Pipe Fitters Handbook

Compliments of

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GRUVLOK COUPLINGS FOR GROOVED END IPS PIPE

Gruvlok couplings for grooved end pipe are available in various nominal pipe sizes. The variety of coupling designs provides a universal means for the connection of pipe, pipe fittings, and other pipe system components.
The wide assortment of GRUVLOK couplings and gasket styles permits selection of the most suitable combination for a specific application, thus providing the most versatile and economical pipe system installation.

Material Specifications

Housing:
Malleable Iron conforming to ASTM A-47
or
Ductile Iron conforming to ASTM A-536

Coatings:
Rust inhibiting paint - color: RED
Hot Dipped Zinc Galvanize
For other coating requirements contact Grinnell

Gaskets:
Elastomers with properties as designated by ASTM D-2000 for each gasket grade.

Bolts and Nuts:
Heat treated, oval-neck track head bolts and heavy hex nuts of carbon steel conforming to ASTM A-183 with a minimum tensile strength of 110,000 psi.
Bolts and nuts are provided electroplated as standard. Stainless steel bolts and nuts are also available.
Contact GRINNELL for details.

General Coupling Data Chart Notes

1	2	3	4	5	6		7			8		9
Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Wk. Pressure PSI MPa	Max. End Load Lbs. N	Range of Pipe End Separation Inches mm	Deflection from ℄		Coupling Dimensions			Coupling Bolts		Approx. Wt. Ea. Lbs. kg.
					Per Coupling Degrees	Pipe in./ft. mm/meter	X	Y	Z	Quantity	Size Inches mm	
							Inches Millimeters					

1 Gruvlok couplings are identified by Nominal Pipe Size.

2 IPS Outside Diameter.

3 Maximum line pressure, including surge, to which a joint should be subjected. Working pressure ratings are based on standard wall steel pipe with standard cut grooves in accordance with Gruvlok specifications on page 26. For Performance Data on other than standard pipe, refer to page 51. **Note: for one time field test only** the maximum joint working pressure may be increased to 1-1/2 times the figure shown.

4 Maximum end load from all internal and/or external forces to which the joint can be subjected based on standard wall steel pipe with standard cut grooves in accordance with Gruvlok specification on page 49 .

5 Range of pipe end separation normally available on the standard cut grooved pipe. The maximum linear movement at the coupling joint is the difference between maximum and minimum pipe end separations. For standard roll groove steel pipe reduce the value by 50%.

6 Maximum allowable deflection of pipe from centerline when using standard cut grooved steel pipe. For standard roll grooved steel pipe reduce the values by 50%.

7 "X", "Y", and "Z" are external dimensions for reference purposes only.

8 The quantity of bolts equals the number of housing segments per coupling

9 Approximate weight for fully assembled coupling with gasket, bolts, and nuts.

Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Wk. Pressure PSI MPa	Max. End Load Lbs. N	Range of Pipe End Separation inches mm	Deflection from ℄ Per Coupling Degrees	Deflection from ℄ Pipe in./ft. mm/meter	Coupling Dimensions X Inches Millimeters	Coupling Dimensions Y Inches Millimeters	Coupling Dimensions Z Inches Millimeters	Coupling Bolts Qty	Coupling Bolts Size Inches mm	Approx. Wt. Ea. Lbs. kg.
1 25	1.315 33.7	1000 6.8	1354 6025	0-⅛ 0-3.2	5°-26'	1.14 95.1	2½ 63.5	4⅛ 104.8	1⅞ 47.6	2	⅜x2 9.5x50.8	1.4 0.6
1¼ 32	1.660 42.4	1000 6.8	2164 9630	0-⅛ 0-3.2	4°-19'	0.91 75.5	2¾ 69.9	4 101.6	1⅞ 47.6	2	⅜x2 9.5x50.8	2.1 1.0
1½ 40	1.900 48.3	1000 6.8	2835 12617	0-⅛ 0-3.2	3°-46'	0.79 65.8	3 76.2	4¼ 108.0	1⅞ 47.6	2	⅜x2 9.5x50.8	2.2 1.0
2 50	2.375 60.3	1000 6.8	4430 19714	0-⅛ 0-3.2	3°-1'	0.63 52.7	3⅝ 92.1	5⅞ 149.2	1⅞ 47.6	2	½x2¾ 12.7x69.9	2.9 1.3
2½ 65	2.875 76.1	1000 6.8	6492 28889	0-⅛ 0-3.2	2°-29'	0.52 43.4	4¼ 108.0	6⅜ 161.9	1⅞ 47.6	2	½x2¾ 12.7x69.9	3.1 1.4
3.0" OD 65	3.000 76.1	1000 6.8	7069 31457	0-⅛ 0-3.2	2°-23'	0.50 41.6	4⅜ 111.1	6½ 165.1	1⅞ 47.6	2	½x2¾ 12.7x69.9	3.4 1.5
3 80	3.500 88.9	1000 6.8	9621 42814	0-⅛ 0-3.2	2°-3'	0.43 35.8	4⅞ 123.8	7⅛ 181.0	1⅞ 47.6	2	½x2¾ 12.7x69.9	3.7 1.7
3½ ▲	4.000 ▲	1000 6.8	12566 55920	0-⅛ 0-3.2	1°-48'	0.38 31.4	5¼ 133.4	8 203.2	1⅞ 47.6	2	⅝x3¼ 15.9x82.6	5.1 2.3
4 100	4.500 114.3	1000 6.8	15904 70774	0-¼ 0-6.4	3°-11'	0.67 55.6	6¼ 158.8	8⅝ 219.1	2 50.8	2	⅝x3¼ 15.9x82.6	6.3 2.9
5 125	5.563 139.7	1000 6.8	24306 108160	0-¼ 0-6.4	2°-35'	0.54 45.1	7¼ 184.2	10½ 266.7	2 50.8	2	¾x4¼ 19.1x108.0	10.8 4.9
6 150	6.625 168.3	1000 6.8	34472 153399	0-¼ 0-6.4	2°-10'	0.45 37.8	8⅝ 219.1	11¾ 298.5	2 50.8	2	¾x4¼ 19.1x108.0	13.3 6.0
6.5" OD 150	6.500 165.1	1000 6.8	33183 147664	0-¼ 0-6.4	2°-12'	0.46 38.4	8½ 215.9	11⅝ 295.3	2 50.8	2	¾x4¼ 19.1x108.0	13.3 6.0
8 200	8.625 219.1	800 5.4	46741 207997	0-¼ 0-6.4	1°-40'	0.35 29.1	11 279.4	14¾ 365.1	2⅜ 60.3	2	⅞x5 22.2x127.0	20.4 9.3
10 250	10.750 273.0	800 5.4	72610 323115	0-¼ 0-6.4	1°-20'	0.28 23.3	13⅛ 333.4	17 431.8	2⅝ 66.7	2	1x5½ 25.4x139.7	26.6 12.1
12 300	12.750 323.9	800 5.4	102141 454528	0-¼ 0-6.4	1°-7'	0.23 19.5	15½ 393.7	19⅛ 485.8	2⅝ 66.7	2	1x6 25.4x152.4	33.0 15.0
14 350	14.000 355.6	300 2.0	46181 205507	0-¼ 0-6.4	1°-2'	0.22 18.0	16⅛ 409.6	20½ 520.7	3 76.2	2	1x6 25.4x152.4	37.1 16.8
16 400	16.000 406.4	300 2.0	60319 268418	0-¼ 0-6.4	0°-54'	0.19 15.7	18⅛ 460.4	22⅞ 581.0	3 76.2	4	1x5½ 25.4x139.7	50.4 22.9
18 ▲	18.000 ▲	300 2.0	76341 339716	0-¼ 0-6.4	0°-48'	0.17 14.0	21⅛ 536.6	25⅜ 644.5	3⅛ 79.4	4	1x5½ 25.4x139.7	71.7 32.5
20 500	20.000 508.0	300 2.0	94248 419403	0-¼ 0-6.4	0°-43'	0.15 12.5	23 584.2	28¼ 717.6	3⅛ 79.4	4	1⅛x5½ 28.6x139.7	82.1 37.2
24 600	24.000 609.6	300 2.0	135717 603940	0-¼ 0-6.4	0°-36'	0.13 10.5	27 685.8	32⅜ 822.3	3⅛ 79.4	4	1⅛x5½ 28.6x139.7	90.0 40.8
28" ID ▲	28.875 733.4	150 1.0	98226 431104	0-¼ 0-6.4	0°-30'	0.11 8.7	33½ 800.1	35½ 901.7	3⅛ 79.4	6	1x5½ 25.4x139.7	105.0 47.6
30" ID ▲	31.000 787.4	150 1.0	113215 503807	0-¼ 0-6.4	0°-28'	0.10 8.1	33¾ 857.3	38¼ 971.6	3⅝ 92.1	6	1x5½ 25.4x139.7	137.0 62.1

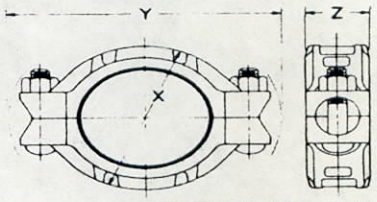
For chart notes refer to page 6

Working Pressure, End Load, Pipe End Separation and Deflection values are based on standard steel pipe with standard cut grooves in accordance with Gruvlok specifications.

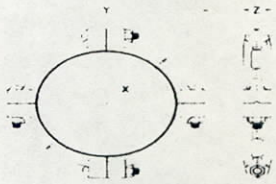
For standard Roll Groove steel pipe reduce the values for pipe end separation and deflection by 50%.

▲ No equivalent metric pipe size.

Fig. 7001 STANDARD



SIZES 1" - 14"



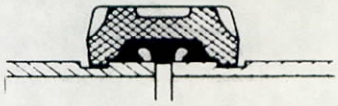
SIZES 16" - 24"

The Fig. 7001 Standard coupling is designed for a wide range of applications: Commercial/Industrial Construction, Mining, Process piping, and many others. The housing design allows for optimum strength without excessive casting weight. The Fig. 7001 coupling has a working pressure rating up to 1000 psi (6.9 MPa). For stainless steel and aluminum coupling requirements contact Grinnell.

Fig. 7001 with Standard Gasket

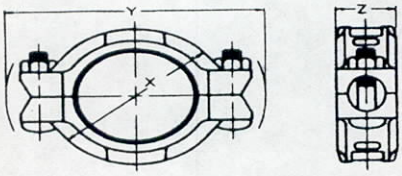
(Standard gasket is used in Figs. 7000, 7001, 7003, & 7004 couplings.)

Fig. 7001 with "Flush Gap™" Gasket



("Flush Gap" gasket is available for use in Figs. 7000, 7001, 7003, and 7004 couplings.)
Beveled end pipe must not be used with "Flush Gap" gaskets.

Fig. 7007 Rigidlok™

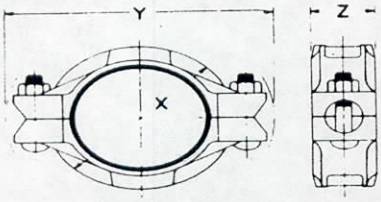


The Fig. 7007 Rigidlok™ Coupling brings reliable pipe joint rigidity to grooved piping systems. The combined actions of the unique housing and innovative bolt hole offset designs firmly grip the pipe providing a secure rigid joint over a wide range of pipe and service conditions. The Fig. 7007 Rigidlok™ Coupling allows for working pressure ratings to 1000 PSI (6.8MPa).

Fig. 7007 Rigidlok™ Coupling (Patent Pending)

Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Wk. Press. PSI Mpa	Max. End Load Lbs. N	Fixed Pipe End Separation Inches mm	Coupling Dimensions X	Y	Z	Coupling Bolts Qty.	Size Inches mm	Approx. Wt. Ea. Lbs. kg.
					Inches Millimeters					
1½ 40	1.900 48.3	1000 6.8	2830 12600	0.09 2.3	3 76.2	4⅞ 123.8	1⅞ 47.6	2	⅜x2 9.5x50.8	1.8 0.8
2 50	2.375 60.3	1000 6.8	4425 19700	0.06 1.5	3½ 88.9	5⅞ 149.2	1⅞ 47.6	2	½x2½ 12.7x69.9	2.7 1.2
2½ 65	2.875 76.1	1000 6.8	6490 28890	0.06 1.5	4 101.6	6½ 165.1	1⅞ 47.6	2	½x2½ 12.7x69.9	3.1 1.4
3 80	3.500 88.9	1000 6.8	9620 42800	0.06 1.5	4¾ 120.7	7 177.8	1⅞ 47.6	2	½x2¾ 12.7x69.9	3.7 1.6
4 100	4.500 114.3	800 5.5	12720 56600	0.20 5.1	5⅞ 149.2	8⅜ 212.7	2⅛ 54.0	2	½x2¾ 12.7x69.9	5.0 2.2
5 125	5.563 139.7	800 5.5	19440 86530	0.20 5.1	7 177.8	10⅛ 257.2	2⅛ 54.0	2	⅝x3¼ 15.9x82.6	6.9 3.1
6 150	6.625 168.3	800 5.5	27570 122650	0.20 5.1	8⅛ 206.4	11⅛ 282.6	2⅛ 54.0	2	⅝x3¼ 15.9x82.6	7.9 3.5
8 200	8.625 219.1	600 4.1	35050 155990	0.23 5.8	10½ 266.7	14⅛ 358.8	2⅝ 66.7	2	¾x4¼ 19.1x108.0	15.9 7.2
10 250	10.750 273.0	500 3.4	45380 201940	0.16 4.1	12⅞ 327.0	17⅛ 435.0	2⅝ 66.7	2	1x6 25.4x152.4	25.9 11.8
12 300	12.750 323.9	400 2.7	51070 227260	0.23 5.8	15 381.0	19⅛ 485.8	2⅝ 66.7	2	1x6 25.4x152.4	30.5 13.8

Fig. 7000 COUPLING



The Fig. 7000 Coupling is designed for applications requiring moderate internal pressures or where weight is a factor.
The Fig. 7000 Coupling is approximately 50% lighter in weight than the Fig. 7001 Coupling, and allows for working pressure ratings up to 500 psi (3.4 MPa)

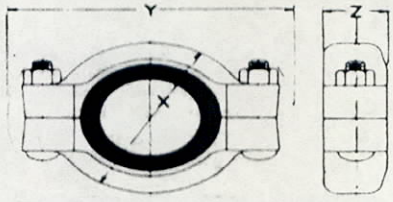
Fig. 7000 Coupling

Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Wk. Pressure PSI Mpa	Max. End Load Lbs. N	Range of Pipe End Separation Inches mm	Deflection from ℄ Per Coupling Degrees	Pipe in./ft. mm/meter	Coupling Dimensions X	Y	Z	Coupling Bolts Qty	Size Inches mm	Approx. Wt. Ea. Lbs. kg.
							Inches Millimeters					
1 25	1.315 33.7	500 3.4	679 3022	0-⅛ 0-3.2	5°-26'	1.14 95.1	2⅜ 60.3	3¾ 95.3	1⅞ 47.6	2	⅜x2 9.5x50.8	1.3 0.6
1¼ 32	1.660 42.4	500 3.4	1082 4815	0-⅛ 0-3.2	4°-19'	0.91 75.5	2¾ 69.9	4 101.6	1⅞ 47.6	2	⅜x2 9.5x50.8	1.4 0.6
1½ 40	1.900 48.3	500 3.4	1418 6309	0-⅛ 0-3.2	3°-46'	0.79 65.8	3 76.2	4¼ 108.0	1⅞ 47.6	2	⅜x2 9.5x50.8	1.5 0.7
2 50	2.375 60.3	500 3.4	2215 9857	0-⅛ 0-3.2	3°-1'	0.63 52.7	3½ 88.9	5½ 139.7	1¾ 44.5	2	⅜x2 9.5x50.8	1.9 0.9
2½ 65	2.875 76.1	500 3.4	3246 14444	0-⅛ 0-3.2	2°-29'	0.52 43.4	4 101.6	6 152.4	1¾ 44.5	2	⅜x2 9.5x50.8	2.0 0.9
3 80	3.500 88.3	500 3.4	4811 21407	0-⅛ 0-3.2	2°-3'	0.43 35.8	4⅝ 117.5	7⅛ 181.0	1¾ 44.5	2	½x2¾ 12.7x69.9	2.7 1.2
3½ ▲	4.000 ▲	500 3.4	6283 27960	0-⅛ 0-3.2	1°-48'	0.38 31.4	5⅛ 130.2	7⅝ 193.7	1¾ 44.5	2	½x2¾ 12.7x69.9	3.1 1.4
4 100	4.500 114.3	400 2.7	6362 28310	0-¼ 0-6.4	3°-11'	0.67 55.6	5⅞ 149.2	8⅜ 212.8	2 50.8	2	½x2¾ 12.7x69.9	4.3 2.0
5 125	5.563 139.7	400 2.7	9722 43264	0-¼ 0-6.4	2°-35'	0.54 45.1	7 177.8	9⅞ 250.8	2 50.8	2	⅝x3¼ 15.9x82.6	5.9 2.7
6 150	6.625 168.3	400 2.7	13789 61359	0-¼ 0-6.4	2°-10'	0.45 37.8	8 203.2	11¼ 285.8	2 50.8	2	⅝x3¼ 15.9x82.6	7.1 3.2
8 200	8.625 219.1	350 2.4	20449 90999	0-¼ 0-6.4	1°-40'	0.35 29.1	10⅜ 263.5	13¾ 349.3	2⅜ 60.3	2	¾x4¼ 19.1x108.0	12.3 5.6

Fig. 7010 Reducing Coupling

Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Wk. Pressure PSI Mpa	Max. End Load Lbs. N	Range of Pipe End Separation Inches mm	Deflection from ℄ Per Coupling Degrees	Deflection from ℄ Pipe in./ft. mm/meter	Coupling Dimensions X Inches Millimeters	Coupling Dimensions Y Inches Millimeters	Coupling Dimensions Z Inches Millimeters	Coupling Bolts Qty	Coupling Bolts Size Inches mm	Approx. Wt. Ea. Lbs. kg.
2x1½ 50x40	2.375x1.900 60.3x48.3	350 2.4	992 4416	⅛ 3.2	1°-53′	0.39 32.9	3¾ 95.3	5½ 139.7	1¾ 44.5	2	⅜x2 9.5x50.8	2.8 1.3
2½x2 65x50	2.875x2.375 76.1x60.3	350 2.4	1551 6900	⅛ 3.2	1°-33′	0.32 27.1	4¼ 108.0	6 152.4	1¾ 44.5	2	⅜x2 9.5x50.8	3.9 1.8
3x2 80x50	3.500x2.375 88.9x60.3	350 2.4	1551 6900	⅛ 3.2	1°-17′	0.27 22.4	5 127.0	7¼ 184.2	1¾ 44.5	2	½x2¾ 12.7x69.9	5.9 2.7
3x2½ 80 x 65	3.500x2.875 88.9x76.1	350 2.4	2272 10111	⅛ 3.2	1°-17′	0.27 22.4	5 127.0	7¼ 184.2	1¾ 44.5	2	½x2¾ 12.7x69.9	5.4 2.4
4x2 100x50	4.500x2.375 114.3x60.3	350 2.4	1551 6900	3/16 4.8	2°-38′	0.55 46.0	6⅜ 161.9	8¾ 222.3	2 50.8	2	⅝x3¾ 15.9x95.3	10.9 4.9
4x2½ 100x65	4.500x2.875 114.3x76.1	350 2.4	2272 10111	3/16 4.8	2°-38′	0.55 46.0	6⅜ 161.9	8¾ 222.3	2 50.8	2	⅝x3¾ 15.9x95.3	10.1 4.6
4x3 100x80	4.500x3.500 114.3x88.9	350 2.4	3367 14985	3/16 4.8	2°-38′	0.55 46.0	6⅜ 161.9	8¾ 222.3	2 50.8	2	⅝x3¾ 15.9x95.3	9.3 4.2
5x4 125x100	5.563x4.500 139.7x114.3	350 2.4	5567 24771	¼ 6.4	2°-5′	0.44 36.4	7½ 190.5	10½ 266.7	2⅛ 54.0	2	¾x4¼ 19.1x108.0	12.5 5.7
6x4 150x100	6.625x4.500 168.3x114.3	350 2.4	5567 24771	¼ 6.4	1°-44′	0.36 30.3	8⅝ 219.1	11¾ 298.5	2⅛ 54.0	2	¾x4¼ 19.1x108.0	16 7.3
6x5 150x125	6.625x5.563 168.3x139.7	350 2.4	8507 37856	¼ 6.4	1°-44′	0.36 30.3	8⅝ 219.1	11¾ 298.5	2⅛ 54.0	2	¾x4¼ 19.1x108.0	14.7 6.7
8x6 200x150	8.625x6.625 219.1x168.3	350 2.4	12065 53690	¼ 6.4	1°-15′	0.26 21.8	11 279.4	14¾ 374.7	2¼ 57.2	2	⅞x5 22.2x127.0	23.4 10.6

Fig. 7010 REDUCING



The Fig. 7010 Reducing Coupling makes it possible to directly connect two different pipe sizes, eliminating the need for two couplings and a reducing fitting. The specially designed reducing coupling gasket with a stiff center rib assures proper positioning of the gasket and prevents the smaller pipe from telescoping into the larger during assembly. The Fig. 7010 Reducing Coupling allows for working pressure ratings up to 350 psi (2.4 MPa).

Fig. 7010
Coupling with Gasket

For chart notes refer to page 6

Working Pressure, End Load, Pipe End Separation and Deflection values are based on standard steel pipe with standard cut grooves in accordance with Gruvlok specifications.

For standard Roll Groove steel pipe reduce the values for pipe end separation and deflection by 50%.

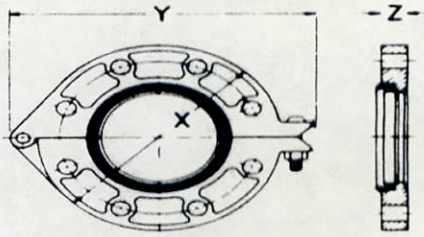
▲ No equivalent metric pipe size.

Fig. 7012 Flange

Patent Pending

Nominal Size Inches mm	Pipe O.D. Inches mm	Max. Press. PSI Mpa	Max. End Load Lbs. N	Latch Bolt Size Inches mm	Flange Dimensions X Inches mm	Flange Dimensions Y Inches mm	Flange Dimensions Z Inches mm	Sealing Surface* A Max. Inches mm	Sealing Surface* B Min. Inches mm	Mating Flange Bolts Qty	Mating Flange Bolts Size Inches mm	Approx. Wt. Ea. Lbs. kg.
2 50	2.375 60.3	250 1.7	1108 4931	⅜ x 2½ 9.5 x 63.5	6 152.4	8⅜ 212.7	13/16 20.6	2⅜ 60.3	3¾ 95.3	4	⅝ x 2¾ 15.9 x 69.9	4.0 1.8
2½ 65	2.875 76.1	250 1.7	1624 7227	⅜ x 2½ 9.5 x 63.5	7 177.8	9 7/16 239.7	13/16 20.6	2⅞ 73.0	4¼ 108.0	4	⅝ x 2¾ 15.9 x 69.9	5.5 2.5
3 80	3.500 88.9	250 1.7	2405 10702	⅜ x 2½ 9.5 x 63.5	7½ 190.5	9 15/16 252.4	13/16 20.6	3½ 88.9	4 15/16 125.4	4	⅝ x 2¾ 15.9 x 69.9	5.8 2.6
4 100	4.500 114.3	250 1.7	3976 17693	⅜ x 2½ 9.5 x 63.5	9 228.6	11½ 292.1	15/16 23.8	4½ 114.3	5½ 139.7	8	⅝ x 3 15.9 x 76.2	9.0 4.1
5 125	5.563 139.7	250 1.7	6078 27047	⅜ x 2½ 9.5 x 63.5	10 254.0	12½ 317.5	15/16 23.8	5 9/16 141.3	6 9/16 166.7	8	¾ x 3 19.1 x 76.2	10.0 4.6
6 150	6.625 168.3	250 1.7	8620 38359	⅜ x 2½ 9.5 x 63.5	11 279.4	13½ 342.9	1 25.4	6⅝ 168.3	7 11/16 195.3	8	¾ x 3¼ 19.1 x 82.6	13.8 6.3
8 200	8.625 219.1	250 1.7	14610 65015	½ x 3½ 12.7 x 88.9	13½ 342.9	16¼ 412.75	1⅛ 28.6	8⅝ 219.1	9⅞ 250.8	8	¾ x 3½ 19.1 x 88.9	19.0 8.7
10 250	10.750 273.0	250 1.7	22690 100971	½ x 3½ 12.7 x 88.9	16 406.4	19 482.6	1 13/16 30.2	10¾ 273.0	12 304.8	12	⅞ x 3¾ 22.2 x 95.3	27.4 12.5
12 300	12.750 323.9	250 1.7	31919 142040	½ x 3½ 12.7 x 88.9	19 482.6	22 558.8	1¼ 31.8	12¾ 323.9	14 355.6	12	⅞ x 3¾ 22.2 x 95.3	38.0 17.3

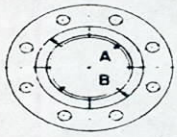
FIG. 7012 FLANGE



The Gruvlok Fig. 7012 Flange allows direct connection of Class 125 or Class 150 flanged components to a grooved piping system. The two halves of the Gruvlok Flange are hinged for ease of handling and are drawn together by a latch bolt which aids in assembly on the pipe. A specially designed gasket provides a leak-tight seal on both the pipe and the mating flange face. The Gruvlok Fig. 7012 Flange requires the use of a metal adapter insert when used against rubber surfaces.

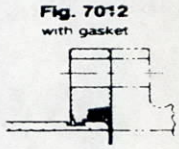
* The effective sealing area of the mating flange must be free from gouges, undulations and deformities of any type to ensure proper sealing of the gasket.

NOTE: The Fig 7012 Flange provides a rigid joint when used on standard grooved pipe in accordance with Gruvlok specifications, therefore no linear or angular movement at the joint is allowed.



Mating Flange*

Fig. 7012
with gasket



GRUVLOK BRANCH OUTLET SYSTEM

Gruvlok Branch Outlet System designs provide a quick and easy outlet at any location along the pipe. A hole that is drilled or cut in the pipe to receive the locating collar of the "Ease Tee" or "Clamp-T" is all that is required. The full, smooth outlet area provides for optimum flow characteristics.

The "Ease Tee" and the "Clamp-T" have specially engineered gaskets which are designed to conform to the pipe O.D., providing a leak-tight seal.

