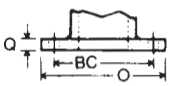
TECH TIP #43

PIPE FLANGE DIMENSIONS

CLASS 125 CAST IRON FLANGES

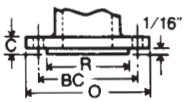
ANSI STANDARD B16.1



Nominal Pipe Size	Diameter of Flange O	Thickness of Flange (Min.) Q	Diameter of Bolt Circle BC	Number of Bolts	Diameter of Bolts	Diameter of Bolt Holes	Length of Bolts
1	4.25	0.44	3.12	4	0.50	0.62	1.75
1¼	4.62	0.50	3.50	4	0.50	0.62	2.00
1½	5.00	0.56	3.88	4	0.50	0.62	2.00
2	6.00	0.62	4.75	4	0.62	0.75	2.25
2½	7.00	0.69	5.50	4	0.62	0.75	2.50
3	7.50	0.75	6.00	4	0.62	0.75	2.50
3½	8.50	0.81	7.00	8	0.62	0.75	2.75
4	9.00	0.94	7.50	8	0.62	0.75	3.00
5	10.00	0.94	8.50	8	0.75	0.88	3.00
6	11.00	1.00	9.50	8	0.75	0.88	3.25
8	13.50	1.12	11.75	8	0.75	0.83	3.50
10	16.00	1.19	14.25	12	0.88	1.00	3.75
12	19.00	1.25	17.00	12	0.88	1.00	3.75
14	21.00	1.38	18.75	12	1.00	1.12	4.25
16	23.50	1.44	21.25	16	1.00	1.12	4.50
18	25.00	1.56	22.75	16	1.12	1.25	4.75
20	27.50	1.69	25.00	20	1.12	1.25	5.00
24	32.00	1.88	29.50	20	1.25	1.38	5.50
30	38.75	2.12	36.00	28	1.25	1.38	6.25
36	46.00	2.38	42.75	32	1.50	1.62	7.00

CLASS 150 STEEL FLANGES

ANSI STANDARD B16.5

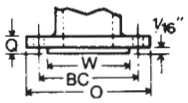


Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange (Min.) C	Diameter of Raised Face R	Diameter of Bolt Circle BC	Number of Bolt-Studs	Diameter of Bolt-Studs	Diameter of Bolt Holes	Length Bolt-Studs with 2 Nuts
2	6.00	0.62	3.62	4.75	4	⅝	0.75	3.25
2½	7.00	0.69	4.12	5.50	4	⅝	0.75	3.50
3	7.50	0.75	5.00	6.00	4	⅝	0.75	3.50
4	9.00	0.94	6.19	7.50	8	⅝	0.75	3.50
5	10.00	0.94	7.31	8.50	8	¾	0.88	3.75
6	11.00	1.00	8.50	9.50	8	¾	0.88	4.00
8	13.50	1.12	10.62	11.75	8	¾	0.88	4.25
10	16.00	1.19	12.75	14.25	12	⅞	1.00	4.50
12	19.00	1.25	15.00	17.00	12	⅞	1.00	4.75
14	21.00	1.38	16.25	18.75	12	1	1.12	5.25
16	23.50	1.44	18.50	21.25	16	1	1.12	5.25
18	25.00	1.56	21.00	22.75	16	1⅛	1.25	5.75
20	27.50	1.69	23.00	25.00	20	1⅛	1.25	6.25
24	32.00	1.88	27.25	29.50	20	1¼	1.38	6.75

BOLT HOLES: Drilling templates are in multiples of four with bolt holes straddling the center lines. The 1/16" raised face is included in the minimum thickness of Class 150 steel flanges.

CLASS 250 CAST IRON FLANGES

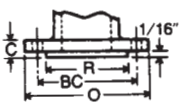
ANSI STANDARD B16.1



Nominal Pipe Size	Diameter of Flange O	Thickness of Flange (Min.) Q	Diameter of Raised Face W	Diameter of Bolt Circle BC	Number of Bolts	Diameter of Bolts	Diameter of Bolt Holes	Length of Bolts
2	6.50	0.88	4.19	5.00	8	0.62	0.75	2.75
2½	7.50	1.00	4.94	5.88	8	0.75	0.88	3.25
3	8.25	1.12	5.69	6.62	8	0.75	0.88	3.50
3½	9.00	1.19	6.31	7.25	8	0.75	0.88	3.50
4	10.00	1.25	6.94	7.88	8	0.75	0.88	3.75
5	11.00	1.38	8.31	9.25	8	0.75	0.88	4.00
6	12.50	1.44	9.69	10.62	12	0.75	0.88	4.00
8	15.00	1.62	11.94	13.00	12	0.88	1.00	4.50
10	17.50	1.88	14.06	15.25	16	1.00	1.12	5.25
12	20.50	2.00	16.44	17.75	16	1.12	1.25	5.50

