice. For +/- 1% accuracy, 1/4" to 4" orifices require a minimum length of 5 pipe diameters upstream and 2 pipe diameters downstream. For the 5" orifices and larger, the minimum is 10 pipe diameters upstream and 4 pipe diameters downstream. Slightly better greater accuracy can be achieved by using the information and charts on page 7.
- Use new, properly reamed and threaded pipe free of chips and debris (e.g. sand, dirt, water).
- Apply good quality pipe sealant, putting a moderate amount on the male threads only. Wipe away any excess after threading the pipe into the gas orifice. If using LP gas, use pipe sealant rated for use with LP gas.
- Do not thread pipe too far or overtighten the pipe. Follow the maximum torque values listed below. Distortion and/or leakage may result from excess pipe in the thread.
- After installation is complete, perform a leak test using soapy water.



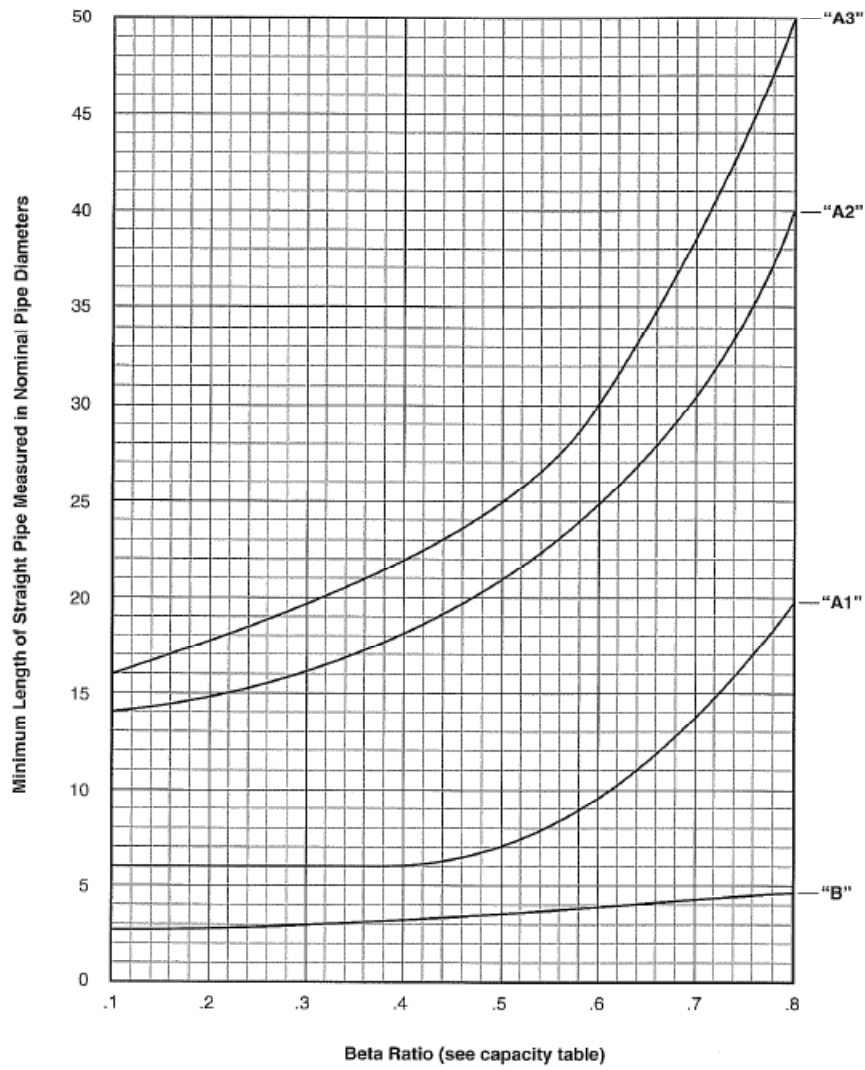
NPT	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2 1/2"
Tmax [lb-in]	443	752	1106	1770	1991	2213	2876

Installation of CO Orifices

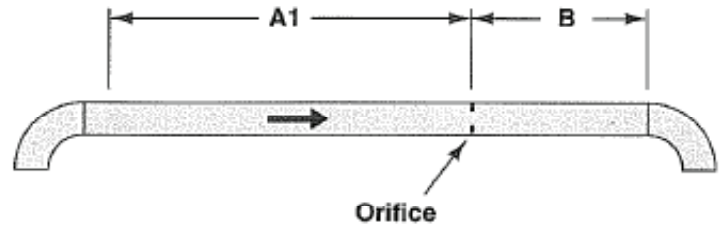
- Position the gas orifice so that that the red pressure tap is on the high pressure side.
- For maximum accuracy, there is a minimum straight run of pipe required upstream and downstream of the gas orifice. See page 3 for these requirements.
- If welding the gas orifice directly to the pipe, apply the weld to the area as shown in the figure "socket weld".
- If mounting the gas orifice between two welded flanges, apply the weld to the area as shown in the figure "Mounted Between Flanges".



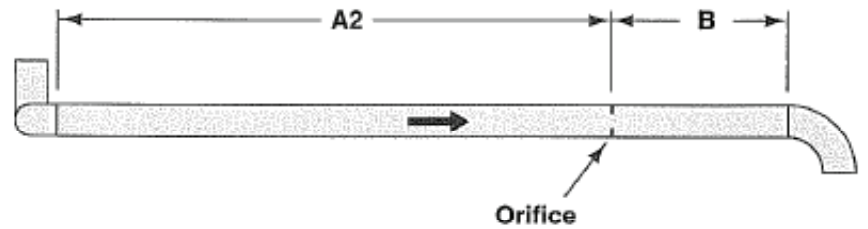
Straight Pipe Lengths Required for Greatest Accuracy



**Single Elbow
Upstream of Orifice**



**Two Elbows
In Different Planes
Upstream of Orifice**



**Valve or Regulator
Upstream of Orifice**