GRUVLOK EASE TEE™ Fig. 7059

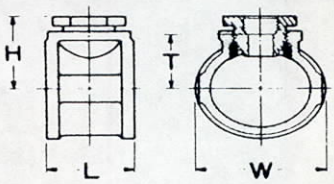


Fig. 7059 Ease Tee™

Nominal Size Run x Outlet FPT Inches mm	Working Pressure PSI MPa		Hole★ Dia. Inches mm	Ease Tee Dimensions				Approx. Wt. Each Lbs. kg.
				H	L	W	T	
	UL Listed	FM Approved		Inches mm				
1 x ½ 25x15	175 1.2	300 2.0	1.0 25.4	1¾ 44.5	2 50.8	1⅞ 47.7	1¼ 31.8	0.9 0.4
1 x ¾ 25x20	175 1.2	300 2.0	1.0 25.4	1¾ 44.5	2 50.8	1⅞ 47.7	1 3/16 30.2	0.8 0.4
1 x 1 25x25	175 1.2	300 2.0	1.0 25.4	2¼ 57.2	2 50.8	1⅞ 47.7	1 17/32 38.9	1.0 0.5
1¼ x ½ 32x15	175 1.2	300 2.0	1.0 25.4	1⅞ 47.6	2⅛ 54.0	2⅜ 60.3	1⅜ 34.9	1.3 0.6
1¼ x ¾ 32x20	175 1.2	300 2.0	1.0 25.4	1⅞ 47.6	2⅛ 54.0	2⅜ 60.3	1 5/16 33.3	1.3 0.6
1¼ x 1 32x25	175 1.2	300 2.0	1.0 25.4	2½ 63.5	2⅛ 54.0	2⅜ 60.3	1 25/32 45.2	1.4 0.6
1½ x ½ 40x15	175 1.2	300 2.0	1.0 25.4	2 50.8	2⅛ 54.0	2⅝ 66.7	1½ 38.1	1.4 0.6
1½ x ¾ 40x20	175 1.2	300 2.0	1.0 25.4	2 50.8	2⅛ 54.0	2⅝ 66.7	1 7/16 36.6	1.4 0.6
1½ x 1 40x25	175 1.2	300 2.0	1.0 25.4	2⅝ 66.7	2⅛ 54.0	2⅝ 66.7	1 29/32 48.4	1.5 0.7
2 x ½ 50x15	175 1.2	300 2.0	1.0 25.4	2¼ 57.2	2⅛ 54.0	3⅛ 79.4	1¾ 44.5	1.6 0.7
2 x ¾ 50x20	175 1.2	300 2.0	1.0 25.4	2¼ 57.2	2⅛ 54.0	3⅛ 79.4	1 11/16 42.9	1.6 0.7
2 x 1 50x25	175 1.2	300 2.0	1.0 25.4	2⅞ 73.0	2⅛ 54.0	3⅛ 79.4	2 5/32 54.8	1.7 0.8
2½ x ½ 65x15	175 1.2	300 2.0	1.0 25.4	2½ 63.5	2⅛ 54.0	3 11/16 93.7	2 50.8	2.0 0.9
2½ x ¾ 65x20	175 1.2	300 2.0	1.0 25.4	2½ 63.5	2⅛ 54.0	3 11/16 93.7	1 15/16 49.3	2.0 0.9
2½ x 1 65x25	175 1.2	300 2.0	1.0 25.4	3⅛ 79.4	2⅛ 54.0	3 11/16 93.7	2 13/32 61.1	2.1 1.0

★ Formerly 13/16" dia. hole. Contact Grinnell for details.

The Fig. 7059 "Ease Tee" is designed for quick and easy installation. It offers the opportunity to install branch outlets without cutting or threading the pipe. The "Ease Tee" requires no special tools for installation. Simply drill a hole in the pipe, slide the "Ease Tee" over the pipe end, position, and hand tighten the outlet adapter into the hole. In less than 30 seconds you can have a ½", ¾", or 1" outlet connection. The "Ease Tee" is UL listed and FM approved for sprinkler systems and can also be used for building services, manifold systems or any system where convenient, low cost outlets are required.

Material Specifications

Body:
Cast iron conforming to ASTM A-126 Class A or Malleable iron conforming to ASTM A-47

Adapter:
Carbon Steel conforming to ASTM A-29

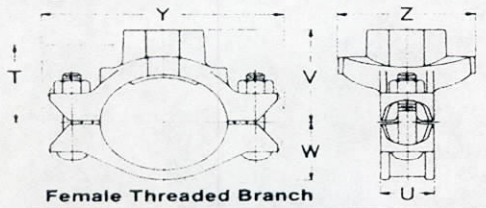
Gasket:
Silicone conforming to ASTM D-2000

Ease Tee Flow Data (Frictional Resistance)	
Size Inches mm	Equiv. Length of Pipe Feet meters
1 x 1 25x25	10.5 3.2
1¼ x 1 32x25	4.0 1.2
1½ x 1 40x25	5.5 1.7
2 x 1 50x25	6.5 2.0
2½ x 1 65x25	7.0 2.1

GRUVLOK CLAMP-T™

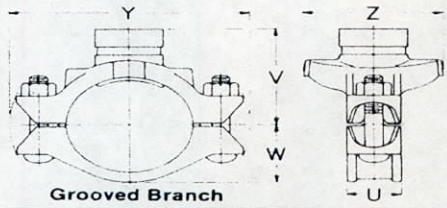
GRUVLOK CLAMP-T™

Fig. 7045



Female Threaded Branch

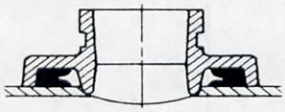
Fig. 7046



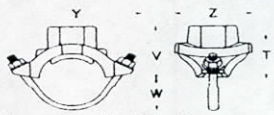
Grooved Branch

The Gruvlok Clamp-T provides for a branch or cross connection in light wall or standard wall steel pipe.
The Fig. 7045 Clamp-T has female pipe threaded branch connection and the Fig. 7046 Clamp-T has a grooved end branch connection. The Clamp-T is designed to provide a full flow and leak-tight branch outlet with working pressure ratings to 300 psi (2.0 MPa).

Nominal Pipe Size Run x Branch Inches mm	Maximum Working Pressure PSI MPa	Hole Dimensions		Clamp-T™ Dimensions							Bolts		Approx. Weight Each	
		Hole Saw Size Inches mm	Maximum Diameter Inches mm	T Inches mm	U Inches mm	V Threaded Inches mm	V Grooved Inches mm	W Inches mm	Y Inches mm	Z Inches mm	Qty. —	Size Inches mm	Threaded Lbs. kg.	Grooved Lbs. kg.
2x½★ 50x15	300 2.0	1½ 38.1	1⅝ 41.3	2⅛ 54.0	9/16 14.3	2⅝ 66.7	—	1½ 38.1	5½ 139.7	3 76.2	1	½-U Bolt 12.7	3.0 1.4	—
2x¾★ 50x20	300 2.0	1½ 38.1	1⅝ 41.3	2⅛ 54.0	9/16 14.3	2⅝ 66.7	—	1½ 38.1	5½ 139.7	3 76.2	1	½-U Bolt 12.7	2.9 1.3	—
2x1★ 50x25	300 2.0	1½ 38.1	1⅝ 41.3	2 50.8	9/16 14.3	2⅝ 66.7	—	1½ 38.1	5½ 139.7	3 76.2	1	½-U Bolt 12.7	2.9 1.3	—
2x1¼★ 50x32	300 2.0	2 50.8	2⅛ 54.0	2 3/16 55.6	9/16 14.3	2⅞ 73.0	2⅞ 73.0	1½ 38.1	7 177.8	3½ 88.9	1	½-U Bolt 12.7	4.0 1.8	4.0 1.8
2x1½★ 50x40	300 2.0	2 50.8	2⅛ 54.0	2 3/16 55.6	9/16 14.3	2⅞ 73.0	2⅞ 73.0	1½ 38.1	7 177.8	3½ 88.9	1	½-U Bolt 12.7	3.9 1.8	3.9 1.8
2½x½★ 65x15	300 2.0	1½ 38.1	1⅝ 41.3	2⅜ 60.3	9/16 14.3	2⅞ 73.0	—	1¾ 44.5	6⅛ 155.6	3 76.2	1	½-U Bolt 12.7	3.0 1.4	—
2½x¾★ 65x20	300 2.0	1½ 38.1	1⅝ 41.3	2⅜ 60.3	9/16 14.3	2⅞ 73.0	—	1¾ 44.5	6⅛ 155.6	3 76.2	1	½-U Bolt 12.7	2.9 1.3	—
2½x1★ 65x25	300 2.0	1½ 38.1	1⅝ 41.3	2¼ 57.2	9/16 14.3	2⅞ 73.0	—	1¾ 44.5	6⅛ 155.6	3 76.2	1	½-U Bolt 12.7	2.9 1.3	—
2½x1¼★ 65x32	300 2.0	2 50.8	2⅛ 54.0	2 7/16 61.9	9/16 14.3	3⅛ 79.4	3⅛ 79.4	1¾ 44.5	6⅛ 155.6	3⅜ 85.7	1	½-U Bolt 12.7	3.4 1.5	3.4 1.5
2½x1½★ 65x40	300 2.0	2 50.8	2⅛ 54.0	2 7/16 61.9	9/16 14.3	3⅛ 79.4	3⅛ 79.4	1¾ 44.5	6⅛ 155.6	3⅜ 85.7	1	½-U Bolt 12.7	3.4 1.5	3.4 1.5
3x½★ 80x15	300 2.0	1½ 38.1	1⅝ 41.3	2½ 63.5	9/16 14.3	3 76.2	—	2⅛ 54.0	7 177.8	3¾ 95.3	1	½-U Bolt 12.7	2.8 1.3	—
3x¾★ 80x20	300 2.0	1½ 38.1	1⅝ 41.3	2½ 63.5	9/16 14.3	3 76.2	—	2⅛ 54.0	7 177.8	3¾ 95.3	1	½-U Bolt 12.7	2.7 1.3	—
3x1★ 80x25	300 2.0	1½ 38.1	1⅝ 41.3	2⅜ 60.3	9/16 14.3	3 76.2	—	2⅛ 54.0	7 177.8	3¾ 95.3	1	½-U Bolt 12.7	2.7 1.3	—
3x1¼ 80x32	300 2.0	2 50.8	2⅛ 54.0	2 11/16 68.3	1½ 38.1	3⅜ 85.7	3½ 88.9	2⅛ 54.0	6⅞ 174.6	3¾ 95.3	2	½x2¾ 12.7x69.9	3.4 1.5	3.4 1.5
3x1½ 80x40	300 2.0	2 50.8	2⅛ 54.0	2 11/16 68.3	1½ 38.1	3⅜ 85.7	3½ 88.9	2⅛ 54.0	6⅞ 174.6	3¾ 95.3	2	½x2¾ 12.7x69.9	4.4 2.0	4.4 2.0
3x2 80x50	300 2.0	2½ 63.5	2⅝ 66.7	2⅝ 66.7	1½ 38.1	3⅜ 85.7	3½ 88.9	2⅛ 54.0	6⅞ 174.6	4⅛ 104.8	2	½x2¾ 12.7x69.9	4.6 2.1	4.6 2.1
4x½★ 100x15	300 2.0	1½ 38.1	1⅝ 41.3	3 76.2	9/16 14.3	3½ 88.9	—	2⅝ 66.7	7¾ 196.9	3¾ 95.3	1	½-U Bolt 12.7	2.9 1.3	—
4x¾★ 100x20	300 2.0	1½ 38.1	1⅝ 41.3	3 76.2	9/16 14.3	3½ 88.9	—	2⅝ 66.7	7¾ 196.9	3¾ 95.3	1	½-U Bolt 12.7	2.8 1.3	—
4x1★ 100x25	300 2.0	1½ 38.1	1⅝ 41.3	2⅞ 73.0	9/16 14.3	3½ 88.9	—	2⅝ 66.7	7¾ 196.9	3¾ 95.3	1	½-U Bolt 12.7	2.7 1.3	—
4x1¼ 100x32	300 2.0	2 50.8	2⅛ 54.0	3 3/16 81.0	1⅞ 47.6	3⅞ 98.4	4 101.6	2⅝ 66.7	7½ 190.5	3¾ 95.3	2	½x2¾ 12.7x69.9	4.5 2.0	4.2 1.9
4x1½ 100x40	300 2.0	2 50.8	2⅛ 54.0	3 3/16 81.0	1⅞ 47.6	3⅞ 98.4	4 101.6	2⅝ 66.7	7½ 190.5	3¾ 95.3	2	½x2¾ 12.7x69.9	4.6 2.1	4.3 2.0
4x2 100x50	300 2.0	2½ 63.5	2⅝ 66.7	3¼ 82.6	1⅞ 47.6	4 101.6	4 101.6	2⅝ 66.7	7½ 190.5	4⅛ 104.8	2	½x2¾ 12.7x69.9	5.2 2.4	4.6 2.1
4x2½ 100x65	300 2.0	2¾ 69.8	2⅞ 73.0	3 1/16 77.8	1⅞ 47.6	4 101.6	4 101.6	2⅝ 66.7	7½ 190.5	4⅜ 111.1	2	½x2¾ 12.7x69.9	5.2 2.4	5.0 2.3
4x3 100x80	300 2.0	3½ 88.9	3⅝ 92.1	3¼ 82.6	1⅞ 47.6	4¼ 108.0	4 101.6	2⅝ 66.7	7½ 190.5	5¼ 133.4	2	½x3½ 12.7x88.9	6.5 3.0	5.6 2.5



Clamp-T with gasket



Clamp-T with U-bolt

★Clamp-T supplied with "U-bolt" lower housing (includes U-bolt and 2 nuts) as shown.

Additional Clamp-T sizes on next page.

Nominal Pipe Size Run x Branch Inches mm	Maximum Working Pressure PSI MPa	Hole Dimensions		Clamp-T™ Dimensions							Bolts		Approx. Weight Each	
						V								
		Hole Saw Size Inches mm	Maximum Diameter Inches mm	T Inches mm	U Inches mm	Threaded Inches mm	Grooved Inches mm	W Inches mm	Y Inches mm	Z Inches mm	Qty. —	Size Inches mm	Threaded Lbs. kg.	Grooved Lbs. kg.
5x1¼ 125x32	300 2.0	2 50.8	2⅛ 54.0	3 1/16 93.7	1⅞ 47.6	4⅜ 111.1	4½ 114.3	3¼ 82.6	9⅛ 231.8	3¾ 95.3	2	⅝x3¼ 15.9x82.6	5.4 2.5	5.5 2.5
5x1½ 125x40	300 2.0	2 50.8	2⅛ 54.0	3 1/16 93.7	1⅞ 47.6	4⅜ 111.1	4½ 114.3	3¼ 82.6	9⅛ 231.8	3¾ 95.3	2	⅝x3¼ 15.9x82.6	5.5 2.5	5.6 2.5
5x2 125x50	300 2.0	2½ 63.5	2⅝ 66.7	3¾ 95.3	1⅞ 47.6	4½ 114.3	4½ 114.3	3¼ 82.6	9⅛ 231.8	4⅛ 104.8	2	⅝x3¼ 15.9x82.6	5.7 2.6	5.5 2.5
5x2½ 125x65	300 2.0	2¾ 69.8	2⅞ 73.0	3 13/16 96.8	1⅞ 47.6	4¾ 120.7	4½ 114.3	3¼ 82.6	9⅛ 231.8	4⅜ 111.1	2	⅝x3¼ 15.9x82.6	7.0 3.2	5.8 2.6
5x3 125x80	300 2.0	3½ 88.9	3⅝ 92.1	4 101.6	1⅞ 47.6	5 127.0	4⅝ 117.5	3¼ 82.6	9⅛ 231.8	5¼ 133.4	2	⅝x3¼ 15.9x82.6	8.7 3.9	7.1 3.2
6x1¼ 150x32	300 2.0	2 50.8	2⅛ 54.0	4 3/16 106.4	2 50.8	4⅞ 123.8	5 127.0	3⅞ 98.4	10⅛ 257.2	3¾ 95.3	2	⅝x4¼ 15.9x108.0	7.8 3.5	7.1 3.2
6x1½ 150x40	300 2.0	2 50.8	2⅛ 54.0	4 3/16 106.4	2 50.8	4⅞ 123.8	5 127.0	3⅞ 98.4	10⅛ 257.2	3¾ 95.3	2	⅝x4¼ 15.9x108.0	7.8 3.5	7.2 3.3
6x2 150x50	300 2.0	2½ 63.5	2⅝ 66.7	4⅛ 104.8	2 50.8	4⅞ 123.8	5 127.0	3⅞ 98.4	10⅛ 257.2	4⅛ 104.8	2	⅝x4¼ 15.9x108.0	7.8 3.5	7.8 3.5
6x2½ 150x65	300 2.0	2¾ 69.8	2⅞ 73.0	4⅛ 104.8	2 50.8	5⅛ 130.2	5⅛ 130.2	3⅞ 98.4	10⅛ 257.2	4⅜ 111.1	2	⅝x4¼ 15.9x108.0	8.4 3.8	7.6 3.5
6x3 150x80	300 2.0	3½ 88.9	3⅝ 92.1	4⅜ 111.1	2 50.8	5⅜ 136.5	5⅛ 130.2	3⅞ 98.4	10⅛ 257.2	5¼ 133.4	2	⅝x4¼ 15.9x108.0	9.6 4.4	8.0 3.6
6x4 150x100	300 2.0	4½ 114.3	4⅝ 117.5	4⅜ 111.1	2 50.8	5½ 139.7	5¼ 133.4	3⅞ 98.4	10⅛ 257.2	6½ 165.1	2	⅝x4¼ 15.9x108.0	10.5 4.8	10.4 4.7
8x2½ 200x65	300 2.0	2¾ 69.8	2⅞ 73.0	5 5/16 135.0	2¼ 57.2	6¼ 158.8	6⅛ 155.6	5 127.0	12¾ 323.9	4⅜ 111.1	2	¾x4¼ 19.1x108.0	11.1 5.0	10.6 4.8
8x3 200x80	300 2.0	3½ 88.9	3⅝ 92.1	5⅜ 136.5	2¼ 57.2	6⅜ 161.9	6⅛ 155.6	5 127.0	12¾ 323.9	5¼ 133.4	2	¾x4¼ 19.1x108.0	13.0 5.9	11.5 5.2
8x4 200x100	300 2.0	4½ 114.3	4⅝ 117.5	5⅜ 136.5	2¼ 57.2	6½ 165.1	6¼ 158.8	5 127.0	12¾ 323.9	6½ 165.1	2	¾x4¼ 19.1x108.0	16.2 7.4	16.2 7.4

Material Specifications

Housing:

Malleable Iron conforming to ASTM A-47 or
Ductile Iron conforming to ASTM A-536

Gaskets:

EPDM or Buna-N compound conforming to ASTM D-2000

Coatings:

Red Enamel
Hot Dipped Zinc Galvanize
For other coating requirements contact Grinnell

Bolts and Nuts:

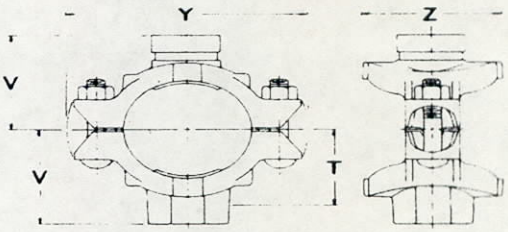
Heat treated, oval-neck track head bolts and heavy hex nuts of carbon steel conforming to ASTM A-183 with a minimum tensile strength of 110,000 psi. Bolts and nuts are provided electroplated as standard.

Clamp-T Flow Data (Frictional Resistance)

Branch Size Inches mm	Fig. 7045 Threaded Branch		Fig. 7046 Grooved Branch	
	C.V. Value	Equiv. Pipe Length Feet Meters	C.V. Value	Equiv. Pipe Length Feet Meters
½ 15	22	1.0 0.3	—	—
¾ 20	25	2.0 0.6	—	—
1 25	44	2.0 0.6	—	—
1¼ 32	76	2.5 0.8	54	5.0 1.5
1½ 40	89	4.0 1.2	95	3.5 1.1
2 50	164	3.5 1.1	148	4.5 1.4
2½ 65	152	12.5 3.8	205	7.0 2.1
3 80	318	8.5 2.6	294	9.5 2.9
4 100	536	8.0 2.4	571	7.0 2.1

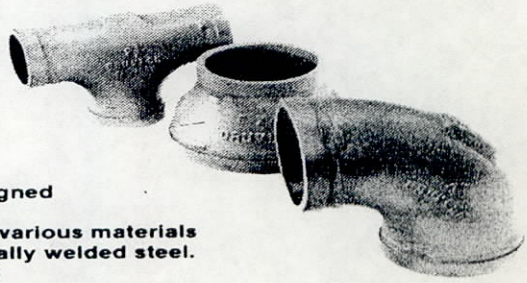
Clamp-T Cross

Fig. 7047
Thread by Thread
Fig. 7048
Groove by Groove
Fig. 7049
Groove by Thread



Clamp-T cross connections are available in various sizes except those with the "U" Bolt designed lower housing. Clamp-T crosses allow greater versatility in piping design. Variable end configurations are obtainable—GrxGr, GrxThd and ThdxThd. Various outlets 1¼" thru 4" sizes can be easily made up.

GRUVLOK GROOVED END FITTINGS



Gruvlok fittings are available through 24" Nominal Pipe size in a variety of styles. These fittings are designed to provide minimum pressure drop and uniform strength. Depending on styles and size, Gruvlok fittings are provided in various materials including malleable iron, ductile iron, forged steel or segmentally welded steel. Pressure ratings of Gruvlok standard fittings conform to those of Fig. 7001 Gruvlok couplings as shown on page 7.

Material Specifications

Cast Fittings:

Malleable iron conforming to ASTM A-47
or
Ductile iron conforming to ASTM A-536

Steel Fittings:

Forged steel conforming to ASTM A-234

Segmentally Welded Steel Fittings:

Carbon steel pipe conforming to ASTM A-53 or ASTM A-120, sizes through 4": Type "F", sizes 5" - 24": Type "E" or "S", Grade "B"

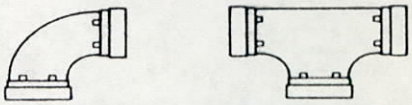
Adapter Flanges:

Class 125 - cast iron conforming to ANSI B-16.1
Class 150 - carbon steel conforming to ANSI B-16.5
Class 300 - carbon steel conforming to ANSI B-16.5

Coatings:

Rust inhibiting paint, color: red.
Hot dipped zinc galvanize
For other coating requirements contact ITT Grinnell.

Flow Data

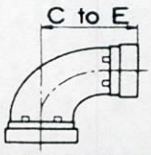


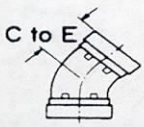
Frictional Resistance

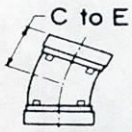
(Expressed as Equivalent Straight Pipe)

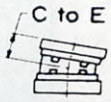
Size Inches mm	Elbows 90° Feet Meters	Elbows 45° Feet Meters	Tee Branch Feet Meters	Tee Run Feet Meters
1 25	2.0 0.6	1.0 0.3	4.5 1.4	2.0 0.6
2 50	3.5 1.1	2.0 0.6	8.5 2.6	3.5 1.1
3 80	5.0 1.5	3.0 0.9	13.0 4.0	5.0 1.5
4 100	7.0 2.1	3.5 1.1	16.0 4.9	7.0 2.1
5 125	8.5 2.6	4.5 1.4	21.0 6.4	8.5 2.6
6 150	10.0 3.0	5.0 1.5	25.0 7.6	10.0 3.0
8 200	13.0 4.0	6.5 2.0	33.0 10.1	13.0 4.0
10 250	17.0 5.2	8.5 2.6	41.0 12.5	17.0 5.2
12 300	20.0 6.1	10.0 3.0	50.0 15.2	20.0 6.1
14 350	23.0 7.0	18.0 5.5	65.0 19.8	23.0 7.0
16 400	25.0 7.6	20.0 6.1	78.0 23.8	25.0 7.6
18 ▲	33.0 10.1	23.0 7.0	88.0 26.8	33.0 10.1
20 500	36.0 11.0	25.0 7.6	98.0 29.9	36.0 11.0
24 600	40.0 12.2	30.0 9.1	120.0 36.6	40.0 12.2

For the branch of a tee that is either increased or reduced in size, use the value that is corresponding to the branch size
Example: for 6" x 6" x 3" tee, the branch value of 3" is 13.0 ft. (4.0 M)
For sizes not listed interpolate from the values shown
▲No equivalent metric pipe size



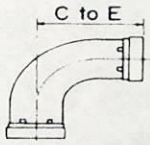


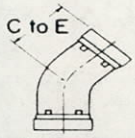




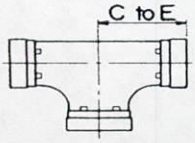
Nominal Size Inches mm	Fig. 7050 90° Elbow		Fig. 7051 45° Elbow		Fig. 7052 22½° Elbow		Fig. 7053 11¼° Elbow	
	Center To End Inches mm	Approx. Weight Each Lbs. kg.	Center To End Inches mm	Approx. Weight Each Lbs. kg.	Center To End Inches mm	Approx. Weight Each Lbs. kg.	Center To End Inches mm	Approx. Weight Each Lbs. kg.
1 25	2¼ 57.2	0.6 0.3	1¾ 44.4	0.6 0.3	1⅝ 41.3	0.5 0.2	1⅜ 34.9	0.3 0.1
1¼ 32	2¾ 69.8	1.1 0.5	1¾ 44.4	0.8 0.4	1¾ 44.4	0.7 0.3	1⅜ 34.9	0.5 0.2
1½ 40	2¾ 69.8	1.3 0.6	1¾ 44.4	0.9 0.4	1¾ 44.4	1.0 0.5	1⅜ 34.9	0.5 0.2
2 50	3¼ 82.6	1.9 0.9	2 50.8	1.5 0.7	1⅞ 47.6	1.5 0.7	1⅜ 34.9	1.3 0.3
2½ 65	3¾ 95.2	3.1 1.4	2¼ 57.2	2.0 0.9	2 50.8	1.8 0.8	1½ 38.1	1.5 0.7
3" O.D. 65	4½ 114.3	4.0 1.8	2½ 63.5	2.5 1.1	—	—	—	—
3 80	4¼ 108.0	4.7 2.1	2½ 63.5	3.5 1.6	2¼ 57.2	3.2 1.5	1½ 38.1	2.9 1.3
3½ ▲	4½ 114.3	5.9 2.7	2¾ 69.8	4.6 2.1	2½ 63.5	4.0 1.8	1¾ 44.4	2.8 1.3
4 100	5 127.0	7.8 3.5	3 76.2	6.1 2.8	2⅝ 66.7	5.3 2.4	1¾ 44.4	3.3 1.5
5 125	5½ 139.7	11.8 5.4	3¼ 82.6	8.5 3.9	2⅞ 73.0	6.8 3.1	2 50.8	5.0 2.3
6 150	6½ 165.1	18.1 8.2	3½ 88.9	11.7 5.3	3⅛ 79.4	8.2 3.7	2 50.8	7.0 3.2
6.5" O.D. 150	6½ 165.1	18.5 8.4	3½ 88.9	12.5 5.7	—	—	—	—
8 200	7¾ 196.8	31.3 14.2	4¼ 108.0	19.8 9.0	3⅞ 98.4	17.8 8.1	2 50.8	10.0 4.5
10 250	9 228.6	53.0 24.1	4¾ 120.6	34.1 15.5	4⅜ 111.1	25.0 11.4	2⅛ 54.0	15.5 7.0
12 300	10 254.0	78.2 35.5	5¼ 133.4	46.3 21.0	4⅞ 123.8	40.0 18.2	2¼ 57.2	29.3 13.3
14 350	11 279.4	160.0 72.6	6 152.4	55.0 25.0	5 127.0	45.9 20.8	3½ 88.9	32.1 14.6
16 400	12 304.8	210.0 95.3	7¼ 184.2	100.0 45.4	5 127.0	*	4 101.6	*
18 ▲	15½ 393.7	275.0 124.7	8 203.0	136.0 61.7	5½ 139.7	*	4½ 114.3	*
20 500	17¼ 438.2	347.0 157.4	9 228.6	178.0 80.7	6 152.4	*	5 127.0	*
24 600	20 508.0	515.0 233.6	11 279.4	255.0 115.7	7 177.8	*	6 152.4	*

★Weight quoted on application. Contact Grinnell.
▲ No equivalent metric pipe size.