CLASS 300 STEEL FLANGES

ANSI STANDARD B16.5



Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange (Min.) C	Diameter of Raised Face R	Diameter of Bolt Circle BC	Number of Bolt-Studs	Diameter of Bolt-Studs	Diameter of Bolt Holes	Length Bolt-Studs with 2 Nuts
1½	6.12	0.81	2.88	4.50	4	¾	0.88	3.75
2	6.50	0.88	3.62	5.00	8	⅝	0.75	3.50
2½	7.50	1.00	4.12	5.88	8	¾	0.88	4.00
3	8.25	1.12	5.00	6.62	8	¾	0.88	4.25
4	10.00	1.25	6.19	7.88	8	¾	0.88	4.50
5	11.00	1.38	7.31	9.25	8	¾	0.88	4.75
6	12.50	1.44	8.50	10.62	12	¾	0.88	4.75
8	15.00	1.62	10.62	13.00	12	⅞	1.00	5.50
10	17.50	1.88	12.75	15.25	16	1	1.12	6.25
12	20.50	2.00	15.00	17.75	16	1⅛	1.25	6.75
14	23.00	2.12	16.25	20.25	20	1⅛	1.25	7.00
16	25.50	2.25	18.50	22.50	20	1¼	1.38	7.50
18	28.00	2.38	21.00	24.75	24	1¼	1.38	7.75
20	30.50	2.50	23.00	27.00	24	1¼	1.38	8.00
24	36.00	2.75	27.25	32.00	24	1½	1.62	9.00

The 1/16" raised face is included in the minimum thickness of Class 300 steel flanges.

Courtesy of Stockham Valves & Fittings

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TECH TIP #44

PIPE PRESSURE AND TEMPERATURE DESIGN LIMITS

2004 ASHRE Systems and Equipment Handbook

Table 5 Application of Pipe, Fittings, and Valves for Heating and Air Conditioning

Application	Pipe Material	Weight	Joint Type	Fitting Class	Fitting Material	System Temperature, °F	System Maximum Pressure at Temperature[a], psig
Recirculating Water	Steel (CW)	Standard	Thread	125	Cast iron	250	125
2 in. and smaller	Copper, hard	Type L	Braze or silver solder[b]		Wrought copper	250	200
	PVC	Sch 80	Solvent	Sch 80	PVC	75	
	CPVC	Sch 80	Solvent	Sch 80	CPVC	150	
	PB	SDR-11	Heat fusion		PB	160	
			Insert crimp		Metal	160	
2.5 to 12 in.	A53 B ERW Steel	Standard	Weld	Standard	Wrought steel	250	400
			Flange	150	Wrought steel	250	250
			Flange	125	Cast iron	250	175
			Flange	250	Cast iron	250	400
			Groove		MI or ductile iron	230	300
	PB	SDR-11	Heat fusion		PB	160	
Steam and Condensate	Steel (CW)	Standard[c]	Thread	125	Cast iron		90
2 in. and smaller			Thread	150	Malleable iron		90
	A53 B ERW Steel	Standard[c]	Thread	125	Cast iron		100
			Thread	150	Malleable iron		125
	A53 B ERW Steel	XS	Thread	250	Cast iron		200
			Thread	300	Malleable iron		250
2.5 to 12 in.	Steel	Standard	Weld	Standard	Wrought steel		250
			Flange	150	Wrought steel		200
			Flange	125	Cast iron		100
	A53 B ERW Steel	XS	Weld	XS	Wrought steel		700
			Flange	300	Wrought steel		500
			Flange	250	Cast iron		200
Refrigerant	Copper, hard	Type L or K	Braze		Wrought copper		
	A53 B SML Steel	Standard	Weld		Wrought steel		
Underground Water							
Through 12 in.	Copper, hard	Type K	Braze or silver solder[b]		Wrought copper	75	350
Through 6 in.	Ductile iron	Class 50	MJ	MJ	Cast iron	75	250
	PB	SDR 9, 11	Heat fusion		PB	75	
		SDR 7, 11.5	Insert crimp		Metal	75	
Potable Water, Inside Building	Copper, hard	Type L	Braze or silver solder[b]		Wrought copper	75	350
	Steel, galvanized	Standard	Thread	125	Galv. cast iron	75	125
				150	Galv. mall. iron	75	125
	PB	SDR-11	Heat fusion		PB	75	
			Insert crimp		Metal	75	

[a] Maximum allowable working pressures have been derated in this table. Higher system pressures can be used for lower temperatures and smaller pipe sizes. Pipe, fittings, joints, and valves must all be considered.

[b] Lead- and antimony-based solders should not be used for potable water systems. Brazing and silver solders should be employed.

[c] Extra strong pipe is recommended for all threaded condensate piping to allow for corrosion.