Nominal Size Inches mm	Fig. 7050 LR 90° Long Radius Elbow		Fig. 7051 LR 45° Long Radius Elbow	
	Center To End Inches mm	Approx. Weight Each Lbs. kg.	Center To End Inches mm	Approx. Weight Each Lbs. kg.
2 50	4⅜ 111.1	2.5 1.1	2¾ 69.8	1.8 0.8
3 80	5⅞ 149.2	6.5 2.9	3⅜ 85.7	4.5 2.0
4 100	7½ 190.5	11.5 5.2	4 101.6	7.5 3.4
6 150	10¾ 273.0	28.5 12.9	5½ 139.7	17.3 7.8
8 200	14¼ 362.0	66.0 29.9	7¼ 184.2	34.0 15.4
10 250	17¼ 438.2	114.0 51.7	8½ 215.9	58.0 26.3
12 300	20½ 520.7	144.0 65.3	10 254.0	94.0 42.6



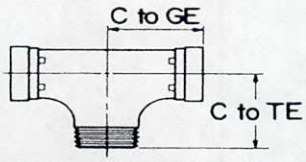
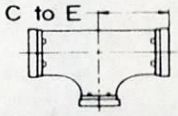
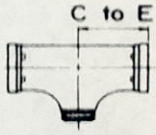


Fig. 7060 Tee			Fig. 7063 Tee with Threaded Branch		
Nominal Size Inches mm	Center To End Inches mm	Approx. Wt. Each Lbs. kg.	Center to Grooved End Inches mm	Center to Threaded End Inches mm	Approx. Wt. Each Lbs. kg.
1 25	2¼ 57.2	1.0 0.5	2¼ 57.2	2¼ 57.2	0.9 0.4
1¼ 32	2¾ 69.9	1.2 0.5	2¾ 69.9	2¾ 69.9	1.4 0.6
1½ 40	2¾ 69.9	2.0 0.9	2¾ 69.9	2¾ 69.9	1.8 0.8
2 50	3¼ 82.6	2.9 1.3	3¼ 82.6	4¼ 108.0	2.8 1.3
2½ 65	3¾ 95.3	4.9 2.2	3¾ 95.3	3¾ 95.3	4.4 2.0
3" O.D. 65	4½ 114.3	6.0 2.7	—	—	—
3 80	4¼ 108.0	7.2 3.3	4¼ 108.0	6 152.4	7.7 3.5
3½ ▲	4½ 114.3	9.8 4.4	4½ 114.3	4½ 114.3	11.0 5.0
4 100	5 127.0	12.3 5.6	5 127.0	7¼ 184.2	11.8 5.4
5 125	5½ 139.7	21.8 9.9	5½ 139.7	5½ 139.7	17.0 7.7
6 150	6½ 165.1	26.8 12.2	6½ 165.1	6½ 165.1	26.0 11.8
6½" O.D. 150	6½ 165.1	26.0 11.8	—	—	—
8 200	7¾ 196.9	39.2 17.8	7¾ 196.9	7¾ 196.9	40.0 18.1
10 250	9 228.6	74.2 33.7	9 228.6	9 228.6	72.0 32.7
12 300	10 254.0	94.1 42.7	10 254.0	10 254.0	99.0 44.9
14 350	11 279.4	150.0 68.0	—	—	—
16 400	12 304.8	188.0 85.3	—	—	—
18 ▲	15½ 393.7	274.0 124.3	—	—	—
20 500	17¼ 438.2	339.0 153.8	—	—	—
24 600	20 508.0	628.0 284.9	—	—	—

▲ No equivalent metric pipe size.





Reducing Tee				Reducing Tee			
Nominal Size Inches mm	Fig. 7061 Std. Center To End Inches mm	Fig. 7064 w/Thd. Br. Center To End Inches mm	Approx. Wt. Each Lbs. kg.	Nominal Size Inches mm	Fig. 7061 Std. Center To End Inches mm	Fig. 7064 w/Thd. Br. Center To End Inches mm	Approx. Wt. Each Lbs. kg.
2x2x1 50x50x25	3¼ 82.6	3¼ 82.6	2.6 1.2	10x10x6 250x250x150	9 228.6	9 228.6	55.0 24.9
2x2x1½ 50x50x40	3¼ 82.6	3¼ 82.6	2.7 1.2	10x10x8 250x250x200	9 228.6	9 228.6	64.7 29.3
2½x2½x2 65x65x50	3¾ 95.2	3¾ 95.2	4.4 2.0	12x12x3 300x300x80	10 254.0	10 254.0	65.0 29.5
3x3x1 80x80x25	4¼ 108.0	4¼ 108.0	7.0 3.2	12x12x4 300x300x100	10 254.0	10 254.0	68.0 30.8
3x3x1½ 80x80x10	4¼ 108.0	4¼ 108.0	5.3 2.4	12x12x5 300x300x125	10 254.0	10 254.0	72.0 32.7
3x3x2 80x80x50	4¼ 108.0	4¼ 108.0	5.5 2.5	12x12x6 300x300x150	10 254.0	10 254.0	75.0 34.0
3x3x2½ 80x80x65	4¼ 108.0	4¼ 108.0	5.8 2.6	12x12x8 300x300x200	10 254.0	10 254.0	80.0 36.3
4x4x1 100x100x25	3¾ 95.2	3¾ 95.2	8.0 3.6	12x12x10 300x300x250	10 254.0	10 254.0	84.0 38.1
4x4x2 100x100x50	5 127.0	5 127.0	10.2 4.6	14x14x8 350x350x200	11 279.4	11 279.4	112.0 50.8
4x4x2½ 100x100x65	5 127.0	5 127.0	11.2 5.1	14x14x10 350x350x250	11 279.4	11 279.4	120.0 54.4
4x4x3 100x100x80	5 127.0	5 127.0	11.4 5.2	14x14x12 350x350x300	11 279.4	11 279.4	134.0 60.8
5x5x2 125x125x50	5½ 139.7	5½ 139.7	14.5 6.6	16x16x8 400x400x200	12 304.8	12 304.8	137.0 62.1
5x5x3 125x125x80	5½ 139.7	5½ 139.7	16.1 7.3	16x16x10 400x400x250	12 304.8	12 304.8	148.0 67.1
5x5x4 125x125x100	5½ 139.7	5½ 139.7	17.9 8.1	16x16x12 400x400x300	12 304.8	12 304.8	154.0 69.9
6x6x2 150x150x50	6½ 165.1	6½ 165.1	26.4 12.0	18x18x10 ▲	15½ 393.7	15½ 393.7	208.0 94.3
6x6x2½ 150x150x65	6½ 165.1	6½ 165.1	26.5 12.0	18x18x12 ▲	15½ 393.7	15½ 393.7	218.0 98.8
6x6x3 150x150x80	6½ 165.1	6½ 165.1	26.5 12.0	18x18x14 ▲	15½ 393.7	—	—
6x6x4 150x150x100	6½ 165.1	6½ 165.1	26.5 12.0	18x18x6 ▲	15½ 393.7	—	—
6x6x5 150x150x125	6½ 165.1	6½ 165.1	28.0 12.7	20x20x14 500x500x350	17¼ 438.2	—	—
8x8x2 200x200x50	7¾ 196.8	7¾ 196.8	33.5 15.2	20x20x16 500x500x400	17¼ 438.2	—	—
8x8x3 200x200x80	7¾ 196.8	7¾ 196.8	33.6 15.2	20x20x18 ▲	17¼ 438.2	—	—
8x8x4 200x200x100	7¾ 196.8	7¾ 196.8	50.0 22.7	24x24x8 600x600x200	20 508.0	20 508.0	461.0 209.1
8x8x5 200x200x125	7¾ 196.8	7¾ 196.8	52.0 23.6	24x24x10 600x600x250	20 508.0	20 508.0	476.0 215.9
8x8x6 200x200x150	7¾ 196.8	7¾ 196.8	54.0 24.5	24x24x12 600x600x300	20 508.0	20 508.0	492.0 223.2
10x10x2 250x250x50	9 228.6	9 228.6	47.0 21.3	24x24x14 600x600x350	20 508.0	—	—
10x10x3 250x250x80	9 228.6	9 228.6	48.0 21.8	24x24x16 600x600x400	20 508.0	—	—
10x10x4 250x250x100	9 228.6	9 228.6	49.0 22.2	24x24x18 ▲	20 508.0	—	—
10x10x5 250x250x125	9 228.6	9 228.6	52.0 23.0	24x24x20 600x600x500	20 508.0	—	—

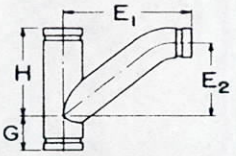


Fig. 7066 Tee Wye					
Nominal Size Inches mm	G Inches mm	H Inches mm	E_1 Inches mm	E_2 Inches mm	Approx. Wt. Each Lbs. kg.
2 x 2 x 2 50 x 50 x 50	2¾ 69.9	7 177.8	9 228.6	4⅝ 117.5	6.4 2.9
2½ x 2½ x 2½ 65 x 65 x 65	3 76.2	7¾ 196.9	10½ 266.7	5¾ 146.1	11.5 5.2
3 x 3 x 3 80 x 80 x 80	3¼ 82.6	8½ 215.9	11½ 292.1	6½ 165.1	16.5 7.5
3½ x 3½ x 3½ ▲	3½ 88.9	10 254.0	13 330.2	7¾ 196.9	22.0 10.0
4 x 4 x 3 100 x 100 x 80	3¾ 95.3	10½ 266.7	12⅞ 327.0	7⅞ 200.0	23.0 10.4
4 x 4 x 4 100 x 100 x 100	3¾ 95.3	10½ 266.7	13⅝ 346.1	8⅛ 206.5	26.0 11.8
5 x 5 x 3 125 x 125 x 80	4 101.6	12½ 317.5	14¼ 362.0	9¼ 235.0	32.0 14.5
5 x 5 x 4 125 x 125 x 100	4 101.6	12½ 317.5	15⅛ 384.3	9⅝ 244.6	35.0 15.9
5 x 5 x 5 125 x 125 x 125	4 101.6	12½ 317.5	16⅛ 409.7	10 254.0	40.0 18.1
6 x 6 x 3 150 x 150 x 80	4½ 114.3	14 355.6	15⁵⁄₁₆ 389.0	10⅜ 261.9	50.0 22.7
6 x 6 x 4 150 x 150 x 100	4½ 114.3	14 355.6	16¼ 412.8	10¾ 273.1	55.0 24.9
6 x 6 x 5 150 x 150 x 125	4½ 114.3	14 355.6	17¼ 438.2	11⅛ 282.7	58.0 26.3
6 x 6 x 6 150 x 150 x 150	4½ 114.3	14 355.6	18¼ 463.6	11½ 292.1	60.5 27.4
8 x 8 x 3 200 x 200 x 80	6 152.4	18 457.2	18³⁄₁₆ 462.0	13³⁄₁₆ 335.0	100.0 45.4
8 x 8 x 4 200 x 200 x 100	6 152.4	18 457.2	19 482.6	13½ 342.9	110.0 49.9
8 x 8 x 5 200 x 200 x 125	6 152.4	18 457.2	20 508.0	13⅞ 352.6	111.0 50.3
8 x 8 x 6 200 x 200 x 150	6 152.4	18 457.2	21⅛ 536.7	14⅜ 365.1	112.0 50.8
8 x 8 x 8 200 x 200 x 200	6 152.4	18 457.2	23¼ 590.6	15¼ 387.4	120.0 54.4
10 x 10 x 3 250 x 250 x 80	6½ 165.1	20½ 520.7	19⅞ 505.0	14⅞ 378.0	130.0 59.0
10 x 10 x 4 250 x 250 x 100	6½ 165.1	20½ 520.7	20¾ 527.1	15¼ 387.4	135.0 61.2
10 x 10 x 5 250 x 250 x 125	6½ 165.1	20½ 520.7	21⅞ 555.8	15¾ 400.1	140.0 63.5
10 x 10 x 6 250 x 250 x 150	6½ 165.1	20½ 520.7	22⅞ 581.2	16⅛ 409.6	145.0 65.8
10 x 10 x 8 250 x 250 x 200	6½ 165.1	20½ 520.7	27¼ 692.2	19¼ 489.0	150.0 68.0
10 x 10 x 10 250 x 250 x 250	6½ 165.1	20½ 520.7	27¼ 692.2	18 457.2	190.0 86.2
12 x 12 x 3 300 x 300 x 80	7 177.8	23 584.2	20 508.00	15¾ 400.1	140.0 63.5
12 x 12 x 4 300 x 300 x 100	7 177.8	23 584.2	20 508.0	15½ 393.7	145.0 65.8
12 x 12 x 6 300 x 300 x 150	7 177.8	23 584.2	20 508.0	15¼ 387.4	165.0 74.8
12 x 12 x 8 300 x 300 x 200	7 177.8	23 584.2	20 508.0	15 381.0	175.0 79.4
12 x 12 x 10 300 x 300 x 250	7 177.8	23 584.2	20 508.0	14¾ 374.6	200.0 90.7
12 x 12 x 12 300 x 300 x 300	7 177.8	23 584.2	31 787.4	20½ 520.7	240.0 108.9

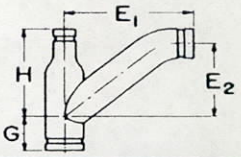


Fig. 7067 Reducing Tee Wye					
Nominal Size Inches mm	G Inches mm	H Inches mm	E_1 Inches mm	E_2 Inches mm	Approx. Wt. Each Lbs. mm
4 x 3 x 3 100 x 80 x 80	1⅝ 41.3	7⅜ 187.3	10¾ 273.1	5⅝ 142.9	16.0 7.3
4 x 3 x 4 100 x 80 x 100	3¾ 95.3	10½ 266.7	13⅝ 346.1	8⅛ 206.4	27.0 12.2
5 x 3 x 3 125 x 80 x 80	1¼ 31.8	9¾ 247.7	11½ 292.1	6½ 165.1	25.0 11.3
5 x 3 x 5 125 x 80 x 125	4 101.6	12½ 317.5	16⅛ 409.6	10 254.0	44.0 20.0
5 x 4 x 3 125 x 100 x 80	1⅞ 47.6	9⅛ 231.8	11⅞ 301.6	6⅞ 174.6	21.0 9.5
5 x 4 x 4 125 x 100 x 100	1⅞ 47.6	9⅛ 231.8	12¾ 323.9	7¼ 184.2	25.0 11.3
6 x 4 x 6 150 x 100 x 150	4½ 114.3	14 355.6	18¼ 463.6	11½ 292.1	61.0 27.7
6 x 5 x 3 150 x 125 x 80	1¼ 31.8	10¾ 273.1	13 330.2	8 203.2	27.0 12.2
6 x 5 x 4 150 x 125 x 100	1¼ 31.8	10¾ 273.1	13⅞ 352.4	8⅜ 212.7	31.0 14.1
8 x 6 x 4 200 x 150 x 100	1 25.4	12 304.8	14¾ 374.7	9¼ 235.0	45.0 20.4
8 x 6 x 8 200 x 150 x 200	6 152.4	18 457.2	23¼ 590.6	15¼ 387.4	95.0 43.1

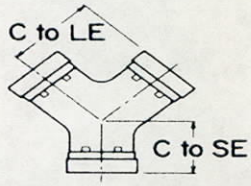
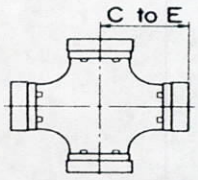
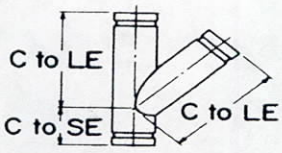
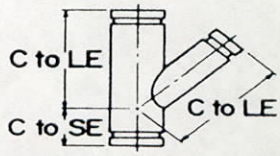


Fig. 7071 90° True Y				Fig. 7071 90° True Y			
Nominal Size Inches mm	Center to Long End Inches mm	Center to Short End Inches mm	Approx. Wt. Each lbs. kg.	Nominal Size Inches mm	Center to Long End Inches mm	Center to Short End Inches mm	Approx. Wt. Each lbs. kg.
1 25	2¼ 57.2	2¼ 57.2	1.1 0.5	6 150	6½ 165.1	4½ 114.3	21.6 9.8
1¼ 32	2¾ 69.9	2½ 63.5	1.5 0.7	8 200	7¾ 196.9	6 152.4	36.0 16.3
1½ 40	2¾ 69.9	2¾ 69.9	1.8 0.8	10 250	9 228.6	6½ 165.1	51.0 23.1
2 50	3¼ 82.6	2¾ 69.9	2.3 1.0	12 300	10 254.0	7 177.8	160.0 72.6
2½ 65	3¾ 95.3	3 76.2	5.0 2.3	14 350	11 279.4	7½ 190.5	136.0 61.7
3 80	4¼ 108.0	3¼ 82.6	6.1 2.8	16 400	12 304.8	8 203.2	166.0 75.3
3½ ▲	4½ 114.3	3½ 88.9	8.3 3.8	18 ▲	15½ 393.7	8½ 215.9	234.0 106.1
4 100	5 127.0	3¾ 95.3	10.5 4.8	20 500	17¼ 438.2	9 228.6	281.0 127.5
5 125	5½ 139.7	4 101.6	15.0 6.8	24 600	20 508.0	10 254.0	523.0 237.2

▲No equivalent metric pipe size







Nominal Size Inches mm	Fig. 7068 Cross: Center To End Inches mm	Fig. 7068 Cross: Approx. Wt. Each Lbs. kg.	Fig. 7069 45° Lateral: Center To Long End Inches mm	Fig. 7069 45° Lateral: Center To Short End Inches mm	Fig. 7069 45° Lateral: Approx. Wt. Each Lbs. kg.
1 25	2¼ 57.2	1.3 0.6	5 127.0	2¼ 57.2	1.5 0.7
1¼ 32	2¾ 69.9	2.1 1.0	5¾ 146.1	2½ 63.5	2.5 1.1
1½ 40	2¾ 69.9	2.5 1.1	6¼ 158.8	2¾ 69.9	3.5 1.6
2 50	3¼ 82.6	2.9 1.3	7 177.8	2¾ 69.9	4.5 2.0
2½ 65	3¾ 95.3	5.2 2.4	7¾ 196.9	3 76.2	10.0 4.5
3 80	4¼ 108.0	7.5 3.4	8½ 215.9	3¼ 82.6	11.0 5.0
3½ ▲	4½ 114.3	9.8 4.4	10 254.0	3½ 88.9	14.0 6.4
4 100	5 127.0	12.2 5.5	10½ 266.7	3¾ 95.3	18.3 8.3
5 125	5½ 139.7	17.6 8.0	12½ 317.5	4 101.6	30.0 13.6
6 150	6½ 165.1	28.3 12.8	14 355.6	4½ 114.3	46.6 21.1
8 200	7¾ 196.9	48.0 21.8	18 457.2	6 152.4	82.8 37.6
10 250	9 228.6	70.0 31.8	20½ 520.7	6½ 165.1	126.5 57.4
12 300	10 254.0	110.0 49.9	23 584.2	7 177.8	165.0 74.8
14 350	11 279.4	140.0 63.5	26½ 673.1	7½ 190.5	215.0 97.6
16 400	12 304.8	170.0 77.1	29 736.6	8 203.2	345.0 156.5
18 ▲	15½ 393.7	260.0 117.9	32 812.8	8½ 215.9	425.0 192.8
20 500	17¼ 438.2	320.0 145.2	35 889.0	9 228.6	517.0 234.5
24 600	20 508.0	585.0 265.4	40 1016.0	10 254.0	940.0 426.4

▲ No equivalent metric pipe size

Nominal Size Inches mm	Fig. 7070 45° Reducing Lateral: Center To Long End Inches mm	Fig. 7070 45° Reducing Lateral: Center To Short End Inches mm	Fig. 7070 45° Reducing Lateral: Approx. Wt. Each Lbs. kg.
3x3x2 80x80x50	8½ 215.9	3¼ 82.6	9.8 4.4
3x3x2½ 80x80x65	8½ 215.9	3¼ 82.6	11.5 5.2
4x4x2 100x100x50	10½ 266.7	3¾ 95.3	15.5 7.0
4x4x2½ 100x100x65	10½ 266.7	3¾ 95.3	17.0 7.7
4x4x3 100x100x80	10½ 266.7	3¾ 95.3	18.5 8.4
5x5x2 125x125x50	12½ 317.5	4 101.6	22.5 10.2
5x5x3 125x125x80	12½ 317.5	4 101.6	26.5 12.0
5x5x4 125x125x100	12½ 317.5	4 101.6	30.5 13.8
6x6x2 150x150x50	14 355.6	4½ 114.3	33.0 15.0
6x6x3 150x150x80	14 355.6	4½ 114.3	37.0 16.8
6x6x4 150x150x100	14 355.6	4½ 114.3	40.0 18.1
6x6x5 150x150x125	14 355.6	4½ 114.3	45.0 20.4
8x8x4 200x200x100	18 457.2	6 152.4	59.6 27.0
8x8x5 200x200x125	18 457.2	6 152.4	68.0 30.8
8x8x6 200x200x150	18 457.2	6 152.4	75.0 34.0
10x10x4 250x250x100	20½ 520.7	6½ 165.1	83.0 37.6
10x10x5 250x250x125	20½ 520.7	6½ 165.1	100.0 45.4
10x10x6 250x250x150	20½ 520.7	6½ 165.1	105.0 47.6
10x10x8 250x250x200	20½ 520.7	6½ 165.1	116.0 52.6
12x12x4 300x300x100	23 584.2	7 177.8	137.0 62.1
12x12x6 300x300x150	23 584.2	7 177.8	140.0 63.5
12x12x8 300x300x200	23 584.2	7 177.8	147.0 66.7

Nominal Size Inches mm	Fig. 7070 45° Reducing Lateral: Center To Long End Inches mm	Fig. 7070 45° Reducing Lateral: Center To Short End Inches mm	Fig. 7070 45° Reducing Lateral: Approx. Wt. Each Lbs. kg.
12x12x10 300x300x250	23 584.2	7 177.8	168.0 76.2
14x14x4 350x350x100	26½ 673.1	7½ 190.5	173.0 78.5
14x14x6 350x350x150	26½ 673.1	7½ 190.5	185.0 83.9
14x14x8 350x350x200	26½ 673.1	7½ 190.5	195.0 88.5
14x14x10 350x350x250	26½ 673.1	7½ 190.5	223.0 101.2
14x14x12 350x350x300	26½ 673.1	7½ 190.5	240.0 108.9
16x16x6 400x400x150	29 736.6	8 203.2	235.0 106.6
16x16x8 400x400x200	29 736.6	8 203.2	250.0 113.4
16x16x10 400x400x250	29 736.6	8 203.2	263.0 119.3
16x16x12 400x400x300	29 736.6	8 203.2	283.0 128.4
16x16x14 400x400x350	29 736.6	8 203.2	307.0 139.3
18x18x6 ▲	32 812.8	8½ 215.9	275.0 124.7
18x18x8 ▲	32 812.8	8½ 215.9	306.0 138.8
18x18x10 ▲	32 812.8	8½ 215.9	321.0 145.6
18x18x12 ▲	32 812.8	8½ 215.9	333.0 151.0
18x18x14 ▲	32 812.8	8½ 215.9	358.0 162.4
18x18x16 ▲	32 812.8	8½ 215.9	382.0 173.3
20x20x12 500x500x300	35 889.0	9 228.6	390.0 176.9
20x20x14 500x500x350	35 889.0	9 228.6	410.0 186.0
20x20x16 500x500x400	35 889.0	9 228.6	440.0 199.6
24x24x16 600x600x400	40 1016.0	10 254.0	725.0 328.9
24x24x20 600x600x500	40 1016.0	10 254.0	785.0 356.1

Concentric Reducers

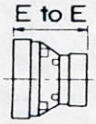


Fig. 7072 GR x GR

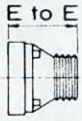


Fig. 7076 GR x THD★

Eccentric Reducers

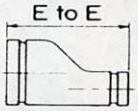


Fig. 7073 GR x GR

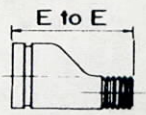


Fig. 7097 GR x THD★

Nominal Size Inches mm	Concentric End to End Inches mm	Concentric Approx. Wt. Each Lbs. kg.	Eccentric End to End Inches mm	Eccentric Approx. Wt. Each Lbs. kg.	Nominal Size Inches mm	Concentric End to End Inches mm	Concentric Approx. Wt. Each Lbs. kg.	Eccentric End to End Inches mm	Eccentric Approx. Wt. Each Lbs. kg.	Nominal Size Inches mm	Concentric End to End Inches mm	Concentric Approx. Wt. Each Lbs. kg.	Eccentric End to End Inches mm	Eccentric Approx. Wt. Each Lbs. kg.
1½x1★ 40x25	2½ 63.5	0.8 0.4	8½ 215.9	4.5 2.0	6x2★ 150x50	4 101.6	4.7 2.1	11½ 292.1	15.0 6.8	14x10 350x250	13 330.2	60.0 27.2	—	—
2x1★ 50x25	2½ 63.5	1.2 0.5	9 228.6	5.0 2.2	6x2½ 150x65	—	—	11½ 292.1	15.0 6.8	14x12 350x300	13 330.2	60.0 27.2	—	—
2x1¼★ 50x32	2½ 63.5	1.3 0.6	9 228.6	5.0 2.2	6x3 150x80	4 101.6	5.4 2.5	11½ 292.1	15.0 6.8	16x8 400x200	14 355.6	70.0 31.8	—	—
2x1½★ 50x40	2½ 63.5	1.3 0.6	9 228.6	5.0 2.2	6x4 150x100	4 101.6	5.6 2.5	11½ 292.1	17.0 7.7	16x10 400x250	14 355.6	70.0 31.8	—	—
2½x2 65x50	2½ 63.5	1.6 0.7	—	—	6x5 150x125	4 101.6	6.0 2.7	11½ 292.1	17.0 7.7	16x12 400x300	14 355.6	70.0 31.8	—	—
3x1★ 80x25	2½ 63.5	1.3 0.6	9½ 241.3	5.5 2.5	8x2½ 200x65	—	—	12 304.8	21.0 9.5	16x14 400x350	14 355.6	70.0 31.8	—	—
3x2★ 80x50	2½ 63.5	1.4 0.7	9½ 241.3	6.0 2.7	8x3 200x80	5 127.0	8.0 3.6	12 304.8	22.0 10.0	18x10 ▲	15 381.0	85.0 38.6	—	—
3x2½★ 80x65	2½ 63.5	1.6 0.7	9½ 241.3	7.0 3.2	8x4 200x100	5 127.0	9.0 4.1	12 304.8	23.0 10.4	18x12 ▲	15 381.0	85.0 38.6	—	—
3½x3 ▲	2½ 63.5	1.9 0.9	9½ 241.3	7.5 3.4	8x5 200x125	5 127.0	10.3 4.7	12 304.8	23.0 10.4	18x14 ▲	15 381.0	85.0 38.6	—	—
4x1★ 100x25	3 76.2	2.1 1.0	10 254.0	8.0 3.6	8x6 200x150	5 127.0	10.6 4.8	12 304.8	24.0 10.9	18x16 ▲	15 381.0	85.0 38.6	—	—
4x1½ 100x40	—	—	10 254.0	8.0 3.6	10x4 250x100	6 152.4	15.5 7.0	13 330.2	35.0 15.9	20x12 500x300	20 508.0	125.0 56.7	—	—
4x2★ 100x50	3 76.2	2.4 1.1	10 254.0	8.0 3.6	10x6 250x150	6 152.4	17.0 7.7	13 330.2	36.0 16.3	20x14 500x350	20 508.0	125.0 56.7	—	—
4x2½★ 100x65	3 76.2	2.6 1.2	10 254.0	8.0 3.6	10x8 250x200	6 152.4	25.0 11.3	13 330.2	37.0 16.8	20x16 500x400	20 508.0	125.0 56.7	—	—
4x3★ 100x80	3 76.2	3.2 1.5	10 254.0	8.0 3.6	12x4 300x100	—	—	14 355.6	47.0 21.3	20x18 ▲	20 508.0	125.0 56.7	—	—
4x3½ ▲	3 76.2	3.6 1.6	10 254.0	8.0 3.6	12x6 300x150	7 177.8	25.0 11.3	14 355.6	48.0 21.8	24x12 600x300	20 508.0	150.0 68.0	—	—
5x2½ 125x65	—	—	11 279.4	10.0 4.5	12x8 300x200	7 177.8	36.0 16.3	14 355.6	49.0 22.2	24x14 600x350	20 508.0	150.0 68.0	—	—
5x3 125x80	—	—	11 279.4	10.0 4.5	12x10 300x250	7 177.8	38.0 17.2	14 355.6	52.0 23.6	24x16 600x400	20 508.0	150.0 68.0	—	—
5x4 125x100	3½ 88.9	4.5 2.0	11 279.4	10.0 4.5	14x6 350x150	13 330.2	60.0 27.2	—	—	24x18 ▲	20 508.0	150.0 68.0	—	—
6x1★ 150x25	4 101.6	4.5 2.0	11½ 292.1	15.0 6.8	14x8 350x200	13 330.2	60.0 27.2	—	—	24x20 600x500	20 508.0	150.0 68.0	—	—