From Chapter 41, "Pipes, Tubes and Fittings", Page 41.6

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TECH TIP #44 (Cont)

STANDARD STEEL PIPE (SCH 40)

Nominal Size, Inches	WEIGHT, LBS. PER FT.		Wall Thickness, Inches	DIAMETER		Threads Per Inch	COUPLINGS			TEST PRESSURES, PSI *
	Threaded & Coupled	Plain End		Outside, Inches	Inside, Inches		Length, Inches	Outside Diameter, Inches	Wt. Per Piece, Pounds	A 53
1/8	.24	.24	.068	.405	.269	27	13/16	.563	.03	700
1/4	.42	.42	.088	.540	.364	18	1 3/16	.719	.07	700
3/8	.57	.57	.091	.675	.493	18	1 3/16	.875	.09	700
1/2	.85	.85	.109	.840	.622	14	1 9/16	1.063	.17	700
3/4	1.13	1.13	.113	1.050	.824	14	1 5/8	1.313	.26	700
1	1.68	1.68	.133	1.315	1.049	11 1/2	2	1.576	.40	700
1 1/4	2.28	2.27	.140	1.660	1.380	11 1/2	2 1/16	1.900	.48	1000
1 1/2	2.73	2.72	.145	1.900	1.610	11 1/2	2 1/16	2.200	.67	1000
2	3.68	3.65	.154	2.375	2.067	11 1/2	2 1/8	2.750	1.05	1000
2 1/2	5.82	5.79	.203	2.875	2.469	8	3 1/8	3.250	2.09	1000
3	7.62	7.58	.216	3.500	3.068	8	3 1/4	4.000	3.35	1000
3 1/2	9.20	9.11	.226	4.000	3.548	8	3 3/8	4.625	4.82	1200
4	10.89	10.79	.237	4.500	4.026	8	3 1/2	5.000	4.61	1200

EXTRA STRONG STEEL PIPE (SCH 80)

Nominal Size, Inches	WEIGHT, LBS. PER FT.		Wall Thickness, Inches	DIAMETER		Threads Per Inch	COUPLINGS			TEST PRESSURES, PSI *
	Threaded & Coupled	Plain End		Outside, Inches	Inside, Inches		Length, Inches	Outside Diameter, Inches	Wt. Per Piece, Pounds	A 53
1/8	.31	.31	.095	.405	.215	27	1 1/16	.563	.04	850
1/4	.54	.54	.119	.540	.302	18	1 5/8	.719	.09	850
3/8	.74	.74	.126	.675	.423	18	1 5/8	.875	.13	850
1/2	1.09	1.09	.147	.840	.546	14	2 1/8	1.063	.24	850
3/4	1.48	1.47	.154	1.050	.742	14	2 1/8	1.313	.34	850
1	2.18	2.17	.179	1.315	.957	11 1/2	2 5/8	1.576	.54	850
1 1/4	3.02	3.00	.191	1.660	1.278	11 1/2	2 3/4	2.054	.03	1300
1 1/2	3.66	3.63	.200	1.900	1.500	11 1/2	2 3/4	2.200	.90	1300
2	5.07	5.02	.218	2.375	1.939	11 1/2	2 7/8	2.875	1.86	1300
2 1/2	7.73	7.66	.276	2.875	2.323	8	4 1/8	3.375	3.27	1300
3	10.33	10.25	.300	3.500	2.900	8	4 1/4	4.000	4.09	1300
3 1/2	12.63	12.51	.318	4.000	3.364	8	4 3/8	4.625	5.92	1700
4	15.17	14.98	.337	4.500	3.826	8	4 1/2	5.200	7.59	1700

* Test pressures are pressures used at the mill for leak checks. See previous page for pressure limit guides.

TECH TIP #44 (Cont)

PVC & CPVC PIPE PRESSURE LIMITS

ESLON THERMOPLASTICS

Pressure/Temperature Relationship

MAXIMUM OPERATING PRESSURE — PSI (WATER @ 73°F)

Nominal Pipe Size (IPS)	Schedule 40 PVC and CPVC	Schedule 80 PVC			Schedule 80 CPVC	SDR Pressure Rated Pipe[4] PVC Plain and Belled End		
	Plain & Belled[1]	Plain End	Threaded[2]	Roll Grooved	Plain End[3]	SDR 26	SDR 21	SDR 13.5
¼"	NA	1130	NA	NA	NA	NA	NA	NA
½"	600	850	420	NA	850	NA	NA	315
¾"	480	690	340	NA	690	NA	200	–
1"	450	630	320	NA	630	NA	200	–
1¼"	370	520	260	NA	520	160	200	–
1½"	330	470	240	NA	470	160	200	–
2"	280	400	200	400	400	160	200	–
2½"	300	420	210	420	420	160	200	–
3"	260	370	190	370	370	160	200	–
4"	220	320	160	320	320	160	200	–
5"	190	290	NR	290	290	160	200	–
6"	180	280	NR	280	280	160	200	–
8"	160	250	NR	250	250	160	200	–
10"	140	230	NR	230	230	160	200	–
12"	130	230	NR	230	230	160	200	–
14"	130	220	NR	220	NA	160	200	–
16"	130	220	NR	220	NA	160	200	–

(NR-Not Recommended)
(NA-Not Available)

1. Threading Schedule 40 and SDR/PR pipe is not recommended.
2. Threading Schedule 80 pipe above 4" is not recommended.
3. CPVC threaded connections should be avoided when possible at elevated temperatures and pressures. (Consult factory.)
4. Standard dimensional ratio pipe (SDR) will carry the same pressure rating for all diameters according to the SDR number.

The operating pressures listed above are based on the hydrostatic design of the product using water as a test medium at 73°F. Compounding nomenclature for Eslon PVC is PVC 1120 with a cell class of 12454-B. For Eslon CPVC pipe it is CPVC 4120 with a cell class of 23447-A.

For schedule-rated products and SDR/PR pipe, the following equation was used to determine operating pressures for outside diameter controlled pipe:

$$P = \frac{2ST}{D - T}$$

Where: **P** = pressure (PSI)
D = average outside diameter
T = minimum wall thickness
S = hydrostatic design stress (HDS)
for Eslon PVC Type I, Grade 1,
HDS = 2,000 PSI
Eslon CPVC also = 2,000 PSI

The following temperature corrections must be used to derate all PVC and CPVC pipe, valves and fittings when operating temperatures are expected to exceed 73°F.

The working pressure of PVC and CPVC pipe is directly affected by temperature changes. When the operating temperature of the pipe increases, the pipe loses its stiffness and tensile strength decreases. A drop in pressure capacity results. The drop can be calculated using this chart. Multiply the pipe's maximum working pressure by the temperature correction factor for a known temperature.

Example: For 2" Schedule 80 PVC pipe, the maximum working pressure is 400 psi. If the operating temperature is known to be 110°F, the correction factor can be found on the chart to be 0.50. The adjusted pressure would then be 400 × 0.50 = 200 psi.

TEMPERATURE CORRECTION FACTORS

Operating Temperature (°F)	70	80	90	100	110	115	120	125	130	140	150	160	170	180	200
PVC 1120	1.00	.88	.75	.62	.50	.45	.40	.35	.30	.22	Not Recommended				
CPVC 4120	1.00	1.00	.91	.82	.77	.74	.65	.66	.62	.50	.47	.40	.32	.25	.20

CAUTION: Eslon Thermoplastics does not recommend its products for use in air or compressed gas systems.

7

TECH TIP #45

SOLDERED FITTINGS AND VALVES

SOLDERS AND WORKING PRESSURES

The table of maximum working pressures below reflects what is generally considered as good engineering practice under reasonably constant and favorable conditions, i.e., pressures which are fairly steady, absence of particularly corrosive media, etc. Unusual conditions require increased safety factors and therefore lower working pressures should be used.

RATED INTERNAL WORKING PRESSURES OF PIPING SYSTEMS MADE OF COPPER WATER TUBE AND SOLDERED FITTINGS—POUNDS PER SQUARE INCH

SOLDER USED IN JOINTS	SERVICE TEMP. DEG. F.	WATER (a) COPPER WATER TUBE—NOMINAL SIZES ¼" to 1" Incl.	1 ¼" to 2" Incl.	2 ½" to 4" Incl.	5" to 8" Incl.	10" to 12" Incl.	SATURATED STEAM ALL
50-50 Tin-Lead (b) Also applies for the 40% tin—60% lead alloy	100	200	175	150	130	100	—
	150	150	125	100	90	70	--
	200	100	90	75	75	50	—
	250	85	75	50	50	40	15 (f)
95-5 Tin-Antimony or 95-5 Tin-Lead (c)	100	500	400	300	150	150	—
	150	400	350	275	150	150	—
	200	300	250	200	150	140	—
	250	200	175	150	140	110	15 (f)
Brazing Alloys (Melting at or above 1000° F.)	250 (d)	300	210	170	150	150	—
	350	270	190	150	150	150	120 (e)

(a) Including other noncorrosive liquids and gases.

(b) ASTM B32, Alloy Grade 50A.

(c) ASTM B32, Alloy Grade 5A.

(d) For service temperatures lower than 250° F., the solders as above may be used.

(e) This pressure is determined by the temperature of saturated steam at 120 lb. pressure or 350° F.

(f) This pressure is determined by the temperature of saturated steam at 15 lb. pressure or 250° F.

NOTE: The values shown are based on data in the National Bureau of Standards Publications, "Building Materials and Structures Reports BMS 58 and BMS 83". The table is from data published by the Copper and Brass Research Association.

INNOVATION IN EVERY VALVE

MILWAUKEE VALVE

7

TECH TIP #46

STEAM PIPE SIZING GUIDE

Did you realize that steam travels at speeds around 82 mph in the average industrial plant piping system?

Did you realize that if you size your steam piping in an office area like the industrial plants, you would have some very upset secretaries complaining about noise? To keep the velocity noise to an acceptable level in a institutional or school setting steam supply piping is generally sized at about 80 ft/sec or 55 mph.