★Denotes available sizes for Fig. 7076 Concentric Reducer (GR x THD) and Fig. 7097 Eccentric Reducer (GR x THD) ▲ No equivalent metric pipe size

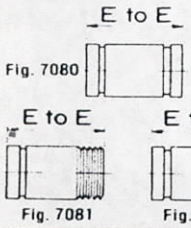
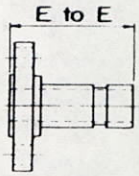


Fig. 7081 Fig. 7082 Fig. 7086 Fig. 7074

Nominal Size Inches mm	Fig. 7080 7081 7082 Adapter Nipples End To End Inches mm	Fig. 7080 7081 7082 Adapter Nipples Approx. Weight Each lbs. kg.	Fig. 7086 Hose Nipples End To End Inches mm	Fig. 7086 Hose Nipples Approx. Weight Each lbs. kg.	Fig. 7074 Cap End To End Inches mm	Fig. 7074 Cap Approx. Weight Each lbs. kg.
1 25	3 76.2	0.4 0.2	3½ 82.6	0.4 0.2	⅞ 22.2	0.3 0.1
1¼ 32	4 101.6	0.8 0.4	3⅝ 92.1	0.7 0.3	⅞ 22.2	0.4 0.2
1½ 40	4 101.6	0.9 0.4	4 101.6	0.8 0.4	⅞ 22.2	0.5 0.2
2 50	4 101.6	1.2 0.5	4⅝ 117.5	1.3 0.6	⅞ 22.2	0.6 0.3
2½ 65	4 101.6	1.9 0.9	5½ 139.7	2.1 1.0	⅞ 22.2	0.8 0.4
3 80	4 101.6	2.5 1.1	6 152.4	3.3 1.5	⅞ 22.2	1.1 0.5
3½ ▲	4 101.6	3.1 1.4	—	—	⅞ 22.2	1.5 0.7
4 100	6 152.4	5.5 2.5	7¼ 184.2	5.5 2.5	1 25.4	2.8 1.3
5 125	6 152.4	7.4 3.4	9¾ 247.7	8.1 3.7	1 25.4	4.2 1.9
6 150	6 152.4	9.5 4.3	11 279.4	13.2 6.0	1 25.4	6.0 2.7
8 200	6 152.4	14.2 6.4	12½ 317.5	24.0 10.9	1 3/16 30.2	11.0 5.0
10 250	8 203.2	27.0 12.2	14 355.6	29.0 13.2	1¼ 31.8	19.0 8.7
12 300	8 203.2	33.0 15.0	16 406.4	46.0 20.9	1¼ 31.8	23.5 10.7



Adapter Flanges

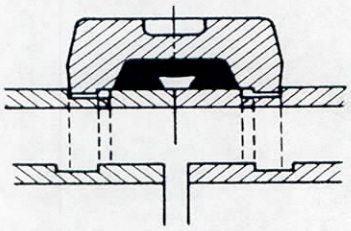
Nominal Size Inches mm	Fig. 7083 Groove X Class 125 C.I. Flange End To End Inches mm	Fig. 7083 Groove X Class 125 C.I. Flange Approx. Weight Each lbs. kg.	Fig. 7084 Groove X Class 150 Flange End To End Inches mm	Fig. 7084 Groove X Class 150 Flange Approx. Weight Each lbs. kg.	Fig. 7085 Groove X Class 300 Flange End To End Inches mm	Fig. 7085 Groove X Class 300 Flange Approx. Weight Each lbs. kg.
1 25	3 76.2	2.2 1.0	3 76.2	2.5 1.1	3 76.2	3.6 1.6
1¼ 32	4 101.6	2.8 1.3	4 101.6	3.8 1.7	4 101.6	4.6 2.1
1½ 40	4 101.6	3.2 1.5	4 101.6	4.1 1.9	4 101.6	7.1 3.2
2 50	4 101.6	5.2 2.4	4 101.6	6.0 2.7	4 101.6	8.2 3.7
2½ 65	4 101.6	8.0 3.6	4 101.6	9.2 4.2	4 101.6	11.9 5.4
3 80	4 101.6	10.2 4.6	4 101.6	10.4 4.7	4 101.6	15.5 7.0
3½ ▲	4 101.6	12.0 5.4	4 101.6	14.0 6.4	4 101.6	21.0 9.5
4 100	6 152.4	17.2 7.8	6 152.4	19.1 8.7	6 152.4	28.0 12.7
5 125	6 152.4	21.4 9.7	6 152.4	23.0 10.4	6 152.4	35.0 15.9
6 150	6 152.4	26.0 11.8	6 152.4	29.5 13.4	6 152.4	50.0 22.7
8 200	6 152.4	38.4 17.4	6 152.4	43.5 19.7	6 152.4	72.0 32.7

DESIGN FACTORS

Movement

Each flexible design Gruvlok coupling can provide for pipe system movement up to the design maximum for the specific size and type coupling being utilized. Movement is possible in the Gruvlok coupling due to two factors: (1) designed-in clearance between the key of the coupling and the groove diameter and groove width, and (2) the gap between pipe ends joined by the coupling.

Linear Movement



Linear Movement:

Linear movement is accommodated within the coupling by allowing the pipe ends to move together or apart in response to pressure thrusts and temperature changes. The available linear movement provided by Standard Gruvlok couplings is as shown by the following:

Linear Movement

Sizes: 1" through 3½"
Linear Movement: 0" to ⅛"

Sizes: 4" through 24"
Linear Movement: 0" to ¼"

The maximum available linear movement is the difference between the maximum and minimum pipe end separation within the coupling and is shown in the coupling performance data for each Gruvlok coupling type (see Section 1).

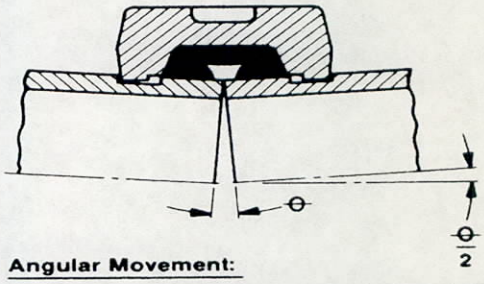
When designing a Gruvlok piping system, an allowance must be made for tolerances in the pipe, groove and coupling. To accomplish this, the Linear movement should as factored as shown below:

Linear Movement Design Factors

Sizes: 1" through 3½"
Reduce maximum movement by 50%

Sizes: 4" through 24"
Reduce maximum movement by 25%

Angular Movement



Angular Movement:

Designed in clearances allow limited deflection of the pipe joint within the coupling, without introducing eccentric loads into the coupling joint.
The maximum available angular movement of Gruvlok coupling joints is shown in the performance data for each coupling type. The amount of angular flexibility varies for each coupling size and type. For design purposes the published figures should be reduced by the below listed factors to account for pipe, groove and coupling tolerances.

Angular Movement Design Factors:

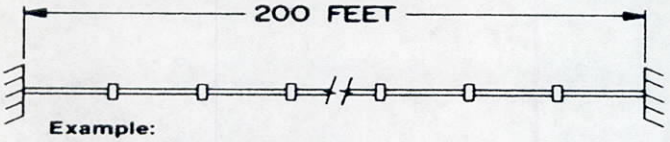
Sizes: 1" through 3½"
Reduce maximum movement by 50%

Sizes: 4" through 24"
Reduce maximum movement by 25%

MOVEMENT APPLICATIONS

Thermal Movement:

A sufficient amount of coupling joints must be provided to accommodate the calculated movement (expansion or contraction) in a pipe run or segment thereof.



Example:

A 200 foot long straight run of 4" steel pipe between anchor points

Minimum Temperature: 40° F. (at time of installation)

Maximum Oper. Temperature: 160° F.

Thermal expansion tables (refer to page 44) show this system will expand a total of 1.80" due to the temperature change.

How many coupling are required to account for the thermal growth?

Available Movement Per Coupling

0.25"	Movement per Coupling (4" Fig. No. 7001 Coupling Performance Data)
× **75%**	Movement Factor (refer to page 37)
0.187"	Movement Available per Coupling

Coupling Required

1.80"	Movement in 200 Ft.
÷ **0.187"**	Movement available per coupling
9.62	Coupling required. Use 10 couplings

In order for the couplings to provide for the movement indicated by the above example it would be necessary to install all couplings with the maximum gap between pipe ends. Conversely if the thermal movement was contraction due to a reduction of system temperature, the coupling joints would have to be installed with the pipe ends butted thus accommodating the "shrink" of the pipe system.

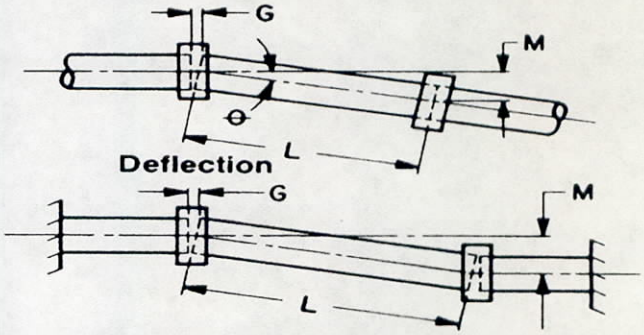
In either case the pipe run in question would have to be anchored at the proper locations to direct pipe system expansion or contraction into the coupling joints.

As can be seen from the above example the pipe end gap within the coupling joint must be considered when designing a grooved-end pipe system to accommodate thermal movement. The couplings *do not* automatically provide for expansion and contraction of piping.

Misalignment and Deflections

The angular movement capability of the Gruvlok coupling permits the assembly of pipe joints where the piping is not properly aligned. At least two couplings are required to provide for lateral pipe misalignment. Deflection (longitudinal misalignment) may be accommodated within a single coupling as long as the angle of deflection does not exceed the value shown in the coupling performance data for the particular size and coupling type.

A pipe joint that utilizes the angular deflection capability of the Gruvlok coupling will react to pressure and thermal forces dependent upon the manner in which it is restrained. An unrestrained joint will react to these forces by straightening, thus reducing, if not eliminating, the deflection at the joint. If joint deflection has been designed into the pipe layout and must be maintained, then sufficient anchors must be provided to resist the lateral forces and hold the joint in the deflected condition.



The amount of deflection from pipe run centerline can be calculated utilizing the following equations:

$$M = L \sin \theta$$

$$\theta = \sin^{-1}\left(\frac{G}{D}\right)$$

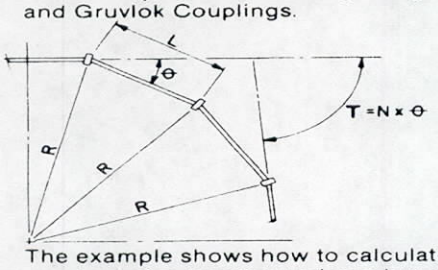
$$M = \frac{G \times L}{D}$$

Where:

- **M** = Misalignment (Inches)
- **G** = Maximum Allowable Pipe End Movement (Inches) as shown under "Performance Data" (Value to be reduced by Design Factor)
- **θ** = Maximum Deflection (Degrees) from centerline as shown under "Performance Data" (Value to be reduced by Design Factor)
- **D** = Pipe Outside Diameter (Inches)
- **L** = Pipe Length (Inches)

Curve Layout:

Utilizing the angular deflection at each coupling joint curves may be laid out using straight pipe lengths and Gruvlok Couplings.



The example shows how to calculate the curve radius, required pipe lengths, and number of required couplings.

$$R = \frac{L}{2 \sin\left(\frac{\theta}{2}\right)}$$

$$L = 2R \sin\left(\frac{\theta}{2}\right)$$

$$N = \frac{T}{\theta}$$

Where:

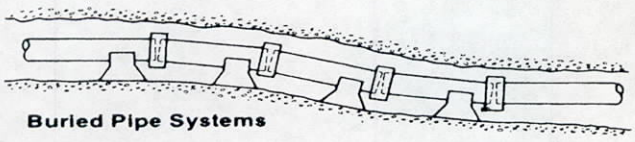
- **N** = Number of Couplings
- **R** = Radius of Curve (feet)
- **L** = Pipe Length (feet)
- **θ** = Deflection from centerline (Degrees) of each Coupling. (See coupling performance data value to be reduced by Design Factor)
- **T** = Total Angular Deflection of all Couplings

Drainage, Buried Systems, Etc.

The flexible design of the Gruvlok coupling makes it ideal for use in a wide variety of systems in which random changes of the pipe direction can be accommodated by the Gruvlok coupling's angular deflection capability rather than requiring the use of special fittings.

Pitched drainage systems, buried pipe systems where pipe laying conditions are subject to settlement, and exposed pipe systems laid on rough ground are but a few of the many types of pipe installations that present conditions that can be provided for within the functional capability of the Gruvlok coupling.

Pitched for Drainage

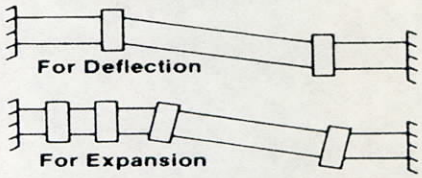


Buried Pipe Systems

Combined Linear and Angular Movement:

The clearance in the grooved coupling joint, will allow a limited capability for combined linear and angular movement. A partially deflected joint will not provide full linear movement capability. A fully deflected coupling joint provides no linear movement capability. The Gruvlok coupling will not allow for both maximum linear and maximum angular movement simultaneously. In systems where both are expected, additional joints may be required.

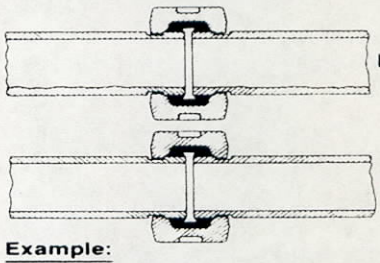
Fully Deflected Joint Will Not Allow For Linear Expansion



In the example above, two couplings were added to account for thermal expansion and the other couplings accommodate only the misalignment. The additional stress from the combined movement is therefore relieved.

Rotational Movement:

Piping systems designed with Gruvlok Couplings can accommodate minor rotational movement from thermal expansion, settlement, vibration, or other similar movements. However, Gruvlok Couplings should never be used as a continuous swivel joint.



Example:

Utilizing the rotational capability of the Gruvlok Coupling, the pipe life of a slurry or similar coarse material, piping system can be extended. For pipe rotation, the system should be shut down and internal pressure relieved. The pipe may then be rotated one-quarter turn, the couplings retightened, and service resumed. If performed on a regular basis, pipe rotation will evenly distribute wear over the entire inner surface of the pipe.

PIPE SUPPORT

When designing the hangers, supports and anchors for a grooved end pipe system, the piping designer must consider certain unique characteristics of the grooved type coupling in addition to many universal pipe hanger and support design factors. As with any pipe system, the hanger or support system must provide for 1) the weight of the pipe, couplings, fluid and pipe system components; 2) reduce stresses at pipe joints; and 3) permit required pipe system movement to relieve stress.

The following special factors should be considered when designing hangers and supports for a grooved end pipe system.

Pipe Hanger Spacing:

The following charts show the maximum span between pipe hangers for straight runs of standard weight steel pipe filled with water or other similar fluids. Do not use these values where critical span calculations are made or where there are concentrated loads between supports.

For straight runs without concentrated loads and where full linear movement is not required.

Nominal Pipe Size Range	Maximum Span Between Hangers
¾" — 1"	7'
1¼" — 2"	10'
2½" — 4"	12'
5" — 8"	14'
10" — 12"	16'
14" — 16"	18'
18" — 24"	20'

For straight runs without concentrated loads and where full linear movement is required.

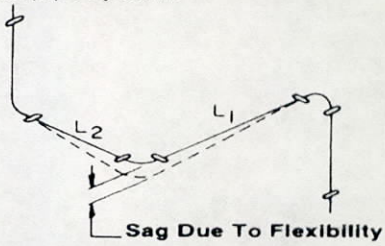
Nominal Pipe Size Range	Pipe Length in Feet *									
	7'	10'	12'	15'	20'	22'	25'	30'	35'	40'
	*Average Hangers Per Pipe Length Evenly Spaced									
¾" — 1"	1	2	2	2	3	3	4	4	5	6
1¼" — 2"	1	2	2	2	3	3	4	4	5	6
2½" — 4"	1	1	2	2	2	2	2	3	4	4
5" — 8"	1	1	1	2	2	2	2	3	3	3
10" — 12"	1	1	1	2	2	2	2	3	3	3
14" — 16"	1	1	1	2	2	2	2	3	3	3
18" — 24"	1	1	1	2	2	2	2	3	3	3

* No pipe length should be left unsupported between any two couplings.

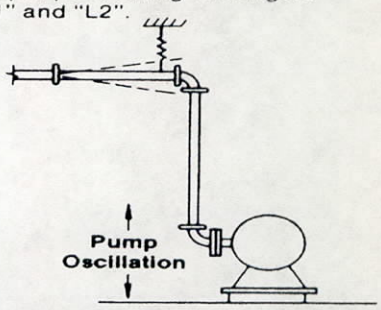
For more detailed information on the designing of pipe support systems refer to the "Grinnell Pipe Hanger Design and Engineering Manual."

Coupling Flexibility:

The grooved coupling's capability to allow angular and rotational movement within the coupling joint must be considered when deciding hanger and support locations. Spring hangers and supports providing for movement in more than one plane are often used to allow the pipe system to move without introducing additional stress into the pipe system.



Example 1 demonstrates the need for each pipe length in a grooved system to be supported. The sag due to the flexibility of the Gruvlok joint could be eliminated with the proper positioning of hangers on both "L1" and "L2".



Example 2 illustrates the effect of pump oscillation on a piping system. A spring hanger should be used to support the pipe section and also respond to the induced vibrations. The couplings in the horizontal run above the riser, should accommodate the deflection without transmitting bending stresses through the pipe system.

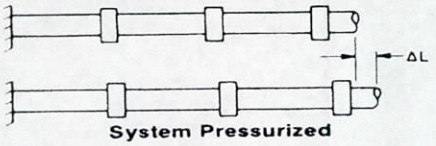
Pressure Thrusts

Gruvlok couplings react to the application of system pressure and restrain the pipe ends from separation due to the pressure force. However, the coupling joint may not be in the self-restraining configuration prior to the application of system pressure.
The Gruvlok coupling does not restrain adjacent pipe section from separation due to pressure forces until the coupling key sections engage the groove walls.

Random coupling joint installation will produce installed coupling conditions ranging from pipe ends fully butted to fully separated to the maximum available gap.
Thus, only after system pressurization will the self-restraining function of the coupling be in effect.
The designer must account for the movement to be encountered when the system is pressurized and the joints are fully separated. Anchor and guide positions must be defined to direct the pipe joint movement such that it is not detrimental to the pipe system.

Examples of the effect of pressure thrust are shown in the following illustrations.

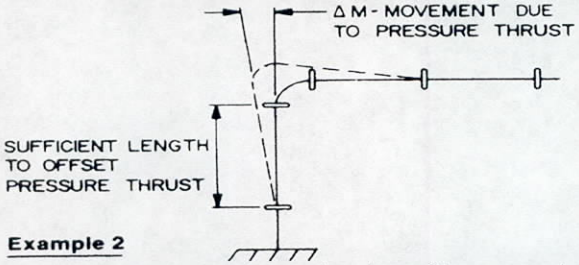
System With No Pressure



System Pressurized

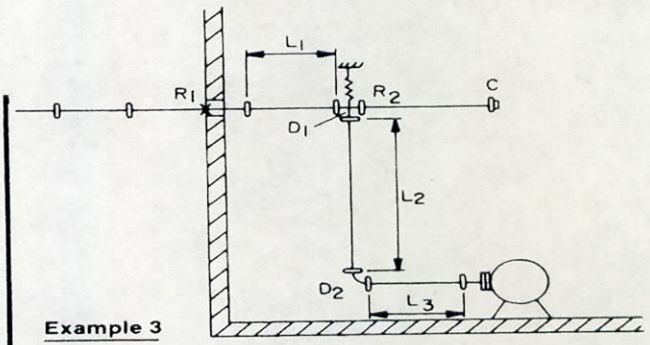
Example 1

The coupling joints have been installed butted or partially open. When pressurized the pipe ends in the coupling joints will separate to the maximum amount permitted by the coupling design.
The coupling key sections will make contact with the groove walls and restrain the pipe from further separation.
The movement at each coupling joint will add with all other joints and produce ΔL.



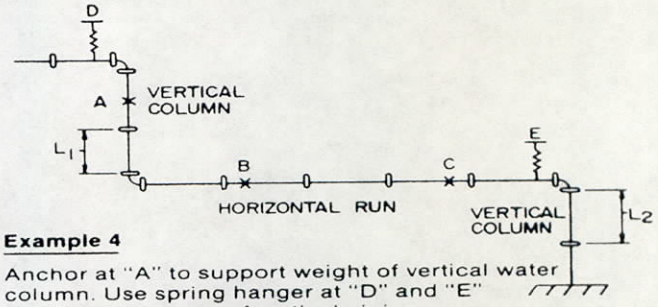
Example 2

In the system shown here, the pipe will move and deflect at the elbow joint due to pressure thrust.
The pipe designer must assure himself that the system has the capability of deflecting sufficiently to absorb this movement without introducing additional stresses into the pipe system. In the deflected condition shown, temperature increases would produce further expansion of the pipe system thus increasing the deflection.



Example 3

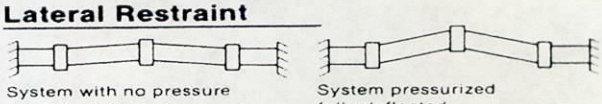
To restrain this system provide a pressure thrust anchor at "R1" to resist the pressure thrust acting through the tee "D1" at the cap "C". Provide a hanger at Point "R2", or a base support at Point "D2" to support the vertical column. If the offsets L_1, L_2, and L_3 are of adequate length to handle expected pipe movements, no additional anchoring is required.
Thermal movement of the pipe system should also be considered, and intermediate anchors located as required, to direct the pipe movement so as to prevent introducing bending stresses into the system.



Example 4

Anchor at "A" to support weight of vertical water column. Use spring hanger at "D" and "E" to allow movement of vertical piping.
Anchors at "B" and "C" if offsets at L_1 and L_2 are insufficiently long to handle expected pipe movements.

Lateral Restraint



System with no pressure partially deflected

System pressurized fully deflected

Example 5

A grooved coupling joint installed in a partially deflected condition between anchor locations will deflect to its fully deflected condition when pressurized. Hangers and supports must be selected with consideration of the hanger's capability to provide lateral restraint.
Light duty hangers, while acceptable in many installations, may deflect against the application of lateral forces and result in "snaking" conditions of the pipe system.

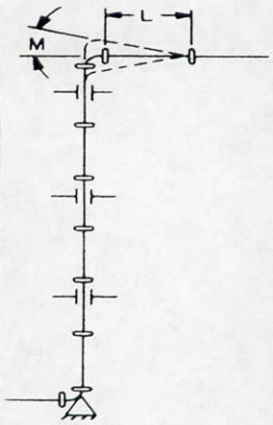
RISER DESIGN

Risers assembled with Gruvlok couplings are generally installed in either of two ways. In the most common method, the pipe ends are butted together within the coupling joint. Note that when installing risers, the gasket is first placed onto the lower pipe and rolled back away from the pipe end prior to positioning the upper pipe. Anchoring of the riser may be done prior to pressurization with the pipe ends butted or while pressurized, when, due to pressure thrust, the pipe ends will be fully separated.

An alternative method of riser installation is to place a metal spacer of a predetermined thickness, between the pipe ends when an additional length of pipe is added to the riser stack. The upper pipe length is anchored, the spacer removed and the coupling is then installed. This method creates a predetermined gap at each pipe joint which can be utilized in pipe systems where thermal movement is anticipated and in systems with rigid (threaded, welded, flanged) branch connections where shear forces due to pressure thrust could damage the rigid connections.

The following examples illustrate methods of installing commonly encountered riser designs.

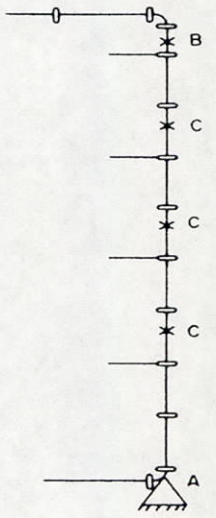
Risers Without Branch Connections



Install the riser with the pipe ends butted. Locate an anchor at the base of the riser (A) to support the total weight of the pipe, couplings and fluid. Provide pipe guides on every other pipe length, as a minimum, to prevent possible deflection of the pipe line at the coupling joints as the riser expands due to pressure thrust or thermal growth. Note that no intermediate anchors are required.

When the system is pressurized the pipe stack will "grow" due to pressure thrust which causes maximum separation of pipe ends within the couplings. This maximum amount of stack growth can be predetermined (see Linear Movement on Pg. 37). In this example the pipe length "L" at the top of the riser must be long enough to permit sufficient deflection (see Angular Movement Pg. 37) to accommodate the total movement "M" from both pressure thrust and thermal gradients.

Risers With Branch Connections



Install the riser with the predetermined gap method. Anchor the pipe at or near the base with a pressure thrust anchor "A" capable of supporting the full pressure thrust, weight of pipe and the fluid column. Anchor at "B" with an anchor capable of withstanding full pressure thrust at the top of the riser plus weight of pipe column. Place intermediate anchors "C" as shown, between anchors "A" and "B". Also place intermediate clamps at every other pipe length as a minimum.

When this system is pressurized, the pipe movement due to pressure thrust will be restrained and there will be no shear forces acting at the branch connections.

PIPE PREPARATION

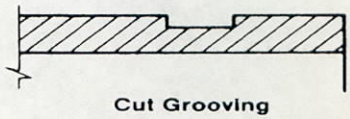
To create a Gruvlok pipe joint, all pipe must be prepared to receive Gruvlok coupling or other Gruvlok pipe system components. The required pipe preparation may be grooving, cutting a hole, or cleaning the pipe ends.

For grooved-end joints pipe may be grooved by either of two distinct methods; cut or roll grooving. Branch outlet connections require a properly sized and correctly located hole to be cut into the pipe. Sock-It connections require cleaning of the pipe end. Gruvlok plain-end pipe couplings do not require grooving, but only that the pipe be free from burrs and other sharp projections which could damage the gasket.

Gruvlok pipe grooving and hole cutting machines are available in a wide variety of designs to meet specific or general requirements. Gruvlok pipe grooving machines produce a groove to proper dimensional tolerances, concentric with the pipe O.D., even on out-of-round pipe. Gruvlok hole cutting tools properly center holes for correct assembly of Gruvlok branch outlet components.

Cut Grooving

Cut grooving is intended for use with standard or heavier wall pipe. Cut grooving produces a groove in the pipe wall by removing metal from the pipe O.D. The groove does not cut as deeply into the pipe wall as does standard pipe threads and much less metal is removed from the pipe wall by the cut groove. The square cut edge of the groove allows for the full expansion, contraction, and deflection capabilities of the Gruvlok coupling.