Did you realize that changing the operating pressure of a steam boiler from a engineering design of 125 psi to say 20 psi changes the steam exit velocity from 2850 feet per minute (47.5 ft per sec) to over 11,000 feet per minute (183 ft per sec).....talk about wet steam, the "carryover" of water with the steam at the lower operating pressure will cause major problems all throughout the system. We can help you with your steam system questions.

Did you realize the pipe size and layout is extremely important at the boiler steam supply outlet nozzle. Boiler manufacturers use very specific criteria to size the supply nozzle based on the capacity and operating pressure. The steam velocity at the nozzle must be kept between the 50-80 ft/sec to maintain dry steam.

Remember, if the question is about steam....Call the steam experts in Oklahoma for over 90 years, Federal Corporation.

ADVANCED TECHTIPS.....Look over the following information from the leaders in steam system components, Spirax Sarco. Contact our office and request Spirax Sarco's fantastic engineering handbook, "Hook-ups". It's free to our customers..... $50.00 a copy to our competitors.

Table 1: Steam Pipe Sizing for Steam Velocity

Capacity of Sch. 80 Pipe in lb/hr steam

Pressure psi	Velocity ft/sec	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	5"	6"	8"	10"	12"
5	50	12	26	45	70	100	190	280	410	760	1250	1770	3100	5000	7100
	80	19	45	75	115	170	300	490	710	1250	1800	2700	5200	7600	11000
	120	29	60	110	175	245	460	700	1000	1800	2900	4000	7500	12000	16500
10	50	15	35	55	88	130	240	365	550	950	1500	2200	3770	6160	8500
	80	24	52	95	150	210	380	600	900	1500	2400	3300	5900	9700	13000
	120	35	72	135	210	330	590	850	1250	2200	3400	4800	9000	14400	20500
20	50	21	47	82	123	185	320	520	740	1340	1980	2900	5300	8000	11500
	80	32	70	120	190	260	520	810	1100	1900	3100	4500	8400	13200	18300
	120	50	105	190	300	440	840	1250	1720	3100	4850	6750	13000	19800	28000
30	50	26	56	100	160	230	420	650	950	1650	2600	3650	6500	10500	14500
	80	42	94	155	250	360	655	950	1460	2700	3900	5600	10700	16500	23500
	120	62	130	240	370	570	990	1550	2100	3950	6100	8700	16000	25000	35000
40	50	32	75	120	190	260	505	790	1100	1900	3100	4200	8200	12800	18000
	80	51	110	195	300	445	840	1250	1800	3120	4900	6800	13400	20300	28300
	120	75	160	290	460	660	1100	1900	2700	4700	7500	111000	19400	30500	42500
60	50	43	95	160	250	360	650	1000	1470	2700	3900	5700	10700	16500	24000
	80	65	140	250	400	600	1000	1650	2400	4400	6500	9400	17500	27200	38500
	120	102	240	410	610	950	1660	2600	3800	6500	10300	14700	26400	41000	58000
80	50	53	120	215	315	460	870	1300	1900	3200	5200	7000	13700	21200	29500
	80	85	190	320	500	730	1300	2100	3000	5000	8400	12200	21000	33800	47500
	120	130	290	500	750	1100	1900	3000	4200	7800	12000	17500	30600	51600	71700
100	50	63	130	240	360	570	980	1550	2100	4000	6100	8800	16300	26500	35500
	80	102	240	400	610	950	1660	2550	3700	6400	10200	14600	26000	41000	57300
	120	150	350	600	900	1370	2400	3700	5000	9100	15000	21600	38000	61500	86300
120	50	74	160	290	440	660	1100	1850	2600	4600	7000	10500	18600	29200	41000
	80	120	270	450	710	1030	1800	2800	4150	7200	11600	16500	29200	48000	73800
	120	175	400	680	1060	1520	2850	4300	6500	10700	17500	26000	44300	70200	97700
150	50	90	208	340	550	820	1380	2230	3220	5500	8800	12900	22000	35600	50000
	80	145	320	570	900	1250	2200	3400	4900	8500	14000	20000	35500	57500	79800
	120	215	450	850	1280	1890	3400	5300	7500	13400	20600	30000	55500	85500	120000
200	50	110	265	450	680	1020	1780	2800	4120	7100	11500	16300	28500	45300	64000
	80	180	410	700	1100	1560	2910	4400	6600	11000	18000	26600	46000	72300	100000
	120	250	600	1100	1630	2400	4350	6800	9400	16900	25900	37000	70600	109000	152000

TECH TIP #47

FRICTION LOSS CHARTS FOR WATER IN PIPES

Pipe friction is the resistance to flow created by the interior surface of the pipe through which a liquid is moving. The smaller the diameter of the pipe, or the greater the rate of flow, the greater the amount of friction (friction loss).

Friction loss is expressed as feet of head in 100 feet of pipe and will vary depending upon the material of which the pipe is made. The following charts show friction losses in steel, copper and plastic pipe.

Loss of Head in Feet, Due to Friction Per 100 Feet of Pipe

These data are for new pipe. Increase by 15% to compensate for aging.