Cut Grooving

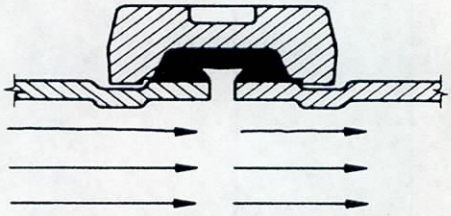
Depth of Cut Groove Vs Threaded

Volume of Metal Removed Cut Groove Vs Threaded

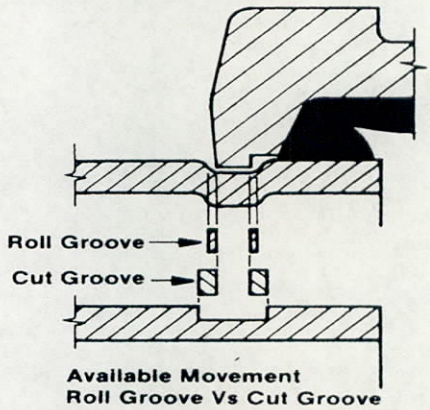
Roll Grooving

Roll grooving does not remove metal. Instead, metal is displaced while forming a groove into the outer surface of the pipe wall. The groove configuration has rounded edges resulting in a less flexible joint which reduces available pipe joint movement by 50% over cut grooved coupling joints. Roll grooving is used on a wide range of pipe thicknesses to 0.375" wall steel pipe and sizes to 24" O.D.

Roll Grooving

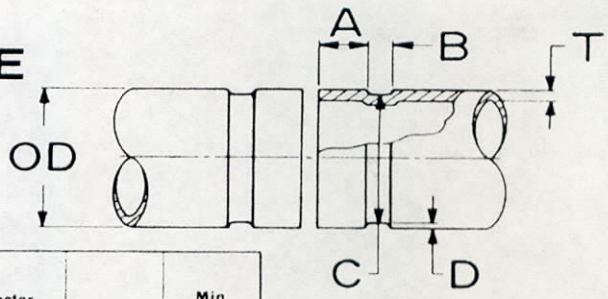


The I.D. "dimple" formed from roll grooving reduces the I.D. (on an average) less than 2%. Tests show less than 0.1 psi (.000684 MPa) pressure drop in 4" (101.6 mm) pipe.



Available Movement Roll Groove Vs Cut Groove

GRUVLOK STANDARD ROLL GROOVE SPECIFICATIONS FOR STEEL & OTHER IPS PIPE

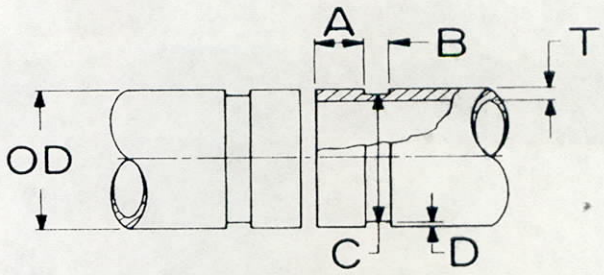


Nominal Size Inches mm	Pipe Outside Diameter Inches mm			Gasket Seat A +0.015 −0.030	Groove Width B +0.030 −0.015	Groove Diameter C		Groove Depth D	Min. Allow. Wall Thick. T
	Actual	Tolerance +	Tolerance −			Actual	Tol. +0.000		
1 25	1.315 33.7	+0.016 +0.406	-0.016 -0.406	0.625 15.875	0.281 7.137	1.190 30.226	-0.015 -0.381	0.063 1.600	0.065 1.651
1¼ 32	1.660 42.4	+0.016 -0.406	-0.016 -0.406	0.625 15.875	0.281 7.137	1.535 38.989	-0.015 -0.381	0.063 1.600	0.065 1.651
1½ 40	1.900 48.3	+0.016 -0.406	-0.016 -0.406	0.625 15.875	0.281 7.137	1.775 45.085	-0.015 -0.381	0.063 1.600	0.065 1.651
2 50	2.375 60.3	+0.024 -0.610	-0.016 -0.406	0.625 15.875	0.344 8.738	2.250 57.150	-0.015 -0.381	0.063 1.600	0.065 1.651
2½ 65	2.875 73.0	+0.029 -0.737	-0.016 -0.406	0.625 15.875	0.344 8.738	2.720 69.088	-0.015 -0.381	0.078 1.981	0.083 2.108
3 O.D. 65	3.000 76.1	+0.030 -0.762	-0.018 -0.457	0.625 15.875	0.344 8.738	2.845 72.263	-0.015 -0.381	0.078 1.981	0.083 2.108
3 80	3.500 88.9	+0.030 -0.762	-0.018 -0.457	0.625 15.875	0.344 8.738	3.344 84.938	-0.015 -0.381	0.078 1.981	0.083 2.108
3½ ▲	4.000 ▲	+0.030 +0.762	-0.018 -0.457	0.625 15.875	0.344 8.738	3.834 97.384	-0.015 -0.381	0.083 2.108	0.083 2.108
4 100	4.500 114.3	+0.035 -0.889	-0.020 -0.508	0.625 15.875	0.344 8.738	4.334 110.084	-0.015 -0.381	0.083 2.108	0.083 2.108
5 125	5.563 141.3	+0.050 -1.270	-0.022 -0.559	0.625 15.875	0.344 8.738	5.395 137.033	-0.015 -0.381	0.084 2.134	0.109 2.769
6 150	6.625 168.3	+0.050 -1.270	-0.024 -0.610	0.625 15.875	0.344 8.738	6.455 163.957	-0.015 -0.381	0.085 2.159	0.109 2.769
6½ O.D. 150	6.500 165.1	+0.050 +1.270	-0.024 -0.610	0.625 15.875	0.344 8.738	6.330 160.782	-0.015 -0.381	0.085 2.159	0.109 2.769
8 200	8.625 219.1	+0.050 +1.270	-0.024 -0.610	0.750 19.050	0.469 11.913	8.441 214.401	-0.020 -0.508	0.092 2.337	0.109 2.769
10 250	10.750 273.0	+0.060 +1.524	-0.025 -0.635	0.750 19.050	0.469 11.913	10.562 268.275	-0.025 -0.635	0.094 2.388	0.134 3.404
12 300	12.750 323.9	+0.060 +1.524	-0.025 -0.635	0.750 19.050	0.469 11.913	12.531 318.287	-0.025 -0.635	0.109 2.769	0.156 3.962
14 350	14.000 355.6	+0.060 -1.524	-0.025 -0.635	0.938 23.825	0.469 11.913	13.781 350.037	-0.025 -0.635	0.109 2.769	0.156 3.962
16 400	16.000 406.4	+0.060 -1.524	-0.025 -0.635	0.938 23.825	0.469 11.913	15.781 400.837	-0.025 -0.635	0.109 2.769	0.165 4.191
18 ▲	18.000 ▲	+0.060 +1.524	-0.030 -0.762	1.000 25.400	0.469 11.913	17.781 451.637	-0.025 -0.635	0.109 2.769	0.165 4.191
20 500	20.000 508.0	+0.060 -1.524	-0.030 -0.762	1.000 25.400	0.469 11.913	19.781 502.437	-0.025 -0.635	0.109 2.769	0.188 4.775
24 600	24.000 609.6	+0.060 -1.524	-0.030 -0.762	1.000 25.400	0.500 14.300	23.656 600.862	-0.025 -0.635	0.172 4.369	0.188 4.775

- Depth of groove "D" minimum dimension listed are important to coupled pipe performance.
- Pipe ends must be square cut. Maximum allowable tolerance from square cut end is .030" for sizes 3½" through 3½", .045" for sizes 4" through 6", and .060" for sizes 8" and above measured from true square line.
- Difference between maximum OD and minimum OD measured at 90° must not exceed total OD tolerance listed.
- Gasket seat must be free from scores and seams.

▲ No equivalent metric pipe size.

GRUVLOK STANDARD CUT GROOVE SPECIFICATIONS FOR STEEL & OTHER METALLIC IPS PIPE



Nominal Size Inches mm	Pipe Outside Diameter Inches mm			Gasket Seat A +0.031 −0.031	Groove Width B +0.031 −0.031	Groove Diameter C		Groove Depth D	Min. Allow. Wall Thick. T
	Actual	Tolerance +	Tolerance —			Actual	Tol. +0.000		
1 25	1.315 33.7	+0.013 +0.330	-0.013 -0.330	0.625 15.875	0.312 7.925	1.190 30.226	-0.015 -0.381	0.062 1.575	0.133 3.378
1¼ 32	1.660 42.4	+0.016 +0.406	-0.016 -0.406	0.625 15.875	0.312 7.925	1.535 38.989	-0.015 -0.381	0.062 1.575	0.140 3.556
1½ 40	1.900 48.3	+0.019 +0.483	-0.019 -0.483	0.625 15.875	0.312 7.925	1.775 45.085	-0.015 -0.381	0.062 1.575	0.145 3.683
2 50	2.375 60.3	+0.024 +0.610	-0.024 -0.610	0.625 15.875	0.312 7.925	2.250 57.150	-0.015 -0.381	0.062 1.575	0.154 3.912
2½ 65	2.875 76.1	+0.029 +0.737	-0.029 -0.737	0.625 15.875	0.312 7.925	2.270 69.088	-0.018 -0.457	0.078 1.981	0.187 4.750
3 O.D. 65	3.000 76.1	+0.030 +0.762	-0.030 -0.762	0.625 15.875	0.312 7.925	2.845 72.263	-0.018 -0.457	0.078 1.981	0.188 4.775
3 80	3.500 88.9	+0.035 +0.889	-0.031 -0.787	0.625 15.875	0.312 7.925	3.344 84.938	-0.018 -0.457	0.078 1.981	0.188 4.775
3½ ▲	4.000 ▲	+0.040 +1.016	-0.031 -0.787	0.625 15.875	0.312 7.925	3.834 97.384	-0.020 -0.508	0.083 2.108	0.188 4.775
4 100	4.500 114.3	+0.045 +1.143	-0.031 -0.787	0.625 15.875	0.375 9.525	4.334 110.084	-0.020 -0.508	0.083 2.108	0.203 5.156
5 125	5.563 139.7	+0.056 +1.422	-0.031 -0.787	0.625 15.875	0.375 9.525	5.395 137.033	-0.022 -0.559	0.084 2.134	0.203 5.156
6 150	6.625 168.3	+0.063 +1.600	-0.031 -0.787	0.625 15.875	0.375 9.525	6.455 163.957	-0.022 -0.559	0.085 2.159	0.219 5.563
6½ O.D. 150	6.500 165.1	+0.063 +1.600	-0.031 -0.787	0.625 15.875	0.375 9.525	6.330 160.782	-0.022 -0.559	0.085 2.159	0.219 5.563
8 200	8.625 219.1	+0.063 +1.600	-0.031 -0.787	0.750 19.050	0.437 11.100	8.441 214.401	-0.025 -0.635	0.092 2.337	0.238 6.045
10 250	10.750 273.0	+0.063 +1.600	-0.031 -0.787	0.750 19.050	0.500 12.700	10.562 268.275	-0.027 -0.686	0.094 2.388	0.250 6.350
12 300	12.750 323.9	+0.063 +1.600	-0.031 -0.787	0.750 19.050	0.500 12.700	12.531 318.287	-0.030 -0.762	0.109 2.769	0.279 7.087
14 350	14.000 355.6	+0.063 +1.600	-0.031 -0.787	0.938 23.825	0.500 12.700	13.781 350.037	-0.030 -0.762	0.109 2.769	0.281 7.137
16 400	16.000 406.4	+0.063 +1.600	-0.031 -0.787	0.938 23.825	0.500 12.700	15.781 400.837	-0.030 -0.762	0.109 2.769	0.312 7.925
18 ▲	18.000 ▲	+0.063 +1.600	-0.031 -0.787	1.000 25.400	0.500 12.700	17.781 451.637	-0.030 -0.762	0.109 2.769	0.312 7.925
20 500	20.000 508.0	+0.063 +1.600	-0.031 -0.787	1.000 25.400	0.500 12.700	19.781 502.437	-0.030 -0.762	0.109 2.769	0.312 7.925
24 600	24.000 609.6	+0.063 +1.600	-0.031 -0.787	1.000 25.400	0.563 14.300	23.656 600.862	-0.030 -0.762	0.172 4.369	0.375 9.525
28 I.D. ▲	28.875 ▲	+0.063 +1.600	-0.031 -0.787	1.000 25.400	0.563 14.300	28.531 724.687	-0.030 -0.762	0.172 4.369	0.437 11.100
30 I.D. ▲	31.000 ▲	+0.063 +1.600	-0.031 -0.787	1.250 31.750	0.625 15.875	30.594 777.088	-0.030 -0.762	0.203 5.156	0.500 12.700

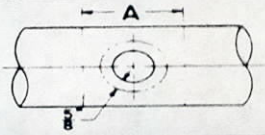
- For grooving pipe with wall thickness less than "T", see Roll Grooving Specifications.
- Gasket seat must be smooth and free from scores and seams.
- Pipe ends must be square cut — maximum allowable tolerance from square cut ends is .020" for sizes ¾" through 3½", .030" for sizes 4" through 8", and .045" for sizes 10" through 24", measured from true square line.
- Difference between maximum OD and minimum OD measured at 90° must not exceed total OD tolerance listed.
- All tolerances not shown are to comply with latest API or ASTM specification applicable to material being used.

▲ No equivalent metric pipe size.

Branch Outlet Pipe: "Ease Tee"™ & "Clamp-T"™

"Ease Tee" and "Clamp-T" installations require the cutting of a hole through the pipe wall. This hole must be properly sized and located on the centerline of the pipe to assure reliable performance of the "Ease Tee" and "Clamp-T" gaskets.
After the hole has been cut into the pipe wall, any burrs and sharp or rough edges must be removed from the hole. The outside pipe surface with in 5/8" from the hole must be clean and smooth. Any scale, projections or indentations which might affect the gasket sealing on the pipe must be removed.
The surface around the entire circumference of the pipe within the "A" dimension in the charts must be free from dirt, scale, or projections which might affect the proper assembly of the "Ease Tee" or "Clamp-T".

Ease Tee™			
Branch Size Inches mm	Hole Dimensions		Surface Prep.
	Hole Saw Size Inches mm	Max. Perm. Diameter Inches mm	"A" Dimension Inches mm
½ 15	1 25.4	1 1/16 27.0	2 1/8 54.0
¾ 20	1 25.4	1 1/16 27.0	2 1/8 54.0
1 25	1 25.4	1 1/16 27.0	2 1/8 54.0

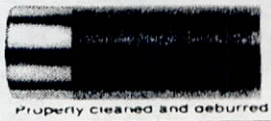


Clamp-T™			
Branch Size Inches mm	Hole Dimensions		Surface Prep.
	Hole Saw Size Inches mm	Max. Perm. Diameter Inches mm	"A" Dimension Inches mm
½, ¾, 1 15, 20, 25	1½ 38.1	1 5/8 41.3	3½ 88.9
1¼, 1½ 32, 40	2 50.8	2 1/8 54.0	4 101.6
2 50	2½ 63.5	2 5/8 66.7	4½ 114.3
2½ 65	2¾ 69.9	2 7/8 73.0	4¾ 120.7
3 80	3½ 88.9	3 5/8 92.1	5½ 139.7
4 100	4½ 114.3	4 5/8 117.5	6½ 165.1

Sock-It™

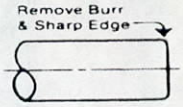
For Sock-It Fittings, the pipe ends must be square cut as measured from a true square line. The maximum allowable tolerance is 0.030" (0.76mm) for all sizes. Any sharp edges, burrs, etc. left on the pipe from cutting must be removed. If these are not removed, they may damage the gasket as the pipe is inserted into the "Sock-It".
After cutting, pipe ends must be completely cleaned a minimum of 1" (25.4mm) back from the pipe end to remove all pipe coating, weld beads, rust, sharp projections, etc., which might affect gasket seating integrity.

Pipe Tolerances			
Size Inches mm	Nom. O.D. Inches mm	Max. O.D. Inches mm	Min. O.D. Inches mm
1 25	1.315 33.401	1.325 33.655	1.295 32.944
1¼ 32	1.660 42.164	1.670 42.418	1.642 41.707
1½ 40	1.900 48.260	1.910 48.514	1.882 47.803
2 50	2.375 60.325	2.385 60.579	2.357 59.868

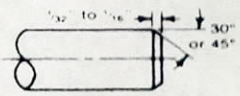


Properly cleaned and deburred

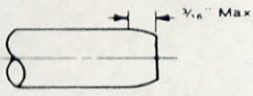
PIPE END CONFIGURATION: ACCEPTABLE



Square cut pipe with O.D. burr and sharp edge removed is preferred configuration

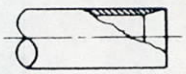


Bevelled pipe
Bevel not to exceed 1/16"

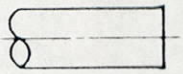


Soft pipe when roll cut may be swaged inward. Swaged portion not to exceed 3/16"

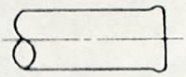
UNACCEPTABLE



Excessive chamfer on I.D. will tend to cut gasket during assembly



Abrasive wheels and saws leave edge burrs especially pronounced on one side. Burrs and sharp edge not acceptable



Dull wheel cutter pushes a ridge up at the pipe O.D. giving an oversize diameter

The sharp O.D. edge left by different methods of cutting pipe must be removed. If this sharp edge is not removed, it may damage the gasket as the pipe is inserted into the "Sock-It" fitting.

Roughneck™

Plain end pipe for use with Fig. 7005 Roughneck Couplings must be free of any notches, bumps, weld bead, score marks, etc. for at least 1½" (38mm) back from the pipe end to provide a smoother sealing surface for the gasket.
Pipe ends (plain or beveled end) must be square cut as measured from a true square line with the maximum allowable tolerance as follows: 0.030" (0.7mm) for 2" through 3½"; 0.045" (1.1mm) for 4" through 6"; and 0.060" (1.5mm) for 8" and larger sizes. The nominal outside diameter of pipe should not vary more than ±1% for sizes up to 2½"; +1% -1/32" for sizes 3" - 5"; +1/16" -1/32" for 6" sizes and up.
Pipe ends must be marked a distance of 1" from the pipe end for Size 2"-4" and 1¼" from the pipe end for Sizes 5"-12" as a guide for centering of the gasket on the pipe ends.

DECIMAL EQUIVALENTS OF FRACTIONS

INCHES	DECIMAL OF AN INCH	INCHES	DECIMAL OF AN INCH
1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
1/3	.333	27/32	.84375
11/32	.34375	55/64	.859375
23/64	.359375	7/8	.875
3/8	.375	57/64	.890625
25/64	.390625	29/32	.90625
13/32	.40625	59/64	.921875
27/64	.421875	15/16	.9375
7/16	.4375	61/64	.953125
29/64	.453125	31/32	.96875
15/32	.46875	63/64	.984375
31/64	.484375	1	1.
1/2	.5		

MINUTES CONVERTED TO DECIMALS OF A DEGREE

MIN.	DEG.	MIN.	DEG.	MIN.	DEG.	MIN.	DEG.	MIN.	DEG.	MIN.	DEG.
1	.0166	11	.1833	21	.3500	31	.5166	41	.6833	51	.8500
2	.0333	12	.2000	22	.3666	32	.5333	42	.7000	52	.8666
3	.0500	13	.2166	23	.3833	33	.5500	43	.7166	53	.8833
4	.0666	14	.2333	24	.4000	34	.5666	44	.7333	54	.9000
5	.0833	15	.2500	25	.4166	35	.5833	45	.7500	55	.9166
6	.1000	16	.2666	26	.4333	36	.6000	46	.7666	56	.9333
7	.1166	17	.2833	27	.4500	37	.6166	47	.7833	57	.9500
8	.1333	18	.3000	28	.4666	38	.6333	48	.8000	58	.9666
9	.1500	19	.3166	29	.4833	39	.6500	49	.8166	59	.9833
10	.1666	20	.3333	30	.5000	40	.6666	50	.8333	60	1.0000

STANDARD PIPE DATA

NOMINAL PIPE DIAM. IN INCHES	ACTUAL INSIDE DIAM. IN INCHES	ACTUAL OUTSIDE DIAM. IN INCHES	WEIGHT PER FOOT POUNDS	LENGTH IN FEET CONTAINING ONE CUBIC FOOT	GALLONS IN ONE LINEAL FOOT
1/8	.269	.405	.244	2526.000	.0030
1/4	.364	.540	.424	1383.800	.0054
3/8	.493	.675	.567	754.360	.0099
1/2	.622	.840	.850	473.910	.0158
3/4	.824	1.050	1.130	270.030	.0277
1	1.049	1.315	1.678	166.620	.0449
1 1/4	1.380	1.660	2.272	96.275	.0777
1 1/2	1.610	1.900	2.717	70.733	.1058
2	2.067	2.375	3.652	49.913	.1743
2 1/2	2.469	2.875	5.793	30.077	.2487
3	3.068	3.500	7.575	19.479	.3840
3 1/2	3.548	4.000	9.109	14.565	.5136
4	4.026	4.500	10.790	11.312	.6613
4 1/2	4.560	5.000	12.538	9.030	.8284
5	5.047	5.563	14.617	7.198	1.0393
6	6.065	6.625	18.974	4.984	1.5008
8	7.981	8.625	28.554	2.878	2.5988
10	10.020	10.750	40.483	1.826	4.0963

BARLOW'S FORMULA

Barlow's Formula is a safe, easy method for finding the relationship between internal fluid pressure and stress in the pipe wall. The formula predicts bursting pressures that have been found to be safely within the actual test bursting pressures.

It is interesting to note that the formula uses the "outside diameter" of pipe and is sometimes referred to as the "outside diameter formula."

$$P = \frac{2 \times t \times S}{D}$$

where:

P = internal units pressure, psi
S = unit stress, psi
D = outside diameter of pipe, in.
t = wall thickness, in.

COMMERCIAL PIPE SIZES

The following table lists the pipe sizes and wall thicknesses currently established as standard, or specifically:

1. The traditional standard weight, extra strong, and double extra strong pipe.
2. The pipe wall thickness schedules listed in American Standard B36.10, which are applicable to carbon steel.

NOMINAL PIPE SIZE	OUTSIDE DIAM.	NOMINAL WALL					
		SCHED. 5S*	SCHED. 10S*	SCHED. 10	SCHED. 20	SCHED. 30	STANDARD†
1/8	0.405	—	0.049	—	—	—	*0.068*
1/4	0.540	—	0.065	—	—	—	*0.088*
3/8	0.675	—	0.065	—	—	—	*0.091*
1/2	0.840	0.065	0.083	—	—	—	*0.109*
3/4	1.050	0.065	0.083	—	—	—	*0.113*
1	1.315	0.065	0.109	—	—	—	*0.133*
1 1/4	1.660	0.065	0.109	—	—	—	*0.140*
1 1/2	1.900	0.065	0.109	—	—	—	*0.145*
2	2.375	0.065	0.109	—	—	—	*0.154*
2 1/2	2.875	0.083	0.120	—	—	—	*0.203*
3	3.500	0.083	0.120	—	—	—	*0.216*
3 1/2	4.000	0.083	0.120	—	—	—	*0.226*
4	4.500	0.083	0.120	—	—	—	*0.237*
5	5.563	0.109	0.134	—	—	—	*0.258*
6	6.625	0.109	0.134	—	—	—	*0.280*
8	8.625	0.109	0.148	—	0.250	0.277	*0.322*
10	10.750	0.134	0.165	—	0.250	0.307	*0.365*
12	12.750	0.156	0.180	—	0.250	0.330	*0.375*
14 O.D.	14.000	0.156	0.250	0.250	0.312	0.375	0.375
16 O.D.	16.000	0.165	0.250	0.250	0.312	0.375	0.375
18 O.D.	18.000	0.165	0.250	0.250	0.312	0.438	0.375
20 O.D.	20.000	0.188	0.250	0.250	0.375	0.500	0.375
22 O.D.	22.000	0.188	0.250	0.250	0.375	0.500	0.375
24 O.D.	24.000	0.218	0.250	0.250	0.375	0.562	0.375
26 O.D.	26.000	—	—	0.312	0.500	—	0.375
28 O.D.	28.000	—	—	0.312	0.500	0.625	0.375
30 O.D.	30.000	0.250	0.312	0.312	0.500	0.625	0.375
32 O.D.	32.000	—	—	0.312	0.500	0.625	0.375
34 O.D.	34.000	—	—	0.312	0.500	0.625	0.375
36 O.D.	42.000	—	—	0.312	0.500	0.625	0.375
42 O.D.	42.000	—	—	—	0.375	—	—

All dimensions are given in inches.

The decimal thicknesses listed for the respective pipe sizes represent their nominal or average wall dimensions. The actual thicknesses may be as much as 12.5% under the nominal thickness because of mill tolerance. Thicknesses shown in light face for Schedule 60 and heavier pipe are not currently supplied by the mills, unless a certain minimum tonnage is ordered.

AND WALL THICKNESSES

3. The pipe wall thickness schedules listed in American Standard B36.19, and ASTM Specification A409, which are applicable *only* to corrosion resistant materials. (NOTE: Schedule 10S is also available in carbon steel in sizes 12" and smaller.)

ASA-B36.10 and B36.19

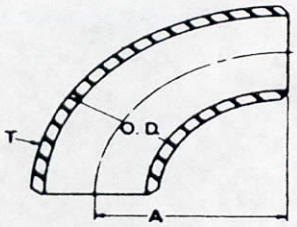
THICKNESS FOR								
SCHED. 40	SCHED. 60	EXTRA STRONG‡	SCHED. 80	SCHED. 100	SCHED. 120	SCHED. 140	SCHED. 160	XX STRONG
0.068	—	*0.095*	0.095	—	—	—	—	—
0.088	—	*0.119*	0.119	—	—	—	—	—
0.091	—	*0.126*	0.126	—	—	—	—	—
0.109	—	*0.147*	0.147	—	—	—	0.188	0.294
0.113	—	*0.154*	0.154	—	—	—	0.219	0.308
0.133	—	*0.179*	0.179	—	—	—	0.250	0.358
0.140	—	*0.191*	0.191	—	—	—	0.250	0.382
0.145	—	*0.200*	0.200	—	—	—	0.281	0.400
0.154	—	*0.218*	0.218	—	—	—	0.344	0.436
0.203	—	*0.276*	0.276	—	—	—	0.375	0.552
0.216	—	*0.300*	0.300	—	—	—	0.438	0.600
0.226	—	*0.318*	0.318	—	—	—	—	—
0.237	—	*0.337*	0.337	—	0.438	—	0.531	0.674
0.258	—	*0.375*	0.375	—	0.500	—	0.625	0.750
0.280	—	*0.432*	0.432	—	0.562	—	0.719	0.864
0.322	0.406	*0.500*	0.500	0.594	0.719	0.812	0.906	0.875
0.365	0.500	*0.500*	0.594	0.719	0.844	1.000	1.125	1.000
0.406	0.562	*0.500*	0.688	0.844	1.000	1.125	1.312	1.000
0.438	0.594	0.500	0.750	0.938	1.094	1.250	1.406	—
0.500	0.656	0.500	0.844	1.031	1.219	1.438	1.594	—
0.562	0.750	0.500	0.938	1.156	1.375	1.562	1.781	—
0.594	0.812	0.500	1.031	1.281	1.500	1.750	1.969	—
—	0.875	0.500	1.125	1.375	1.625	1.875	2.125	—
0.688	0.969	0.500	1.218	1.531	1.812	2.062	2.344	—
—	—	0.500	—	—	—	—	—	—
—	—	0.500	—	—	—	—	—	—
—	—	0.500	—	—	—	—	—	—
0.688	—	0.500	—	—	—	—	—	—
0.688	—	0.500	—	—	—	—	—	—
0.750	—	0.500	—	—	—	—	—	—
—	—	0.500	—	—	—	—	—	—

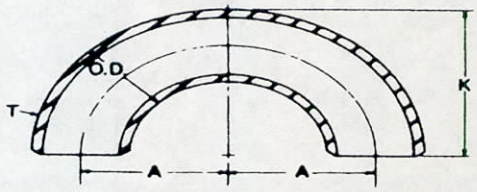
*Schedules 5S and 10S are available in corrosion resistant materials and Schedule 10S is also available in carbon steel.

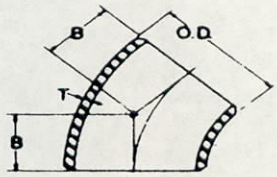
†Thicknesses shown in italics are available also in stainless steel, under the designation Schedule 40S.

‡Thicknesses shown in italics are available also in stainless steel, under the designation Schedule 80S.

DIMENSIONS

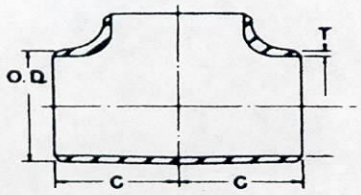


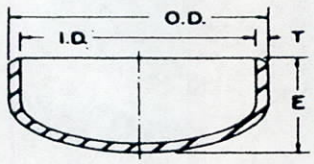


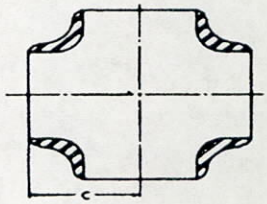


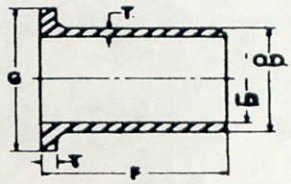
NOM PIPE SIZE	OD	WALL THICKNESS T				90° ELBOWS	
		STD.	XS	160	XX	LONG R A	SHORT R A
½	.840	.109	.147	—	—	1½	—
¾	1.050	.113	.154	—	.308	1⅛	—
1	1.315	.133	.179	.250	.358	1½	1
1¼	1.660	.140	.191	.250	.382	1⅞	1¼
1½	1.900	.145	.200	.281	.400	2¼	1½
2	2.375	.154	.218	.344	.436	3	2
2½	2.875	.203	.276	.375	.552	3¾	2½
3	3.500	.216	.300	.438	.600	4½	3
3½	4.000	.226	.318	—	.636	5¼	3½
4	4.500	.237	.337	.531	.674	6	4
5	5.563	.258	.375	.625	.750	7½	5
6	6.625	.280	.432	.719	.864	9	6
8	8.625	.322	.500	.906	.875	12	8
10	10.750	.365	.500	1.125	1.000	15	10
12	12.750	.375	.500	1.312	1.000	18	12
14	14.000	.375	.500	—	—	21	14
16	16.000	.375	.500	—	—	24	16
18	18.000	.375	.500	—	—	27	18
20	20.000	.375	.500	—	—	30	20
22	22.000	.375	.500	—	—	33	—
24	24.000	.375	.500	—	—	36	24
26	26.000	.375	.500	—	—	39	—
30	30.000	.375	.500	—	—	45	30
34	34.000	.375	.500	—	—	51	—
36	36.000	.375	.500	—	—	54	36
42	42.000	.375	.500	—	—	63	48

WELDING FITTINGS



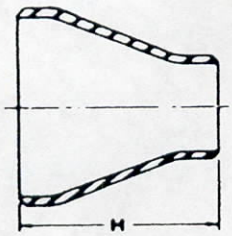


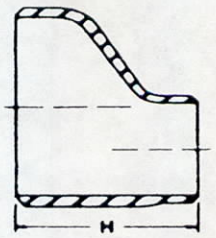


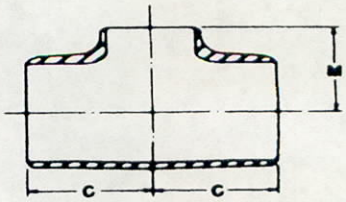


180° RETURNS		45° ELBOWS	TEES	CAPS	CROSSES	STUB ENDS	
LONG R K	SHORT R K	B	C	E	C	F	G
1 7/8	—	5/8	1	1	—	3	1 3/8
1 11/16	—	7/16	1 1/8	1	—	3	1 11/16
2 3/16	1 5/8	7/8	1 1/2	1 1/2	—	4	2
2 3/4	2 1/16	1	1 7/8	1 1/2	1 7/8	4	2 1/2
3 1/4	2 7/16	1 1/8	2 1/4	1 1/2	2 1/4	4	2 7/8
4 3/16	3 3/16	1 3/8	2 1/2	1 1/2*	2 1/2	6	3 5/8
5 3/16	3 15/16	1 3/4	3	1 1/2*	3	6	4 1/8
6 1/4	4 3/4	2	3 3/8	2*	3 3/8	6	5
7 1/4	5 1/2	2 1/4	3 3/4	2 1/2*	3 3/4	6	5 1/2
8 1/4	6 1/4	2 1/2	4 1/8	2 1/2*	4 1/8	6	6 3/16
10 5/16	7 3/4	3 1/8	4 7/8	3*	4 7/8	8	7 5/16
12 5/16	9 5/16	3 3/4	5 5/8	3 1/2*	5 5/8	8	8 1/2
16 5/16	12 5/16	5	7	4*	7	8	10 5/8
20 3/8	15 3/8	6 1/4	8 1/2	5*	8 1/2	10	12 3/4
24 3/8	18 3/8	7 1/2	10	6*	10	10	15
28	21	8 3/4	11	6 1/2*	11	12	16 1/4
32	24	10	12	7*	12	12	18 1/2
36	27	11 1/4	13 1/2	8*	13 1/2	12	21
40	30	12 1/2	15	9*	15	12	23
44	—	13 1/2	16 1/2	10	16 1/2	—	—
48	36	15	17	10 1/2	17	12	27 1/4
52	—	16	19 1/2	10 1/2	—	—	—
60	45	18 1/2	22	10 1/2	—	—	—
—	—	21	25	10 1/2	—	—	—
—	54	22 1/4	26 1/2	10 1/2	—	—	—
—	—	26	—	12	—	—	—

*Dimensions apply to STD and XS only.

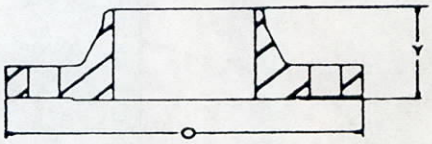






NOM PIPE SIZE		CONCENTRIC AND ECCENTRIC REDUCERS	REDUCING OUTLET TEES	
		H	C	M
1/2 ×	1/4 3/8	—	1	1 1
3/4 ×	3/8 1/2	1 1/2	1 1/8	1 1/8 1 1/8
1 ×	3/8 1/2 3/4	2	1 1/2	1 1/2 1 1/2 1 1/2
1 1/4 ×	1/2 3/4 1	2	1 7/8	1 7/8 1 7/8 1 7/8
1 1/2 ×	1/2 3/4 1 1 1/4	2 1/2	2 1/4	2 1/4 2 1/4 2 1/4 2 1/4
2 ×	3/4 1 1 1/4 1 1/2	3	2 1/2	1 3/4 2 2 1/4 2 3/8
2 1/2 ×	1 1 1/4 1 1/2 2	3 1/2	3	2 1/4 2 1/2 2 5/8 2 3/4
3 ×	1 1 1/4 1 1/2 2 2 1/2	— 3 1/2	3 3/8	2 5/8 2 3/4 2 7/8 3 3 1/4
3 1/2 ×	1 1/4 1 1/2 2 2 1/2 3	4	— 3 3/4	— 3 1/8 3 1/4 3 1/2 3 5/8
4 ×	1 1/2 2 2 1/2 3 3 1/2	4	4 1/8	3 3/8 3 1/2 3 3/4 3 7/8 4
5 ×	2 2 1/2 3 3 1/2 4	5	4 7/8	4 1/8 4 1/4 4 3/8 4 1/2 4 5/8
6 ×	2 1/2 3 3 1/2 4 5	5 1/2	5 5/8	4 3/4 4 7/8 5 5 1/8 5 3/8
8 ×	3 3 1/2 4 5 6	— 6	7	6 6 6 1/8 6 3/8 6 5/8
10 ×	4 5 6 8	7	8 1/2	7 1/4 7 1/2 7 5/8 8
12 ×	5 6 8 10	8	10	8 1/2 8 5/8 9 9 1/2
14 ×	6 8 10 12	13	11	9 3/8 9 1/4 10 1/8 10 5/8

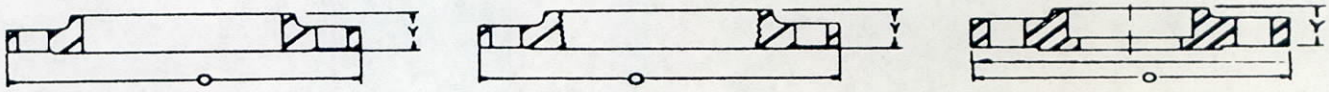
WELDING NECK FLANGES



NOM PIPE SIZE	150 LB.		300 LB.		400 LB.		600 LB.	
	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (2)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (2)
1/2	3 1/2	1 7/8	3 3/4	2 1/16	For sizes 3 1/2 and smaller use 600 Lb. Standard		3 3/4	2 1/16
3/4	3 7/8	2 1/16	4 5/8	2 1/4			4 5/8	2 1/4
1	4 1/4	2 3/16	4 7/8	2 7/16			4 7/8	2 7/16
1 1/4	4 5/8	2 1/4	5 1/4	2 9/16			5 1/4	2 5/8
1 1/2	5	2 7/16	6 1/8	2 11/16			6 1/8	2 3/4
2	6	2 1/2	6 1/2	2 3/4			6 1/2	2 7/8
2 1/2	7	2 3/4	7 1/2	3			7 1/2	3 1/8
3	7 1/2	2 3/4	8 1/4	3 1/8			8 1/4	3 1/4
3 1/2	8 1/2	2 13/16	9	3 3/16			9	3 3/8
4	9	3	10	3 3/8	10	3 1/2	10 3/4	4
5	10	3 1/2	11	3 7/8	11	4	13	4 1/2
6	11	3 1/2	12 1/2	3 7/8	12 1/2	4 1/16	14	4 5/8
8	13 1/2	4	15	4 3/8	15	4 5/8	16 1/2	5 1/4
10	16	4	17 1/2	4 5/8	17 1/2	4 7/8	20	6
12	19	4 1/2	20 1/2	5 1/8	20 1/2	5 3/8	22	6 1/8
14	21	5	23	5 5/8	23	5 7/8	23 3/4	6 1/2
16	23 1/2	5	25 1/2	5 3/4	25 1/2	6	27	7
18	25	5 1/2	28	6 1/4	28	6 1/2	29 1/4	7 1/4
20	27 1/2	5 11/16	30 1/2	6 3/8	30 1/2	6 5/8	32	7 1/2
22	29 1/2	5 7/8	33	6 1/2	33	6 3/4	34 1/4	7 3/4
24	32	6	36	6 5/8	36	6 7/8	37	8
26	34 1/4	5	38 1/4	7 1/4	38 1/4	7 5/8	40	8 3/4
30	38 3/4	5 1/8	43	8 1/4	43	8 5/8	44 1/2	9 3/4
34	43 3/4	5 5/16	47 1/2	9 1/8	47 1/2	9 1/2	49	10 5/8
36	46	5 3/8	50	9 1/2	50	9 7/8	51 3/4	11 1/8
42	53	5 5/8	57	10 7/8	57	11 3/8	58 3/4	12 3/4

(1) The 1/16" raised face **is** included in "Length thru Hub 'Y'."
(2) The 1/4" raised face **is not** included in "Length thru Hub 'Y'."

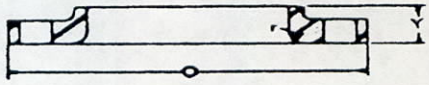
SLIP-ON, THREADED, AND SOCKET TYPE FLANGES



NOM PIPE SIZE	150 LB.		300 LB.		400 LB.		600 LB.	
	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (2)	OUTSIDE DIAM OF FLANGE O (2)	LENGTH THRU HUB Y (2)
1/2	3 1/2	5/8	3 3/4	7/8	For sizes 3 1/2 and smaller use 600 Lb. Standard		3 3/4	7/8
3/4	3 7/8	5/8	4 5/8	1			4 5/8	1
1	4 1/4	11/16	4 7/8	1 1/16			4 7/8	1 1/16
1 1/4	4 5/8	13/16	5 1/4	1 1/16			5 1/4	1 1/8
1 1/2	5	7/8	6 1/8	1 3/16			6 1/8	1 1/4
2	6	1	6 1/2	1 5/16			6 1/2	1 7/16
2 1/2	7	1 1/8	7 1/2	1 1/2			7 1/2	1 5/8
3	7 1/2	1 3/16	8 1/4	1 11/16			8 1/4	1 13/16
3 1/2	8 1/2	1 1/4	9	1 3/4			9	1 15/16
4	9	1 5/16	10	1 7/8	10	2‡	10 3/4	2 1/8‡
5	10	1 7/16	11	2‡	11	2 1/8‡	13	2 3/8‡
6	11	1 9/16	12 1/2	2 1/16‡	12 1/2	2 1/4‡	14	2 5/8‡
8	13 1/2	1 3/4	15	2 7/16‡	15	2 11/16‡	16 1/2	3‡
10	16	1 15/16	17 1/2	2 5/8‡	17 1/2	2 7/8‡	20	3 3/8‡
12	19	2 3/16	20 1/2	2 7/8‡	20 1/2	3 1/8‡	22	3 5/8‡
14	21	2 1/4	23	3‡	23	3 5/16‡	23 3/4	3 11/16‡
16	23 1/2	2 1/2	25 1/2	3 1/4‡	25 1/2	3 11/16‡	27	4 3/16‡
18	25	2 11/16	28	3 1/2‡	28	3 7/8‡	29 1/4	4 5/8‡
20	27 1/2	2 7/8	30 1/2	3 3/4‡	30 1/2	4‡	32	5‡
22	29 1/2	3 1/8†‡	33	4†‡	33	4 1/4†‡	34 1/4	5 1/4†‡
24	32	3 1/4	36	4 3/16‡	36	4 1/2‡	37	5 1/2‡
26	34 1/4	3 3/8†‡	38 1/4	7 1/4†‡	38 1/4	7 5/8†‡	40	8 3/4†‡
30	38 3/4	3 1/2†‡	43	8 1/4†‡	43	8 5/8†‡	44 1/2	9 3/4†‡
34	43 3/4	3 11/16†‡	47 1/2	9 1/8†‡	47 1/2	9 1/2†‡	49	10 5/8†‡
36	46	3 3/4†‡	50	9 1/2†‡	50	9 7/8†‡	51 3/4	11 1/8†‡
42	53	4†‡	57	10 7/8†‡	57	11 3/8†‡	58 3/4	12 3/4†‡

*Not available in Slip-On type.
†Not available in Threaded type.
‡Not available in Socket type.

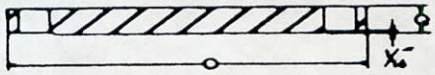
LAP JOINT FLANGES



NOM PIPE SIZE	150 LB.		300 LB.		400 LB.		600 LB.	
	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (1)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (2)	OUTSIDE DIAM OF FLANGE O	LENGTH THRU HUB Y (2)
1/2	3 1/2	5/8	3 3/4	7/8	For sizes 3 1/2 and smaller use 600 Lb. Standard		3 3/4	7/8
3/4	3 7/8	5/8	4 5/8	1			4 5/8	1
1	4 1/4	11/16	4 7/8	1 1/16			4 7/8	1 1/16
1 1/4	4 5/8	13/16	5 1/4	1 1/16			5 1/4	1 1/8
1 1/2	5	7/8	6 1/8	1 3/16			6 1/8	1 1/4
2	6	1	6 1/2	1 5/16			6 1/2	1 7/16
2 1/2	7	1 1/8	7 1/2	1 1/2			7 1/2	1 5/8
3	7 1/2	1 3/16	8 1/4	1 11/16			8 1/4	1 13/16
3 1/2	8 1/2	1 1/4	9	1 3/4			9	1 15/16
4	9	1 5/16	10	1 7/8	10	2	10 3/4	2 1/8
5	10	1 7/16	11	2	11	2 1/8	13	2 3/8
6	11	1 9/16	12 1/2	2 1/16	12 1/2	2 1/4	14	2 5/8
8	13 1/2	1 3/4	15	2 7/16	15	2 11/16	16 1/2	3
10	16	1 15/16	17 1/2	3 3/4	17 1/2	4	20	4 3/8
12	19	2 3/16	20 1/2	4	20 1/2	4 1/4	22	4 5/8
14	21	3 1/8	23	4 3/8	23	4 5/8	23 3/4	5
16	23 1/2	3 7/16	25 1/2	4 3/4	25 1/2	5	27	5 1/2
18	25	3 13/16	28	5 1/8	28	5 3/8	29 1/4	6
20	27 1/2	4 1/16	30 1/2	5 1/2	30 1/2	5 3/4	32	6 1/2
24	32	4 3/8	36	6	36	6 1/4	37	7 1/4

(1) The 1/16" raised face is included in "Length thru Hub 'Y'."
(2) The 1/4" raised face is **not** included in "Length thru Hub 'Y'."

BLIND FLANGES



NOM PIPE SIZE	150 LB.		300 LB.		400 LB.		600 LB.	
	OUTSIDE DIAM OF FLANGE O	THICK-NESS Q (1)	OUTSIDE DIAM OF FLANGE O	THICK-NESS Q (1)	OUTSIDE DIAM OF FLANGE O	THICK-NESS Q (2)	OUTSIDE DIAM OF FLANGE O	THICK-NESS Q (2)
1/2	3 1/2	7/16	3 3/4	9/16			3 3/4	9/16
3/4	3 7/8	1/2	4 5/8	5/8			4 5/8	5/8
1	4 1/4	9/16	4 7/8	11/16			4 7/8	11/16
1 1/4	4 5/8	5/8	5 1/4	3/4	For sizes 3 1/2 and smaller use 600 Lb. Standard		5 1/4	13/16
1 1/2	5	11/16	6 1/8	13/16			6 1/8	7/8
2	6	3/4	6 1/2	7/8			6 1/2	1
2 1/2	7	7/8	7 1/2	1			7 1/2	1 1/8
3	7 1/2	15/16	8 1/4	1 1/8			8 1/4	1 1/4
3 1/2	8 1/2	15/16	9	1 3/16			9	1 3/8
4	9	15/16	10	1 1/4	10	1 3/8	10 3/4	1 1/2
5	10	15/16	11	1 3/8	11	1 1/2	13	1 3/4
6	11	1	12 1/2	1 7/16	12 1/2	1 5/8	14	1 7/8
8	13 1/2	1 1/8	15	1 5/8	15	1 7/8	16 1/2	2 3/16
10	16	1 3/16	17 1/2	1 7/8	17 1/2	2 1/8	20	2 1/2
12	19	1 1/4	20 1/2	2	20 1/2	2 1/4	22	2 5/8
14	21	1 3/8	23	2 1/8	23	2 3/8	23 3/4	2 3/4
16	23 1/2	1 7/16	25 1/2	2 1/4	25 1/2	2 1/2	27	3
18	25	1 9/16	28	2 3/8	28	2 5/8	29 1/4	3 1/4
20	27 1/2	1 11/16	30 1/2	2 1/2	30 1/2	2 3/4	32	3 1/2
22	29 1/2	1 13/16	33	2 5/8	33	2 7/8	34 1/4	3 3/4
24	32	1 7/8	36	2 3/4	36	3	37	4
26	34 1/4	2	38 1/4	3 1/8	38 1/4	3 1/2	40	4 1/4
30	38 3/4	2 1/8	43	3 5/8	43	4	44 1/2	4 1/2
34	43 3/4	2 5/16	47 1/2	4	47 1/2	4 3/8	49	4 3/4
36	46	2 3/8	50	4 1/8	50	4 1/2	51 3/4	4 7/8
42	53	2 5/8	57	4 5/8	57	5 1/8	58 3/4	5 1/2

(1) The 1/16" raised face is included in "thickness 'Q'."
(2) The 1/4" raised face is **not** included in "thickness 'Q'."

BOLTING DIMENSIONS FOR 150 LB. FLANGES

NOM PIPE SIZE	150 LB. STEEL FLANGES				
	DIAM OF BOLT CIRCLE	DIAM OF BOLTS	NO. OF BOLTS	LENGTH OF STUDS 1/16" RAISED FACE	BOLT LENGTH
1/2	2 3/8	1/2	4	2 1/4	1 3/4
3/4	2 3/4	1/2	4	2 1/4	2
1	3 1/8	1/2	4	2 1/2	2
1 1/4	3 1/2	1/2	4	2 1/2	2 1/4
1 1/2	3 7/8	1/2	4	2 3/4	2 1/4
2	4 3/4	5/8	4	3	2 3/4
2 1/2	5 1/2	5/8	4	3 1/4	3
3	6	5/8	4	3 1/2	3
3 1/2	7	5/8	8	3 1/2	3
4	7 1/2	5/8	8	3 1/2	3
5	8 1/2	3/4	8	3 3/4	3 1/4
6	9 1/2	3/4	8	3 3/4	3 1/4
8	11 3/4	3/4	8	4	3 1/2
10	14 1/4	7/8	12	4 1/2	3 3/4
12	17	7/8	12	4 1/2	4
14	18 3/4	1	12	5	4 1/4
16	21 1/4	1	16	5 1/4	4 1/2
18	22 3/4	1 1/8	16	5 3/4	4 3/4
20	25	1 1/8	20	6	5 1/4
22	27 1/4	1 1/4	20	6 1/2	5 1/2
24	29 1/2	1 1/4	20	6 3/4	5 3/4
26	31 3/4	1 1/4	24	7	6
30	36	1 1/4	28	7 1/4	6 1/4
34	40 1/2	1 1/2	32	8	7
36	42 3/4	1 1/2	32	8 1/4	7
42	49 1/2	1 1/2	36	8 3/4	7 1/2

Stud lengths for lap joint flanges are equal to lengths shown plus the thickness of two laps of the stub ends.

Bolting arrangement for 125 lb. cast iron flanges are the same as shown for 150 lb. steel flanges.

BOLTING DIMENSIONS FOR 300 LB. FLANGES

NOM PIPE SIZE	300 LB. STEEL FLANGES				
	DIAM OF BOLT CIRCLE	DIAM OF BOLTS	NO. OF BOLTS	LENGTH OF STUDS 1/16" RAISED FACE	BOLT LENGTH
1/2	2 5/8	1/2	4	2 1/2	2
3/4	3 1/4	5/8	4	2 3/4	2 1/2
1	3 1/2	5/8	4	3	2 1/2
1 1/4	3 7/8	5/8	4	3	2 3/4
1 1/2	4 1/2	3/4	4	3 1/2	3
2	5	5/8	8	3 1/4	3
2 1/2	5 7/8	3/4	8	3 3/4	3 1/4
3	6 5/8	3/4	8	4	3 1/2
3 1/2	7 1/4	3/4	8	4 1/4	3 3/4
4	7 7/8	3/4	8	4 1/4	3 3/4
5	9 1/4	3/4	8	4 1/2	4
6	10 5/8	3/4	12	4 3/4	4 1/4
8	13	7/8	12	5 1/4	4 3/4
10	15 1/4	1	16	6	5 1/4
12	17 3/4	1 1/8	16	6 1/2	5 3/4
14	20 1/4	1 1/8	20	6 3/4	6
16	22 1/2	1 1/4	20	7 1/4	6 1/2
18	24 3/4	1 1/4	24	7 1/2	6 3/4
20	27	1 1/4	24	8	7
22	29 1/4	1 1/2	24	8 3/4	7 1/2
24	32	1 1/2	24	9	7 3/4
26	34 1/2	1 5/8	28	10	8 3/4
30	39 1/4	1 3/4	28	11 1/4	10
34	43 1/2	1 7/8	28	12 1/4	10 3/4
36	46	2	32	12 3/4	11 1/4
42	52 3/4	2	36	13 3/4	13 1/2

Bolting arrangement for 250 lb. cast iron flanges are the same as shown for 300 lb. steel flanges.

BOLTING DIMENSIONS FOR 400 AND 600 LB. FLANGES

NOM PIPE SIZE	400 LB. STEEL FLANGES				600 LB. STEEL FLANGES			
	DIAM OF BOLT CIRCLE	DIAM OF BOLTS	NO. OF BOLTS	LENGTH OF STUDS 1/4" RAISED FACE	DIAM OF BOLT CIRCLE	DIAM OF BOLTS	NO. OF BOLTS	LENGTH OF STUDS 1/4" RAISED FACE
1/2	2 5/8	1/2	4	3	2 5/8	1/2	4	3
3/4	3 1/4	5/8	4	3 1/4	3 1/4	5/8	4	3 1/4
1	3 1/2	5/8	4	3 1/2	3 1/2	5/8	4	3 1/2
1 1/4	3 7/8	5/8	4	3 3/4	3 7/8	5/8	4	3 3/4
1 1/2	4 1/2	3/4	4	4	4 1/2	3/4	4	4
2	5	5/8	8	4	6	5/8	8	4
2 1/2	5 7/8	3/4	8	4 1/2	5 7/8	3/4	8	4 1/2
3	6 5/8	3/4	8	4 3/4	6 5/8	3/4	8	4 3/4
3 1/2	7 1/4	7/8	8	5 1/4	7 1/4	7/8	8	5 1/4
4	7 7/8	7/8	8	5 1/4	8 1/2	7/8	8	5 1/2
5	9 1/4	7/8	8	6 1/2	10 1/2	1	8	6 1/4
6	10 5/8	7/8	12	5 3/4	11 1/2	1	12	6 1/2
8	13	1	12	6 1/2	13 3/4	1 1/8	12	7 1/2
10	15 1/4	1 1/8	16	7 1/4	17	1 1/4	16	8 1/4
12	17 3/4	1 1/4	16	7 3/4	19 1/4	1 1/4	20	8 1/2
14	20 1/4	1 1/4	20	8	20 3/4	1 3/8	20	9
16	22 1/2	1 3/8	20	8 1/2	23 3/4	1 1/2	20	9 3/4
18	24 3/4	1 3/8	24	8 3/4	25 3/4	1 5/8	20	10 1/2
20	27	1 1/2	24	9 1/2	28 1/2	1 5/8	24	11 1/4
22	29 1/4	1 5/8	24	10	30 5/8	1 3/4	24	12
24	32	1 3/4	24	10 1/2	33	1 7/8	24	12 3/4
26	34 1/2	1 3/4	28	11 1/2	36	1 7/8	28	13 1/4
30	39 1/4	2	28	13	40 1/4	2	28	14
34	43 1/2	2	28	13 3/4	44 1/2	2 1/4	28	15
36	46	2	32	14	47	2 1/2	28	15 3/4
42	52 3/4	2 1/2	32	16 1/4	53 3/4	2 3/4	28	17 1/2

Stud lengths for lap joint flanges are equal to lengths shown minus 1/2" plus the thickness of two laps of the stub ends.