½"			
Flow U.S. Gal. Min.	Steel ID .622"	Copper ID .625"	Plastic ID .622"
0.5	.582	.35	.314
1.0	2.10	1.26	1.14
1.5	4.44	2.67	2.38
2.0	7.57	4.56	4.10
2.5	11.4	6.88	6.15
3.0	16.0	9.66	8.65
3.5	21.3	12.9	11.5
4.0	27.3	16.4	14.8
4.5	33.9	20.4	18.3
5.0	41.2	24.8	22.2
5.5	49.2	29.5	26.6
6.0	57.8	34.8	31.2
6.5	67.0	40.2	36.2
7.0	76.8	46.1	41.5
7.5	87.3	52.5	47.2
8.0	98.3	59.4	53.0
8.5	110.0	66.0	59.5
9.0	122.0	73.5	66.0
9.5	135.0	81.0	73.0
10.0	149.0	89.4	80.5

¾"			
Flow U.S. Gal. Min.	Steel ID .824"	Copper ID .822"	Plastic ID .824"
1.5	1.13	.70	.61
2.0	1.93	1.21	1.04
2.5	2.91	1.82	1.57
3.0	4.08	2.56	2.21
3.5	5.42	3.4	2.93
4.0	6.94	4.36	3.74
4.5	8.63	5.4	4.66
5.0	10.5	6.57	5.66
6.0	14.7	9.22	7.95
7.0	19.6	12.2	10.6
8.0	25.0	15.7	13.5
9.0	31.1	19.5	16.8
10.0	37.8	23.7	20.4
11.0	45.1	28.2	24.4
12.0	53.0	33.2	28.6
13.0	61.5	38.5	33.2
14.0	70.5	44.2	38.0
16.0	90.2	56.6	48.6
18.0	112.0	70.4	60.5
20.0	136.0	83.5	73.5

1"			
Flow U.S. Gal. Min.	Steel ID 1.049"	Copper ID 1.062"	Plastic ID 1.049"
2	.595	.345	.322
3	1.26	.732	.680
4	2.14	1.24	1.15
5	3.42	1.88	1.75
6	4.54	2.63	2.45
8	7.73	4.50	4.16
10	11.7	6.77	6.31
12	16.4	9.47	8.85
14	21.8	12.6	11.8
16	27.9	16.2	15.1
18	34.7	20.1	18.7
20	42.1	24.4	22.8
22	50.2	28.8	27.1
24	59.0	34.0	31.9
26	68.4	39.7	36.9
28	78.5	45.5	42.5
30	89.2	51.6	48.1
35	119.0	68.7	64.3
40	152.0	88.0	82.0
45	189.0	109.0	102.0

1 ¼"			
Flow U.S. Gal. Min.	Steel ID 1.380"	Copper ID 1.368"	Plastic ID 1.380"
4	.564	.364	.304
5	.853	.545	.460
6	1.20	.765	.649
7	1.59	1.02	.360
8	2.04	1.31	1.10
10	3.08	1.98	1.67
12	4.31	2.75	2.33
14	5.73	3.64	3.10
16	7.34	4.68	3.96
18	9.13	5.81	4.93
20	11.1	7.10	6.00
25	16.8	10.7	9.06
30	23.5	15.0	12.7
35	31.2	20.0	16.9
40	40.0	25.6	21.6
50	60.4	38.7	32.6
60	84.7	54.1	45.5
70	114.0	72.2	61.5
80	144.0	92.4	77.9
90	179.0	115.0	96.6

1 ½"			
Flow U.S. Gal. Min.	Steel ID 1.61"	Copper ID 1.60"	Plastic ID 1.61"
4	.267	.165	.144
6	.565	.358	.305
8	.962	.611	.520
10	1.45	.923	.786
12	2.04	1.29	1.10
14	2.71	1.71	1.46
16	3.47	2.2	1.87
18	4.31	2.75	2.33
20	5.24	3.31	2.83
25	7.90	5.00	4.26
30	11.1	7.00	6.0
35	14.7	9.35	7.94
40	18.9	12.0	10.2
45	23.4	14.9	12.63
50	28.5	18.1	15.4
55	34.0	21.5	18.35
60	40.0	25.3	21.6
65	46.4	29.0	25.1
70	53.2	33.8	28.7
75	60.4	38.0	32.6
80	68.1	43.1	36.8
85	76.2	47.6	41.2
90	84.7	53.6	45.7
95	93.6	58.8	50.5
100	103.0	65.1	56.6

Courtesy of Sta-Rite Pumps

TECH TIP #47 (Cont.)

FRICTION LOSS CHARTS

Loss of Head in Feet, Due to Friction Per 100 Feet of Pipe

These data are for new pipe. Increase by 15% to compensate for aging.