STANDARD CAST IRON COMPANION FLANGES AND BOLTS

(For working pressures up to 125 psi steam, 175 psi WOG)

SIZE	DIAM OF FLANGE	BOLT CIRCLE	NO. OF BOLTS	SIZE OF BOLTS	LENGTH OF BOLTS
3/4	3 1/2	2 1/2	4	3/8	1 3/8
1	4 1/4	3 1/8	4	1/2	1 1/2
1 1/4	4 5/8	3 1/2	4	1/2	1 1/2
1 1/2	5	3 7/8	4	1/2	1 3/4
2	6	4 3/4	4	5/8	2
2 1/2	7	5 1/2	4	5/8	2 1/4
3	7 1/2	6	4	5/8	2 1/2
3 1/2	8 1/2	7	8	5/8	2 1/2
4	9	7 1/2	8	5/8	2 3/4
5	10	8 1/2	8	3/4	3
6	11	9 1/2	8	3/4	3
8	13 1/2	11 3/4	8	3/4	3 1/4
10	16	14 1/4	12	7/8	3 1/2
12	19	17	12	7/8	3 3/4
14	21	18 3/4	12	1	4 1/4
16	23 1/2	21 1/4	16	1	4 1/4

EXTRA HEAVY CAST IRON COMPANION FLANGES AND BOLTS

(For working pressures up to 250 psi steam, 400 psi WOG)

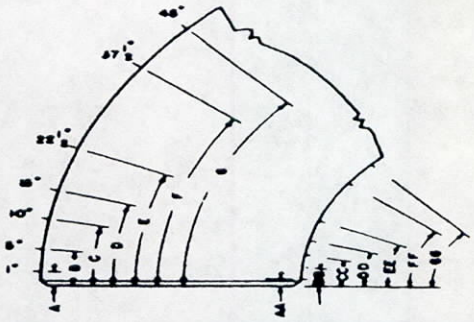
PIPE SIZES	DIAM OF FLANGES	DIAM OF BOLT CIRCLE	NO. OF BOLTS	DIAM OF BOLTS	LENGTH OF BOLTS
1	4 7/8	3 1/2	4	5/8	2 1/4
1 1/4	5 1/4	3 7/8	4	5/8	2 1/2
1 1/2	6 1/8	4 1/2	4	3/4	2 1/2
2	6 1/2	5	8	5/8	2 1/2
2 1/2	7 1/2	5 7/8	8	3/4	3
3	8 1/4	6 5/8	8	3/4	3 1/4
3 1/2	9	7 1/4	8	3/4	3 1/4
4	10	7 7/8	8	3/4	3 1/2
5	11	9 1/4	8	3/4	3 3/4
6	12 1/2	10 5/8	12	3/4	3 3/4
8	15	13	12	7/8	4 1/4
10	17 1/2	15 1/4	16	1	5
12	20 1/2	17 3/4	16	1 1/8	5 1/2
14 O.D.	23	20 1/4	20	1 1/8	5 3/4
16 O.D.	25 1/2	22 1/2	20	1 1/4	6
18 O.D.	28	24 3/4	24	1 1/4	6 1/4
20 O.D.	30 1/2	27	24	1 1/4	6 3/4
24 O.D.	36	32	24	1 1/2	7 1/2
30 O.D.	43	39 1/4	28	1 3/4	8 1/2
36 O.D.	50	46	32	2	9 1/2
42 O.D.	57	52 3/4	36	2	10
48 O.D.	65	60 3/4	40	2	11

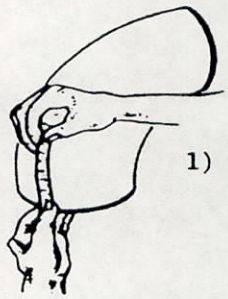
ASTM CARBON STEEL PIPE AND FLANGE SPECIFICATIONS

	DESCRIPTION AND APPLICATIONS	ASTM SPEC NO.	GRADE OR TYPE	MINIMUM TENSILE PROPERTIES: TENSILE STRENGTH PSI	MINIMUM TENSILE PROPERTIES: YIELD PT OR STRENGTH PSI	ELONGATION (% IN 2") STD ROUND	ELONGATION (% IN 2") RECTANGULAR t 5/16"	ELONGATION (% IN 2") RECTANGULAR 5/16"	CHEMICAL COMPOSITION, % C	MN	P	S
PIPE AND TUBING	Seamless milled steel PIPE for high-temperature service, suitable for bending, flanging and similar forming operations.	(1) A106	A	48,000	30,000	28 long. or (4) 20 trans.	17.5+56t or 12.5+40t	35 25	.25 max	.27 to .93	.048 max	.058 max
	As above, except use Grade A for close coiling, cold bending or forge welding.	(1) A106	B	60,000	35,000	22 long or (4) 12 trans.	15.0+48t or 6.5+32t	30 16.5	.30 max	.29 to 1.06	.048 max	.058 max
	Black or hot-dip galv. seamless or res.-welded steel PIPE suitable for coiling, bending, flanging, and other special purposes, suitable for welding.	A 53	A	48,000	30,000	28	17.5+56t	35	(2)	—	(3)	—
	As above, except use Grade A for close coiling, cold bending or forge welding.	A 53	B	60,000	35,000	22	15.0+48t	30	(2)	—	(3)	—
	Black or hot-dip galv. seamless or res.-welded steel PIPE for ordinary uses. (When tension, flattening or bend test required, order to A-53).	A120	—	—	—	—	—	—	—	—	—	—
	Resistance welded steel PIPE for liquid, gas or vapor.	A135	A	48,000	30,000	—	17.5+56t	35	—	—	.050 max	.060 max
	As above, except use Grade A for flanging and bending.	A135	B	60,000	35,000	—	15.0+48t	30	—	—	.050 max	.060 max
	Electric-fusion-welded straight- or spiral-seam PIPE for liquid, gas or vapor from mill grades of plate.	A139	A	48,000	30,000	—	17.5+56t	35	—	.30 to 1.00	.040 max	.050 max
	As above.	A139	B	60,000	35,000	—	15.0+48t	30	.30 max	.30 to 1.00	.040 max	.050 max
FORGED PIPE, FLANGES,	Forged or rolled steel pipe flanges, fittings (6) valves and parts for high temperature service. Heat treatment required; may be annealed or normalized.	A105	I	60,000	30,000	25	—	—	.35 (5) max	.90 max	.05 max	.05 max
	As above.	A105	II	70,000	36,000	22	—	—	.35 (5) max	.90 max	.05 max	.05 max
	As above except for general service. Heat treatment is not required.	A181	I	60,000	30,000	22	—	—	.35 (5) max	.90 max	.05 max	.05 max
	As above.	A181	II	70,000	36,000	18	—	—	.35 (5) max	.90 max	.05 max	.05 max

(1) .10% silicon minimum.
(2) Open hearth, .13 max for 1/8" and 1/4" size resistance welded pipe only.
(3) Seamless: open hearth .048 max, acid bessemar .11 max; Res.-welded: open hearth .050 max.
(4) Longitudinal or transverse direction of test specimen with respect to pipe axis.
(5) When flanges will be subject to fusion welding, the carbon content shall not exceed .35%. When carbon is restricted to .35% max, it may be necessary to add silicon to meet required tensile properties. The silicon content shall not exceed .35%.
(6) Factory-made Wrought Carbon Steel and Ferritic Alloy Steel Welding Fitting Specifications are covered under ASTM A234.

HOW TO CUT ODD-ANGLE ELBOWS

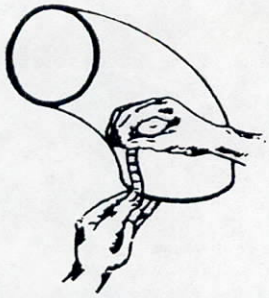




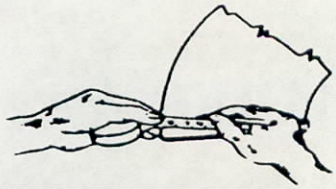
1) MEASURE DISTANCE ON OUTSIDE ARC

ODD DEGREE LONG RADIUS ELBOWS

NOM SIZE	OUTSIDE ARC						
	A	B	C	D	E	F	G
2	5/64	3/8	23/32	1 3/32	1 21/32	2 3/4	3 9/32
2 1/2	3/32	7/16	29/32	1 11/32	2 1/32	3 3/8	4 1/16
3	7/64	9/16	1 1/8	1 5/8	2 15/32	4 3/32	4 29/32
3 1/2	1/8	5/8	1 9/32	1 29/32	2 27/32	4 3/4	5 11/16
4	9/64	23/32	1 7/16	2 5/32	3 1/4	5 13/32	6 15/32
5	3/16	29/32	1 25/32	2 11/16	4 1/32	6 23/32	8 1/16
6	7/32	1 1/16	2 5/32	3 7/32	4 27/32	8 1/16	9 21/32
8	9/32	1 7/16	2 27/32	4 9/32	6 13/32	10 11/16	12 13/16
10	11/32	1 25/32	3 9/16	5 11/32	8	13 11/32	16
12	7/16	2 1/8	4 1/4	6 3/8	9 9/16	15 31/32	19 5/32
14	1/2	2 7/16	4 7/8	7 5/16	11	18 5/16	22
16	9/16	2 13/16	5 19/32	8 3/8	12 9/16	20 15/16	25 1/8
18	5/8	3 1/8	6 9/32	9 7/16	14 1/8	23 9/16	28 9/32
20	11/16	3 1/2	7	10 15/32	15 23/32	26 3/16	31 13/32
22	3/4	3 27/32	7 11/16	11 17/32	17 9/32	28 13/16	34 9/16
24	27/32	4 3/16	8 3/8	12 9/16	18 27/32	31 13/32	37 11/16
26	29/32	4 17/32	9 3/32	13 5/8	20 13/32	34 1/32	40 27/32
30	1 1/32	5 1/4	10 15/32	15 3/4	23 9/16	39 1/4	47 1/8
34	1 5/32	5 29/32	11 27/32	17 13/16	26 23/32	44 17/32	53 3/8
36	1 7/32	6 1/4	12 17/32	18 7/8	28 7/32	47	56 17/32
42	1 7/16	7 5/16	14 5/8	22	32 31/32	54 31/32	65 15/16



2) MEASURE DISTANCE ON INSIDE ARC



3) WRAP TAPE AROUND ELBOW AND MARK CUTTING LINE

ODD DEGREE LONG RADIUS ELBOWS

NOM SIZE	INSIDE ARC						
	AA	BB	CC	DD	EE	FF	GG
2	1/32	5/32	5/16	15/32	23/32	1 3/16	1 7/16
2 1/2	3/64	3/16	13/32	19/32	29/32	1 1/2	1 13/16
3	3/64	1/4	1/2	23/32	1 3/32	1 13/16	2 5/32
3 1/2	1/16	9/32	9/16	27/32	1 9/32	2 1/8	2 9/16
4	1/16	5/16	21/32	31/32	1 15/32	2 7/16	2 15/16
5	5/64	13/32	13/16	1 1/4	1 27/32	3 3/32	3 23/32
6	3/32	1/2	1	1 1/2	2 7/32	3 23/32	4 15/32
8	1/8	11/16	1 11/32	2	3 1/32	5 1/32	6 1/32
10	5/32	27/32	1 11/16	2 17/32	3 25/32	6 5/16	7 9/16
12	7/32	1	2 1/32	3 1/16	4 9/16	7 19/32	9 1/8
14	1/4	1 7/32	2 7/16	3 21/32	5 1/2	9 5/32	11
16	9/32	1 13/32	2 13/16	4 3/16	6 9/32	10 15/32	12 5/8
18	5/16	1 9/16	3 1/8	4 23/32	7 1/16	11 25/32	14 1/8
20	11/32	1 3/4	3 1/2	5 1/4	7 27/32	13 3/32	15 11/16
22	3/8	1 29/32	3 27/32	5 3/4	8 5/8	14 3/8	17 9/32
24	13/32	2 3/32	4 3/16	6 9/32	9 7/16	15 11/16	18 27/32
26	15/32	2 9/32	4 17/32	6 13/16	10 7/32	17 1/32	20 13/32
30	17/32	2 5/8	5 1/4	7 7/8	11 25/32	19 5/8	23 9/16
34	19/32	2 31/32	5 29/32	8 29/32	13 3/8	22 9/32	26 11/16
36	5/8	2 13/16	6 1/4	9 7/16	14 1/8	23 5/8	28 1/4
42	23/32	3 21/32	7 5/16	10 19/32	16 1/2	26 3/8	32 31/32

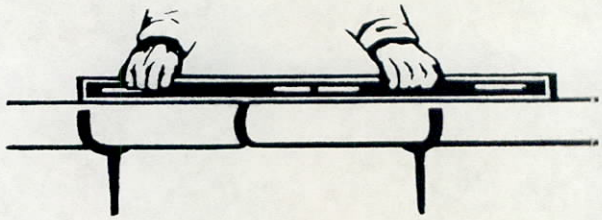
ALIGNMENT OF PIPE

Proper alignment is important if a piping system is to be correctly fabricated. Poor alignment may result in welding difficulties and a system that does not function properly.

Welding rings may be employed to assure proper alignment as well as the correct welding gap. In addition to using welding rings, some simple procedures can be followed to assist the pipe fitter. Below and on the following page are alignment procedures commonly used by today's craftsmen.

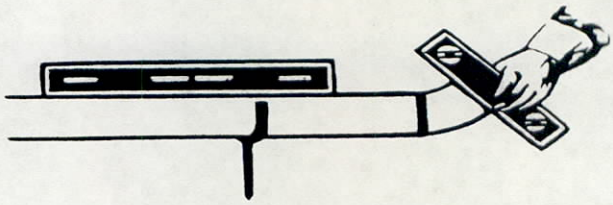
PIPE-TO-PIPE

1. Level one length of pipe using spirit level
2. Bring lengths together leaving only small welding gap
3. Place spirit level over both pipes as shown and maneuver unpositioned length until both are level
4. Tack weld top and bottom
5. Rotate pipe 90°
6. Repeat procedure



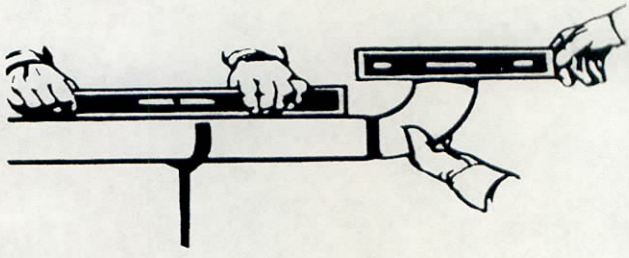
45° ELBOW-TO-PIPE

1. Level pipe using spirit level
2. Place fitting to pipe leaving small welding gap
3. Place 45° spirit level on face of elbow and maneuver elbow until bubble is centered
4. Tack weld in place



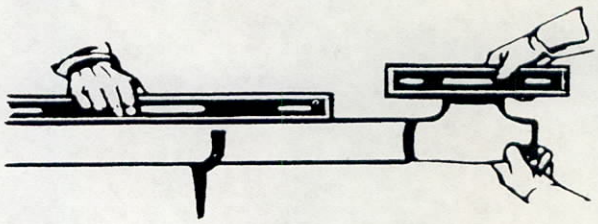
90° ELBOW-TO-PIPE

1. Level pipe using spirit level
2. Place fitting to pipe leaving small welding gap
3. Place spirit level on face of elbow and maneuver elbow until level
4. Tack weld in place



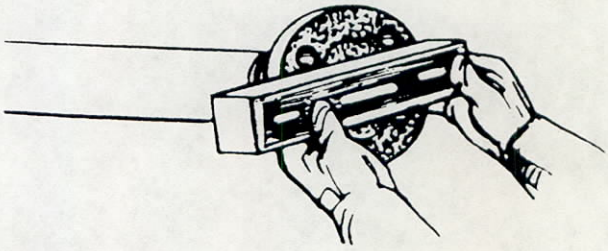
TEE-TO-PIPE

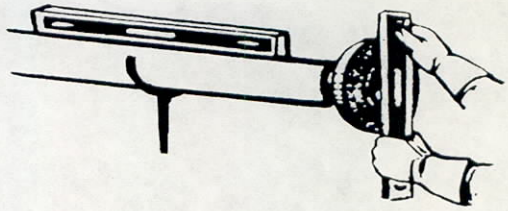
1. Level pipe using spirit level
2. Place tee to pipe leaving small welding gap
3. Place spirit level on face of tee and maneuver tee until level
4. Tack weld in place



FLANGE-TO-PIPE

1. Bring flange to pipe end leaving small welding gap
2. Align top two holes of flange with spirit level
3. Tack weld in place
4. Center square on face of flange as shown
5. Tack weld in place
6. Check sides in same way

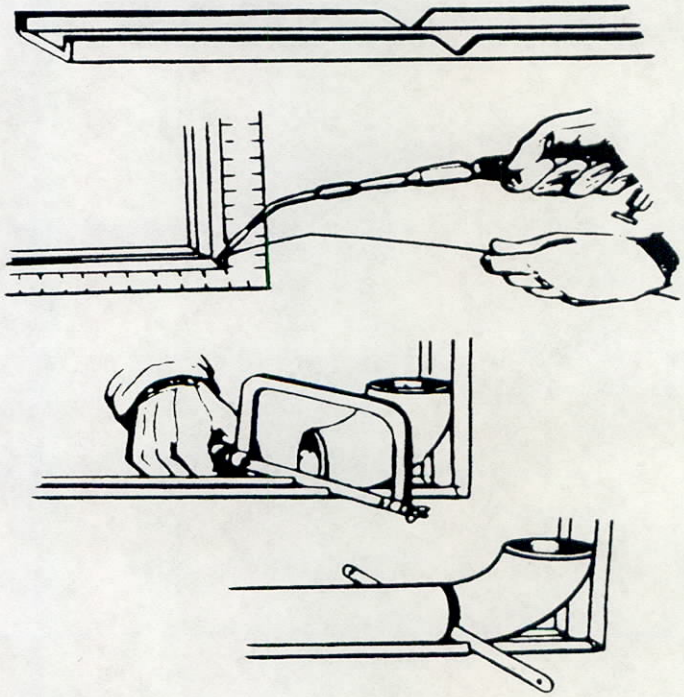




JIG FOR SMALL DIAMETER PIPING

The jig is made from channel iron 3′ 9″ long. Use ⅛″ x 1½″ for pipe sizes 1¼″ thru 3″; 1⅛″ x ¾″ for sizes 1″ or smaller.

1. Cut out 90° notches about 9″ from end.
2. Heat bottom of notch with torch.
3. Bend channel iron to 90° angle and weld sides.
4. Place elbow in jig and saw half thru sides of channel iron as shown. Repeat this step with several elbows so jig may be used for different operations.
5. A used hack saw blade placed in notch as shown will provide proper welding gap.



DRILL SIZES FOR PIPE TAPS

SIZE OF TAP	NUMBER OF THREADS PER INCH	DIAM. OF DRILL	SIZE OF TAP	NUMBER OF THREADS PER INCH	DIAM. OF DRILL
1/8	27	11/32	2	11 1/2	2 3/16
1/4	18	7/16	2 1/2	8	2 9/16
3/8	18	37/64	3	8	3 3/16
1/2	14	23/32	3 1/2	8	3 11/16
3/4	14	59/64	4	8	4 3/16
1	11 1/2	1 5/32	4 1/2	8	4 3/4
1 1/4	11 1/2	1 1/2	5	8	5 5/16
1 1/2	11 1/2	1 49/64	6	8	6 5/16

TAP AND DRILL SIZES

(American Standard Coarse)

SIZE OF DRILL	SIZE OF TAP	THREADS PER INCH	SIZE OF DRILL	SIZE OF TAP	THREADS PER INCH
7	1/4	20	49/64	7/8	9
F	5/16	18	53/64	15/16	9
5/16	3/8	16	7/8	1	8
U	7/16	14	63/64	1 1/8	7
27/64	1/2	13	1 7/64	1 1/4	7
31/64	9/16	12	1 13/64	1 3/8	6
17/32	5/8	11	1 11/32	1 1/2	6
19/32	11/16	11	1 29/64	1 5/8	5 1/2
21/32	3/4	10	1 9/16	1 3/4	5
23/32	13/16	10	1 11/16	1 7/8	5
			1 25/32	2	4 1/2

PIPE AND WATER WEIGHT PER LINE FOOT

NOM. PIPE SIZE	WEIGHT OF:		WEIGHT OF:	
	STD. PIPE	WATER	XS PIPE	WATER
½	.851	.132	1.088	.101
¾	1.131	.231	1.474	.187
1	1.679	.374	2.172	.311
1 ¼	2.273	.648	2.997	.555
1 ½	2.718	.882	3.632	.765
2	3.653	1.453	5.022	1.278
2 ½	5.794	2.073	7.662	1.835
3	7.580	3.200	10.250	2.860
3 ½	9.110	4.280	12.510	3.850
4	10.790	5.510	14.990	4.980
5	14.620	8.660	20.780	7.880
6	18.980	12.510	28.580	11.290
8	28.560	21.680	43.400	19.800
10	40.500	34.100	54.700	32.300
12	49.600	49.000	65.400	47.000
14	54.600	59.700	72.100	57.500
16	62.600	79.100	82.800	76.500
18	70.600	101.200	93.500	98.300
20	78.600	126.000	104.100	122.800
24	94.600	183.800	125.500	179.900
30	118.700	291.000	157.600	286.000

WEIGHT PER FOOT OF SEAMLESS BRASS AND COPPER PIPE

NOMINAL PIPE SIZE	REGULAR			EXTRA STRONG		
	YELLOW BRASS	RED BRASS	COPPER	YELLOW BRASS	RED BRASS	COPPER
½	0.91	0.93	0.96	1.19	1.23	1.25
¾	1.23	1.27	1.30	1.62	1.67	1.71
1	1.73	1.78	1.82	2.39	2.46	2.51
1 ¼	2.56	2.63	2.69	3.29	3.39	3.46
1 ½	3.04	3.13	3.20	3.99	4.10	4.19
2	4.01	4.12	4.22	5.51	5.67	5.80

WATER PRESSURE TO FEET HEAD

POUNDS PER SQUARE INCH	FEET HEAD	POUNDS PER SQUARE INCH	FEET HEAD
1	2.31	100	230.90
2	4.62	110	253.93
3	6.93	120	277.07
4	9.24	130	300.16
5	11.54	140	323.25
6	13.85	150	346.34
7	16.16	160	369.43
8	18.47	170	392.52
9	20.78	180	415.61
10	23.09	200	461.78
15	34.63	250	577.24
20	46.18	300	692.69
25	57.72	350	808.13
30	69.27	400	922.58
40	92.36	500	1154.48
50	115.45	600	1385.39
60	138.54	700	1616.30
70	161.63	800	1847.20
80	184.72	900	2078.10
90	207.81	1000	2309.00

NOTE: One pound of pressure per square inch of water equals 2.309 feet of water at 62° Fahrenheit. Therefore, to find the feet head of water for any pressure not given in the table above, multiply the pressure pounds per square inch by 2.309.

FEET HEAD OF WATER TO PSI

FEET HEAD	POUNDS PER SQUARE INCH	FEET HEAD	POUNDS PER SQUARE INCH
1	.43	100	43.31
2	.87	110	47.64
3	1.30	120	51.97
4	1.73	130	56.30
5	2.17	140	60.63
6	2.60	150	64.96
7	3.03	160	69.29
8	3.46	170	73.63
9	3.90	180	77.96
10	4.33	200	86.62
15	6.50	250	108.27
20	8.66	300	129.93
25	10.83	350	151.58
30	12.99	400	173.24
40	17.32	500	216.55
50	21.65	600	259.85
60	25.99	700	303.16
70	30.32	800	346.47
80	34.65	900	389.78
90	38.98	1000	433.00

NOTE: One foot of water at 62° Fahrenheit equals .433 pound pressure per square inch. To find the pressure per square inch for any feet head not given in the table above, multiply the feet head by .433.

BOILING POINTS OF WATER AT VARIOUS PRESSURES

VACUUM, IN INCHES OF MERCURY	BOILING POINT	VACUUM, IN INCHES OF MERCURY	BOILING POINT
29	76.62	7	198.87
28	99.93	6	200.96
27	114.22	5	202.25
26	124.77	4	204.85
25	133.22	3	206.70
24	140.31	2	208.50
23	146.45	1	210.25
22	151.87	Gauge Lbs.	
21	156.75	0	212.0
20	161.19	1	215.6
19	165.24	2	218.5
18	169.00	4	224.4
17	172.51	6	229.8
16	175.80	8	234.8
15	178.91	10	239.4
14	181.82	15	249.8
13	184.61	25	266.8
12	187.21	50	297.7
11	189.75	75	320.1
10	192.19	100	337.9
9	194.50	125	352.9
8	196.73	200	387.9

FLOW CONVERSION CHART

The accompanying chart provides fast answers to many problems that may confront the pipe fitter. Procedures for using the chart are as follows:

Note that there are three sets of figures shown in connection with the extreme left-hand column A. The column marked "1 in. standard" gives the internal diameter of standard pipe (somewhat greater than 1 for 1 in. standard pipe). The column marked "2 exact" gives the exact diameter. The column marked "3 extra heavy" gives the internal diameter of extra heavy pipe.

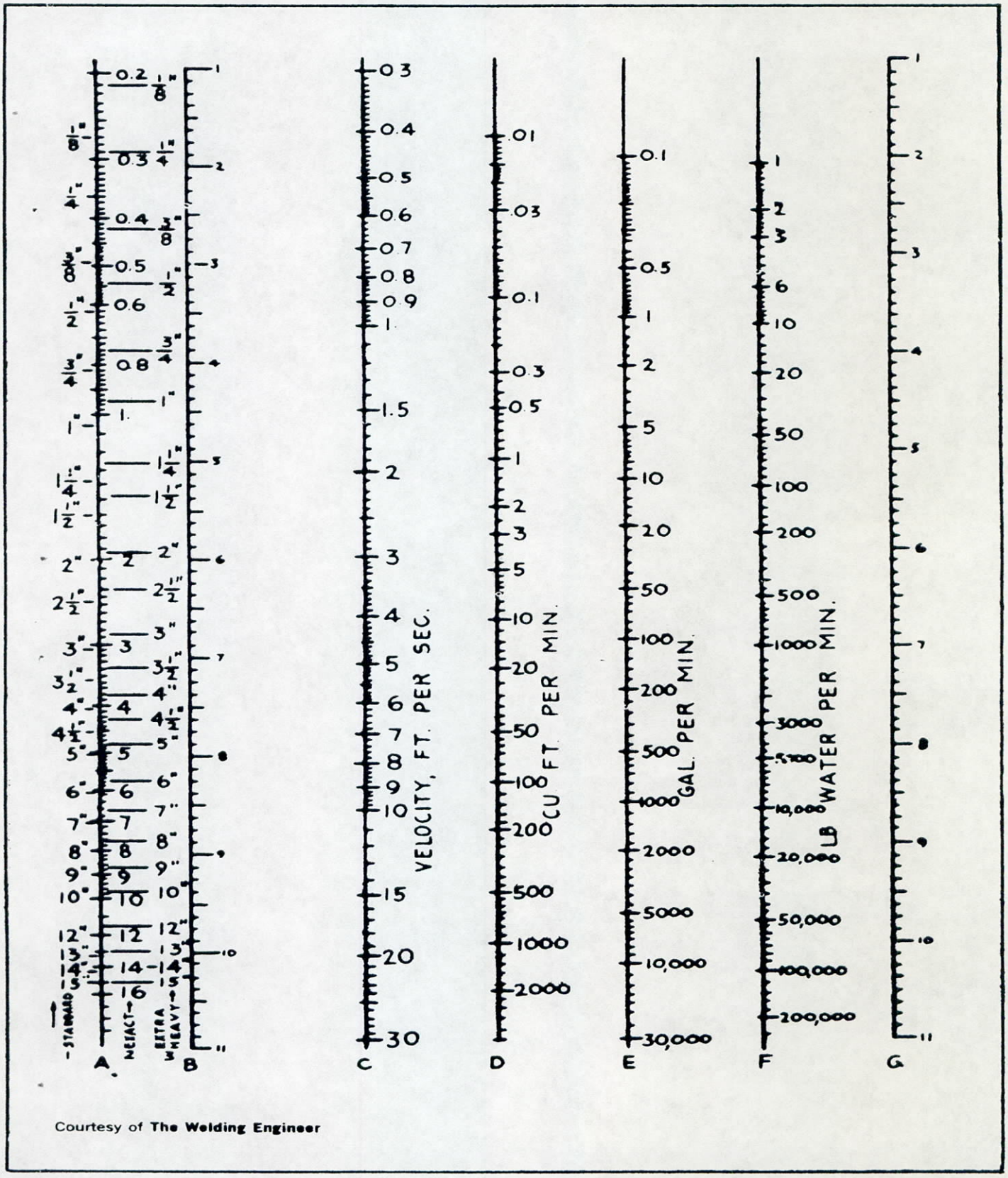
EXAMPLE: How much water is passing through a pipe having an I.D. of exactly 1 in. the velocity of the water being 3 F.P.S.? To apply the chart to the problem locate 1 in. in column A over the word "exact" and run a straight line from the point through the 3 in column C. From the intersection of this line with column B, run a straight line horizontally to column G. The intersection of this line at columns D, E and F gives the following information:

Column D shows the cubic feet/minute flowing through the pipe; column E shows the volume of flow in gallons/minute; column F gives the weight of the water in pounds/minute. (For liquids other than water, multiply the value of column F by the specific gravity of the liquid for accurate weight conversion.) See chart page 31.