2"			
Flow U.S. Gal. Min.	Steel ID 2.067"	Copper ID 2.062"	Plastic ID 2.067"
10	.431	.268	.233
15	.916	.569	.495
20	1.55	.962	.839
25	2.35	1.45	1.27
30	3.29	2.03	1.78
35	4.37	2.71	2.36
40	5.60	3.47	3.03
45	6.96	4.31	3.76
50	8.46	5.24	4.57
55	10.1	6.22	5.46
60	11.9	7.34	6.44
70	15.8	9.78	8.53
80	20.2	12.5	10.9
90	25.1	15.6	13.6
100	30.5	18.9	16.5
110	36.4	22.5	19.7
120	42.7	26.6	23.1
130	49.6	30.7	26.8
140	56.9	35.2	30.6
150	64.7	40.1	35.0
160	72.8	45.1	39.3
170	81.4	50.5	44.0
180	90.5	56.1	48.9
190	100.	62.0	54.0
200	110.	68.0	59.4

2½"			
Flow U.S. Gal. Min.	Steel ID 2.469"	Copper ID 2.500"	Plastic ID 2.469"
20	.654	.375	.353
30	1.39	.792	.750
40	2.36	1.35	1.27
50	3.56	2.04	2.92
60	4.99	2.86	2.69
70	6.64	3.82	3.58
80	8.50	4.88	4.59
90	10.6	6.06	5.72
100	12.8	7.37	6.90
110	15.3	8.80	8.25
120	18.0	10.3	9.71
130	20.9	12.0	11.3
140	23.9	13.7	12.9
150	27.3	15.6	14.7
160	30.7	17.6	16.6
170	34.3	19.7	18.5
180	38.1	21.9	20.6
190	42.1	24.2	22.7
200	46.3	26.6	25.0
220	55.3	31.8	29.8
240	66.4	37.4	35.8
260	75.3	43.3	41.6
280	86.3	49.4	46.6
300	98.1	56.8	52.9

3"			
Flow U.S. Gal. Min.	Steel ID 3.067"	Copper ID 2.985"	Plastic ID 3.067"
10	.1		
15	.1		
20	.2	.132	.125
25	.3	.193	.188
30	.5	.275	.260
35	.7	.346	.335
40	.9	.448	.435
45	1.0	.576	.525
50	1.3	.723	.650
60	1.9	.942	.880
70	2.5	1.56	1.15
80	3.3	1.96	1.45
90	4.1	2.05	1.82
100	4.9	2.37	2.20
110	6.0	2.81	2.63
120	6.9	3.34	3.20
130	8.1	3.82	3.65
140	9.3	4.85	4.20
150	10.6	5.60	4.65
175	12.3	6.85	5.80
200	18.0	8.94	7.80
225	22.0	10.6	9.40
250	27.0	12.9	11.8
275	32.0	15.0	13.7
300	38.0	16.5	15.8
350	49.0	22.4	21.6
400		29.1	
450		45.1	
500		54.4	
550		65.1	
600			

4"			
Flow U.S. Gal. Min.	Steel ID 4.025"	Copper ID 3.936"	Plastic ID 4.025"
20	.06		
25	.09		
30	.13		
35	.18		
40	.22	.126	.111
45	.28	.152	.148
50	.34	.172	.166
60	.46	.236	.225
70	.62	.341	.294
80	.79	.41	.38
90	1.0	.52	.48
100	1.2	.65	.59
110	1.4	.72	.70
120	1.7	.89	.82
130	1.9	.97	.94
140	2.2	1.23	1.09
150	2.5	1.41	1.22
175	3.4	1.82	1.60
200	4.3	2.40	2.04
225	5.5	2.95	2.50
250	6.6	3.55	3.20
275	7.8	3.95	3.70
300	9.0	4.58	4.30
350	11.8	5.63	5.40
400	16.0	7.28	6.90
450	19.0	9.16	8.60
500	24.0	11.2	10.2
550	29.0	13.5	12.1
600	33.8	16.0	14.0
650		18.4	16.5
700		21.5	18.8

Courtesy of Sta-Rite Pumps

TECH TIP #47 (Cont.)

FRICTION LOSS CREATED BY PIPE FITTINGS

The friction created by fittings is expresed as the equivalent length of straight pipe. For example, the loss through a 1" regular 90° ELL is equal to that created by 5.2 feet of straight 1" steel pipe. Determine total friction by combining fitting loss with pipe loss.

Equivalent Length of Straight Pipe for Various Fittings. Turbulent Flow Only.

FITTINGS			¼	⅜	½	¾	1	1¼	1½	2	2½	3	4
Regular 90° Ell	Screwed	Steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
		C. I.										9.0	11.0
	Flanged	Steel			.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4	5.9
		C. I.										3.6	4.8
Long Radius 90° Ell	Screwed	Steel	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.6	4.0	4.6
		C. I.										3.3	3.7
	Flanged	Steel			1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4	4.2
		C. I.										2.8	3.4
Regular 45° Ell	Screwed	Steel	.34	.52	.71	.92	1.3	1.7	2.1	2.7	3.2	4.0	5.5
		C. I.										3.3	4.5
	Flanged	Steel			.45	.59	.81	1.1	1.3	1.7	2.0	2.6	3.5
		C. I.										2.1	2.9
Tee-Line Flow	Screwed	Steel	.79	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12.0	17.0
		C. I.										9.9	14.0
	Flanged	Steel			.69	.82	1.0	1.3	1.5	1.8	1.9	2.2	2.8
		C. I.										1.9	2.2
Tee-Branch Flow	Screwed	Steel	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12.0	13.0	17.0	21.0
		C. I.										14.0	17.0
	Flanged	Steel			2.0	2.6	3.3	4.4	5.2	6.6	7.5	9.4	12.0
		C. I.										7.7	10.0
180° Return Bend	Screwed	Steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
		C. I.										9.0	11.0
	Flanged	Steel			.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4	5.9
		C. I.										3.6	4.8
	Long Rad. Flanged	Steel			1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4	4.2
		C. I.										2.8	3.4
Globe Valve	Screwed	Steel	21.0	22.0	22.0	24.0	29.0	37.0	42.0	54.0	62.0	79.0	110.0
		C. I.										65.0	86.0
	Flanged	Steel			38.0	40.0	45.0	54.0	59.0	70.0	77.0	94.0	120.0
		C. I.										77.0	99.0
Gate Valve	Screwed	Steel	.32	.45	.56	.67	.84	1.1	1.2	1.5	1.7	1.9	2.5
		C. I.										1.6	2.0
	Flanged	Steel								2.6	2.7	2.8	2.9
		C. I.										2.3	2.4
Angle Valve	Screwed	Steel	12.8	15.0	15.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0
		C. I.										15.0	15.0
	Flanged	Steel			15.0	15.0	17.0	18.0	18.0	21.0	22.0	28.0	38.0
		C. I.										23.0	31.0
Swing Check Valve	Screwed	Steel	7.2	7.3	8.0	8.8	11.0	13.0	15.0	19.0	22.0	27.0	38.0
		C. I.										22.0	31.0
	Flanged	Steel			3.8	5.3	7.2	10.0	12.0	17.0	21.0	27.0	38.0
		C. I.										22.0	31.0
Coupling or Union	Screwed	Steel	.14	.18	.21	.24	.29	.36	.39	.45	.47	.53	.65
		C. I.										.44	.52
	Bell Mouth Inlet	Steel	.04	.07	.10	.13	.18	.26	.31	.43	.52	.67	.95
		C. I.										.55	.77
	Square Mouth Inlet	Steel	.44	.68	.96	1.3	1.8	2.6	3.1	4.3	5.2	6.7	9.5
		C. I.										5.5	7.7
	Re-entrant Pipe	Steel	.88	1.4	1.9	2.6	3.6	5.1	6.2	8.5	10.0	13.0	19.0
		C. I.										11.0	15.0
	Sudden Enlargement	$b = \frac{(V_1 - V_2)^2}{2g}$ FEET OF FLUID; IF $V_2 = 0$ $b = \frac{V_1^2}{2g}$ FEET OF FLUID											

Courtesy of Sta-Rite Pumps

TECH TIP #48

NATURAL GAS PIPE SIZING

CAPACITY OF PIPE—NATURAL GAS (CFH)

With Pressure Drop of 0.3" and Specific Gravity of 0.60

Pipe Length In Feet	Pipe Size—Inches (IPS)								
	½	¾	1	1¼	1½	2	2½	3	4
10	132	278	520	1050	1600	3050	4800	8500	17500
20	92	190	350	730	1100	2100	3300	5900	12000
30	73	152	285	590	890	1650	2700	4700	9700
40	63	130	245	500	760	1450	2300	4100	8300
50	56	115	215	440	670	1270	2000	3600	7400
60	50	105	195	400	610	1150	1850	3250	6800
70	46	96	180	370	560	1050	1700	3000	6200
80	43	90	170	350	530	990	1600	2800	5800
90	40	84	160	320	490	930	1500	2600	5400
100	38	79	150	305	460	870	1400	2500	5100
125	34	72	130	275	410	780	1250	2200	4500
150	31	64	120	250	380	710	1130	2000	4100
175	28	59	110	225	350	650	1050	1850	3800
200	26	55	100	210	320	610	980	1700	3500

MULTIPLIERS USED WITH ABOVE TABLE

Use When Specific Gravity is not 0.60

Specific Gravity	Multiplier
0.50	1.10
0.55	1.04
0.60	1.00
0.65	.962
0.70	.926
0.75	.895
0.80	.867
0.85	.841

Specific Gravity	Multiplier
0.90	.817
1.00	.775
PROPANE-AIR	
1.10	.740
1.20	.707
1.30	.680
1.40	.655
1.50	.632

Specific Gravity	Multiplier
PROPANE	
1.55	.622
1.60	.612
1.70	.594
1.80	.577
1.90	.565
BUTANE	
2.00	.547

Pressure Drop not 0.3"

Pressure Drop	Multiplier
0.1	.577
0.2	.815
0.3	1.00
0.5	1.29
1.0	1.83
2.0	2.58
3.0	3.16
4.0	3.65

NOTES

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