If a quantity in columns D, E or F is known then velocity may be determined by reversing the procedure. Draw a horizontal line from the known point to column G. From this intersection draw a line to the exact I.D. of the pipe in column A and extend this line to cross column C. The intersection with column C gives the velocity in feet/second.

The chart can be used as a conversion chart to determine the number of gallons in a certain number of cubic feet of liquid. The horizontal line already drawn to determine answers in columns C and D will provide the answer to the conversion in column E.

A little practice will prove this chart to be a real time-saver.



Courtesy of **The Welding Engineer**

HEAT LOSSES FROM HORIZONTAL BARE STEEL PIPE

(BTU per hour per linear foot at 70°F room temperature)

NOM. PIPE SIZE	HOT WATER (180°F)	STEAM 5 PSIG (20 PSIA)
½	60	96
¾	73	118
1	90	144
1 ¼	112	179
1 ½	126	202
2	155	248
2 ½	185	296
3	221	355
3 ½	244	401
4	279	448

TOTAL THERMAL EXPANSION OF PIPING MATERIAL IN INCHES PER 100 FT. ABOVE 32°F.

TEMPERATURE °F	CARBON AND CARBON MOLY STEEL	CAST IRON	COPPER	BRASS AND BRONZE	WROUGHT IRON
32	0	0	0	0	0
100	0.5	0.5	0.8	0.8	0.5
150	0.8	0.8	1.4	1.4	0.9
200	1.2	1.2	2.0	2.0	1.3
250	1.7	1.5	2.7	2.6	1.7
300	2.0	1.9	3.3	3.2	2.2
350	2.5	2.3	4.0	3.9	2.6
400	2.9	2.7	4.7	4.6	3.1
450	3.4	3.1	5.3	5.2	3.6
500	3.8	3.5	6.0	5.9	4.1
550	4.3	3.9	6.7	6.5	4.6
600	4.8	4.4	7.4	7.2	5.2
650	5.3	4.8	8.2	7.9	5.6
700	5.9	5.3	9.0	8.5	6.1
750	6.4	5.8	—	—	6.7
800	7.0	6.3	—	—	7.2
850	7.4	—	—	—	—
900	8.0	—	—	—	—
950	8.5	—	—	—	—
1000	9.1	—	—	—	—

WEIGHTS OF METALS

MATERIAL	CHEMICAL SYMBOL	WEIGHT, IN POUNDS PER CUBIC INCH	WEIGHT, IN POUNDS PER CUBIC FOOT
Aluminum	Al	.093	160
Antimony	Sb	.2422	418
Brass	—	.303	524
Bronze	—	.320	552
Chromium	Cr	.2348	406
Copper	Cu	.323	558
Gold	Au	.6975	1205
Iron (cast)	Fe	.260	450
Iron (wrought)	Fe	.2834	490
Lead	Pb	.4105	710
Manganese	Mn	.2679	463
Mercury	Hg	.491	849
Molybdenum	Mo	.309	534
Monel	—	.318	550
Platinum	Pt	.818	1413
Steel (mild)	—	.2816	490
Steel (stainless)	—	.277	484
Tin	Sn	.265	459
Titanium	Ti	.1278	221
Zinc	Zn	.258	446

COLORS AND APPROXIMATE TEMPERATURE FOR CARBON STEEL

Black Red	990°F
Dark Blood Red	1050
Dark Cherry Red	1175
Medium Cherry Red	1250
Full Cherry Red	1375
Light Cherry, Scaling	1550
Salmon, Free Scaling	1650
Light Salmon	1725
Yellow	1825
Light Yellow	1975
White	2220

TEMPERATURE DATA CHART

MELTING POINTS

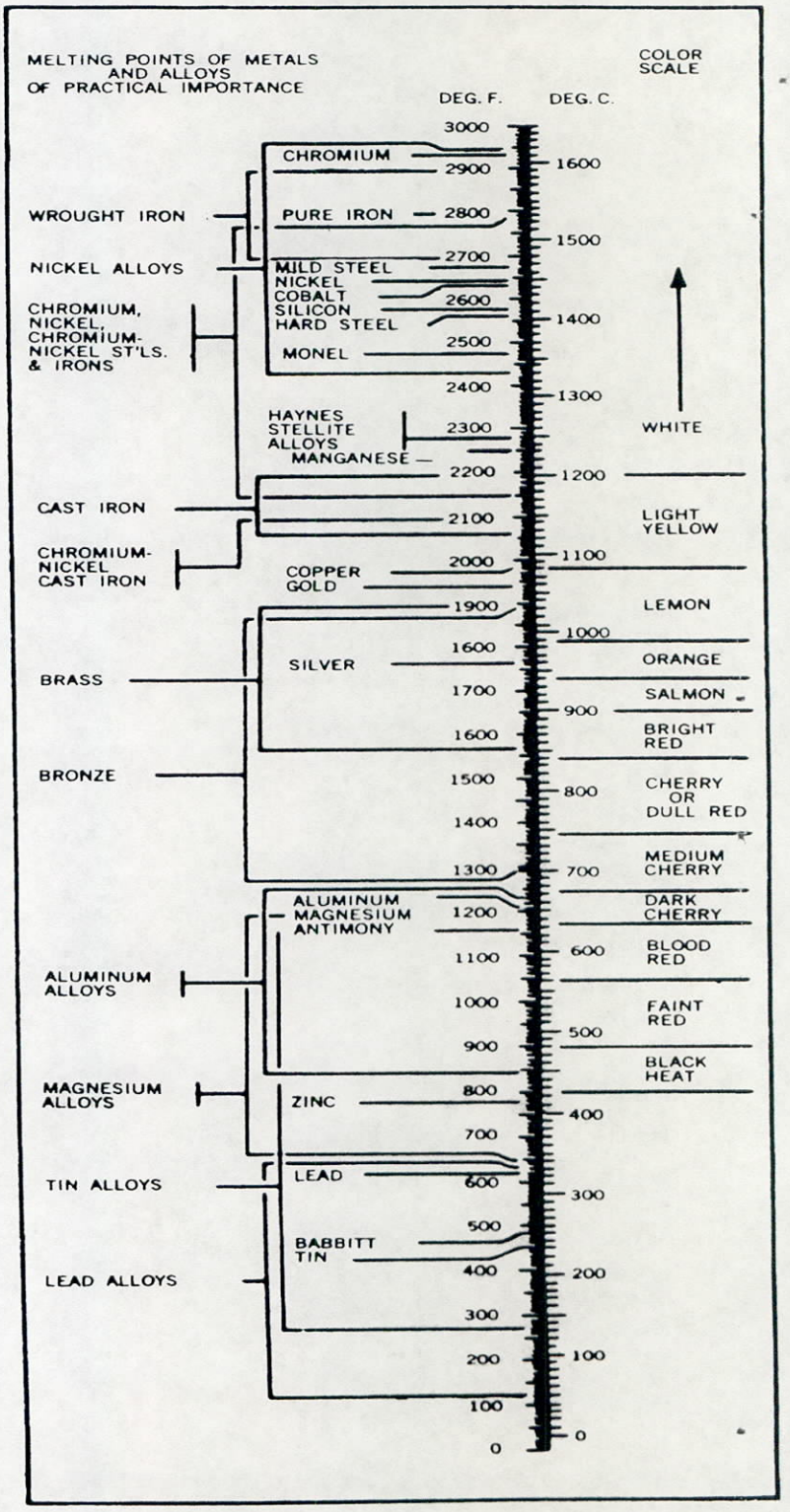
This chart contains basic information on working with metals at elevated temperatures. The most commonly used metals are listed.

TEMPERATURE COLOR SCALE

Another use for the chart is in estimating the temperature of metals by color when no heat measuring devices are available. Using the chart is, in most cases, faster, while maintaining a good degree of accuracy.

CONVERSION DATA

A ready means for converting fahrenheit to centigrade is also provided.



SPECIFIC GRAVITY OF GASES

Dry Air (1 cu. ft. at 60°F. and 29.92" Hg. weighs .07638 pound)		1.000
Acetylene	C_2H_2	0.91
Ethane	C_2H_6	1.05
Methane	CH_4	0.554
Ammonia	NH_3	0.596
Carbon-dioxide	CO_2	1.53
Carbon-monoxide	CO	0.967
Butane	C_4H_{10}	2.067
Butene	C_4H_8	1.93
Chlorine	Cl_2	2.486
Helium	He	0.138
Hydrogen	H_2	0.0696
Nitrogen	N_2	0.9718
Oxygen	O_2	1.1053

SPECIFIC GRAVITY OF LIQUIDS

LIQUID	TEMP °F	SPECIFIC GRAVITY
Water (1 cu.-ft. weighs 62.41 lb.)	50	1.00
Brine (Sodium Chloride 25%)	32	1.20
Pennsylvania Crude Oil	80	0.85
Fuel Oil No. 1 and 2	85	0.95
Gasoline	80	0.74
Kerosene	85	0.82
Lubricating Oil SAE 10-20-30	115	0.94

TYPICAL BTU VALUES OF FUELS

ASTM RANK SOLIDS	BTU VALUES PER POUND
Anthracite Class I	11,230
Bituminous Class II Group 1	14,100
Bituminous Class II Group 3	13,080
Sub-Bituminous Class III Group 1	10,810
Sub-Bituminous Class III Group 2	9,670

LIQUIDS	BTU VALUES PER GAL.
Fuel Oil No. 1	136,000
Fuel Oil No. 2	138,000
Fuel Oil No. 4	145,000
Fuel Oil No. 5	148,000
Fuel Oil No. 6	152,000

GASES	BTU VALUES PER CU. FT.
Natural Gas	935 to 1132
Producers Gas	163
Illuminating Gas	534
Mixed (Coke oven and water gas)	545

Value for natural gas from "Industrial Furnaces," Volume II, by W. Trinks, page 2.

USEFUL DEFINITIONS

ALLOY STEEL: A steel which owes its distinctive properties to elements other than carbon.

AREA OF A CIRCLE: The measurement of the surface within a circle. To find the area of a circle, multiply the product of the radius times the radius by Pi (3.142). Commonly written $A = \pi r^2$.

BRAZE WELD OR BRAZING: A process of joining metals using a nonferrous filler metal or alloy, the melting point of which is higher than 800°F but lower than that of the metals to be joined.

BUTT WELD: A circumferential weld in pipe fusing the abutting pipe walls completely from inside wall to outside wall.

CARBON STEEL: A steel which owes its distinctive properties chiefly to the various percentages of carbon (as distinguished from the other elements) which it contains.

CIRCUMFERENCE OF A CIRCLE: The measurement around the perimeter of a circle. To find the circumference, multiply Pi (3.142) by the diameter. (Commonly written as πd).

COEFFICIENT OF EXPANSION: A number indicating the degree of expansion or contraction of a substance.

The coefficient of expansion is not constant and varies with changes in temperature. For linear expansion it is expressed as the change in length of one unit of length of a substance having one degree rise in temperature.

CORROSION: The gradual destruction or alteration of a metal or alloy caused by direct chemical attack or by electrochemical reaction.

CREEP: The plastic flow of pipe within a system; the permanent set in metal caused by stresses at high temperatures. Generally associated with a time rate of deformation.

USEFUL DEFINITIONS

DIAMETER OF A CIRCLE: A straight line drawn through the center of a circle from one extreme edge to the other. Equal to twice the radius.

DUCTILITY: The property of elongation, above the elastic limit, but under the tensile strength.

A measure of ductility is the percentage of elongation of the fractured piece over its original length.

ELASTIC LIMIT: The greatest stress which a material can withstand without a permanent deformation after release of the stress.

EROSION: The gradual destruction of metal or other material by the abrasive action of liquids, gases, solids or mixtures thereof.

RADIUS OF A CIRCLE: A straight line drawn from the center to the extreme edge of a circle.

SOCKET FITTING: A fitting used to join pipe in which the pipe is inserted into the fitting. A fillet weld is then made around the edge of the fitting and the outside wall of the pipe.

SOLDERING: A method of joining metals using fusable alloys, usually tin and lead, having melting points under 700°F.

STRAIN: Change of shape or size of a body produced by the action of a stress.

STRESS: The intensity of the internal, distributed forces which resist a change in the form of a body. When external forces act on a body they are resisted by reactions within the body which are termed stresses.

DEFINITIONS (Continued)

TENSILE STRESS: One that resists a force tending to pull a body apart.

COMPRESSIVE STRESS: One that resists a force tending to crush a body.

SHEARING STRESS: One that resists a force tending to make one layer of a body slide across another layer.

TORSIONAL STRESS: One that resists forces tending to twist a body.

TENSILE STRENGTH: The maximum tensile stress which a material will develop. The tensile strength is usually considered to be the load in pounds per square inch at which a test specimen ruptures.

TURBULENCE: Any deviation from parallel flow in a pipe due to rough inner walls, obstructions or directional changes.

VELOCITY: Time rate of motion in a given direction and sense, usually expressed in feet per second.

VOLUME OF A PIPE: The measurement of the space within the walls of the pipe. To find the volume of a pipe, multiply the length (or height) of the pipe by the product of the inside radius times the inside radius by Pi (3.142). Commonly written as $V = h\pi r^2$.

WELDING: A process of joining metals by heating until they are fused together, or by heating and applying pressure until there is a plastic joining action. Filler metal may or may not be used.

YIELD STRENGTH: The stress at which a material exhibits a specified limiting permanent set.

LIST OF ABBREVIATIONS

Abbreviations conform to the practice of the American Standard Abbreviations for Scientific and Engineering Terms, ASA Z10.1.

abs	Absolute
AGA	American Gas Association
AISI	American Iron and Steel Institute
Amer Std	American Standard
API	American Petroleum Institute
ASA	American Standards Association
ASHVE	American Society of Heating and Ventilating Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
B & S	Bell and spigot or Brown & Sharpe (gauge)
bbl	Barrel
Btu	British thermal unit(s)
C	Centigrade
cfm	Cubic feet per minute
cfs	Cubic feet per second
CI	Cast iron
CS	Cast steel
Comp	Companion
C to F	Center to face
°C	Degrees Centigrade
°F	Degrees Fahrenheit
diam	Diameter
dwg	Drawing
ex-hy	Extra-heavy
F&D	Faced and drilled
F	Fahrenheit
F to F	Face to face
flg	Flange or flanges

LIST OF ABBREVIATIONS (Continued)

flgd	Flanged
g	Gage or gauge
hex	Hexagonal
hg	mercury
IBBM	Iron body bronze (or brass) mounted
ID	Inside diameter
kw	Kilowatt(s)
MI	Malleable iron
max	Maximum
min	Minimum
mtd	Mounted
MSS	Manufacturers Standardization Society (of Valve and Fittings Industry)
NEWWA	New England Water Works Association
NPS	Nominal pipe size (formerly IPS for iron pipe size)
OD	Outside diameter
OS&Y	Outside screw and yoke
OWG	Oil, water, gas (see WOG)
psig	Pounds per square inch, gage
red	Reducing
sch or sched	Schedule
scd	Screwed
SF	Semifinished
Spec	Specification
SSP	Steam service pressure
SSU	Seconds Saybolt Universal
Std	Standard
Trans	Transactions
WOG	Water, oil, gas (see OWG)
WWP	Working water pressure
XS	Extra strong
XXS	Double extra strong

UNIT CONVERSIONS

FLOW

1 gpm	= 0.134 cu. ft. per min.
	= 500 lb. per hr. x sp. gr.
500 lb. per hr.	= 1 gpm ÷ sp. gr.
1 cu. ft. per min. (cfm)	= 448.8 gal. per hr. (gph)

POWER

1 Btu per hr.	= 0.293 watt
	= 12.96 ft. lb. per min.
	= 0.00039 hp
1 ton refrigeration (U.S.)	= 288,000 Btu per 24 hr.
	= 12,000 Btu per hr.
	= 200 Btu per min.
	= 83.33 lb. ice melted per hr. from and at 32°F.
	= 2000 lb. ice melted per 24 hr. from and at 32°F.
1 hp	= 550 ft. lb. per sec.
	= 746 watt
	= 2545 Btu per hr.
1 boiler hp	= 33,480 Btu per hr.
	= 34.5 lb. water evap. per hr. from and at 212°F.
	= 9.8 kw.
1 kw.	= 3413 Btu per hr.

MASS

1 lb. (avoir.)	= 16 oz. (avoir.)
	= 7000 grain
1 ton (short)	= 2000 lb.
1 ton (long)	= 2240 lb.

PRESSURE

1 lb. per sq. in.	= 2.31 ft. water at 60°F
	= 2.04 in. hg at 60°F.
1 ft. water at 60°F	= 0.433 lb. per sq. in.
	= 0.884 in. hg at 60°F
1 in. Hg at 60°F	= 0.49 lb. per sq. in.
	= 1.13 ft. water at 60°F
lb. per sq. in. Absolute (psia)	= lb. per sq. in. gauge (psig) + 14.7

UNIT CONVERSIONS

TEMPERATURE

°C = (°F −32) × 5/9

VOLUME

1 gal. (U.S.) = 128 fl. oz. (U.S.)
= 231 cu. in.
= 0.833 gal. (Brit.)

1 cu. ft. = 7.48 gal. (U.S.)

WEIGHT OF WATER

1 cu. ft. at 50°F. weighs 62.41 lb.
1 gal. at 50°F. weighs 8.34 lb.
1 cu. ft. of ice weighs 57.2 lb.
Water is at its greatest density at 39.2°F.
1 cu. ft. at 39.2°F. weighs 62.43 lb.

WEIGHT OF LIQUID

1 gal. (U.S.) = 8.34 lb. × sp. gr.
1 cu. ft. = 62.4 lb. × sp. gr.

1 lb. = 0.12 U.S. gal. ÷ sp. gr.
= 0.016 cu. ft. ÷ sp. gr.

WORK

1 Btu (mean) = 778 ft. lb.
= 0.293 watt hr.
= 1/180 of heat required to change temp of 1 lb. water from 32°F to 212°F

1 hp-hr = 2545 Btu (mean)
= 0.746 kwhr

1 Kwhr = 3413 Btu (mean)
= 1.34 hp-hr

STANDARD CONVERSIONS

TO CHANGE	TO	MULTIPLY BY
Inches	Feet	0.0833
Inches	Millimeters	25.4
Feet	Inches	12
Feet	Yards	0.3333
Yards	Feet	3
Square inches	Square feet	0.00694
Square feet	Square inches	144
Square feet	Square yards	0.11111
Square yards	Square feet	9
Cubic inches	Cubic feet	0.00058
Cubic feet	Cubic inches	1728
Cubic feet	Cubic yards	0.03703
Cubic yards	Cubic feet	27
Cubic inches	Gallons	0.00433
Cubic feet	Gallons	7.48
Gallons	Cubic inches	231
Gallons	Cubic feet	0.1337
Gallons	Pounds of water	8.33
Pounds of water	Gallons	0.12004
Ounces	Pounds	0.0625
Pounds	Ounces	16
Inches of water	Pounds per square inch	0.0361
Inches of water	Inches of mercury	0.0735
Inches of water	Ounces per square inch	0.578
Inches of water	Pounds per square foot	5.2
Inches of mercury	Inches of water	13.6
Inches of mercury	Feet of water	1.1333
Inches of mercury	Pounds per square inch	0.4914
Ounces per square inch	Inches of mercury	0.127
Ounces per square inch	Inches of water	1.733
Pounds per square inch	Inches of water	27.72
Pounds per square inch	Feet of water	2.310
Pounds per square inch	Inches of mercury	2.04
Pounds per square inch	Atmospheres	0.0681
Feet of water	Pounds per square inch	0.434
Feet of water	Pounds per square foot	62.5
Feet of water	Inches of mercury	0.8824
Atmospheres	Pounds per square inch	14.696
Atmospheres	Inches of mercury	29.92
Atmospheres	Feet of water	34
Long tons	Pounds	2240
Short tons	Pounds	2000
Short tons	Long tons	0.89285

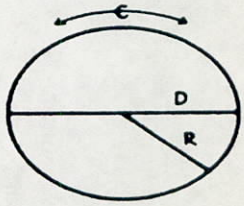
FORMULAS

Where:

A = Area; A_1 = Surface area of solids;
V = Volume; C = Circumference

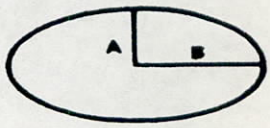
Circle

$$A = 3.142 \times R \times R$$
$$C = 3.142 \times D$$
$$R = \frac{D}{2}$$
$$D = 2 \times R$$



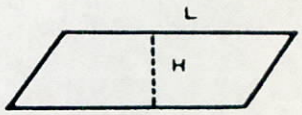
Ellipse

$$A = 3.142 \times A \times B$$
$$C = 6.283 \times \frac{\sqrt{A^2 + B^2}}{2}$$



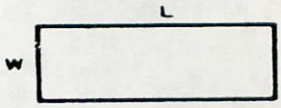
Parallelogram

$$A = H \times L$$



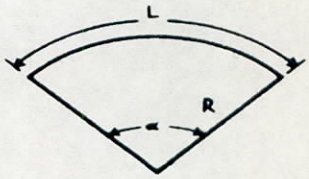
Rectangle

$$A = W \times L$$



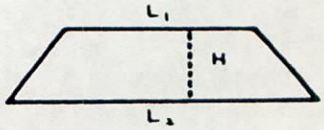
Sector of circle

$$A = \frac{3.142 \times R \times R \times \alpha}{360}$$
$$L = .01745 \times R \times \alpha$$
$$\alpha = \frac{L}{.01745 \times R}$$
$$R = \frac{L}{.01745 \times \alpha}$$



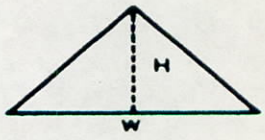
Trapezoid

$$A = H \times \frac{L_1 + L_2}{2}$$



Triangle

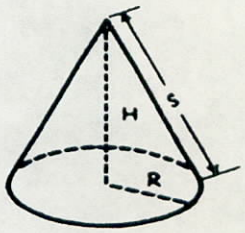
$$A = \frac{W \times H}{2}$$



FORMULAS

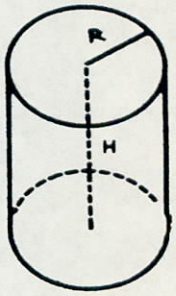
Cone

$$A_1 = 3.142 \times R \times S + 3.142 \times R \times R$$
$$V = 1.047 \times R \times R \times H$$



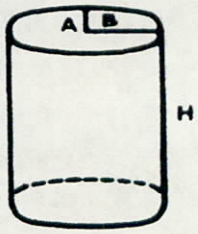
Cylinder

$$A_1 = 6.283 \times R \times R + 6.283 \times R \times R$$
$$V = 3.142 \times R \times R \times H$$



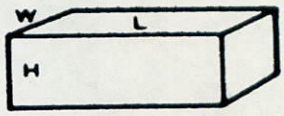
Elliptical Tanks

$$V = 3.142 \times A \times B \times H$$
$$A_1 = 6.283 \times \frac{\sqrt{A^2 + B^2}}{2} \times H + 6.283 \times A \times B$$



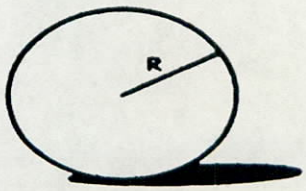
Rectangular solid

$$A_1 = 2[W \times L + L \times H + H \times W]$$
$$V = W \times L \times H$$



Sphere

$$A_1 = 12.56 \times R \times R$$
$$V = 4.188 \times R \times R \times R$$



For above containers:

Capacity in gallons $= \frac{V}{231}$ when V is in cubic inches.

Capacity in gallons $= 7.48 \times V$ when V is in cubic feet.

HARDNESS CONVERSION NUMBERS

BRINELL INDENTATION DIAMETER, MM.	BRINELL HARDNESS NO. — 10-MM. BALL 3000-KG. LOAD: STANDARD OR TUNGSTEN CARBIDE BALL	DIAMOND PYRAMID HARDNESS NUMBER. 50-KG. LOAD	ROCKWELL HARDNESS NUMBER: B-SCALE 100-KG. LOAD 1/16 IN. DIA. BALL	ROCKWELL HARDNESS NUMBER: C-SCALE 150-KG. LOAD BRALE PENETRATOR	ROCKWELL SUPERFICIAL HARDNESS NUMBER SUPERFICIAL BRALE PENETRATOR: 15-N SCALE 15-KG. LOAD	30-N SCALE 30-KG. LOAD	45-N SCALE 45-KG. LOAD	SHORE SCLEROSCOPE HARDNESS NUMBER	TENSILE STRENGTH (APPROX.) 1000 PSI.
2.95	429	455	—	45.7	83.4	64.6	49.9	61	217
3.00	415	440	—	44.5	82.8	63.5	48.4	59	210
3.05	401	425	—	43.1	82.0	62.3	46.9	58	202
3.10	388	410	—	41.8	81.4	61.1	45.3	56	195
3.15	375	396	—	40.4	80.6	59.9	43.6	54	188
3.20	363	383	—	39.1	80.0	58.7	42.0	52	182
3.25	352	372	(110.0)	37.9	79.3	57.6	40.5	51	176
3.30	341	360	(109.0)	36.9	78.6	56.4	39.1	50	170
3.35	331	350	(108.5)	35.5	78.0	55.4	37.8	48	166
3.40	321	339	(108.0)	34.3	77.3	54.3	36.4	47	160
3.45	311	328	(107.5)	33.1	76.7	53.3	34.4	46	155
3.50	302	319	(107.0)	32.1	76.1	52.2	33.8	45	150
3.55	293	309	(106.0)	30.9	75.5	51.2	32.4	43	145
3.60	285	301	(105.5)	29.9	75.0	50.3	31.2	—	141
3.65	277	292	(104.5)	28.8	74.4	49.3	29.9	41	137
3.70	269	284	(104.0)	27.6	73.7	48.3	28.5	40	133
3.75	262	276	(103.0)	26.6	73.1	47.3	27.3	39	129
3.80	255	269	(102.0)	25.4	72.5	46.2	26.0	38	126
3.85	248	261	(101.0)	24.2	71.7	45.1	24.5	37	122
3.90	241	253	100.0	22.8	70.9	43.9	22.8	36	118
3.95	235	247	99.0	21.7	70.3	42.9	21.5	35	115
4.00	229	241	98.2	20.5	69.7	41.9	20.1	34	111
4.05	223	234	97.3	(18.8)	—	—	—	—	—
4.10	217	228	96.4	(17.5)	—	—	—	33	105
4.15	212	222	95.5	(16.0)	—	—	—	—	102
4.20	207	218	94.6	(15.2)	—	—	—	32	100
4.25	201	212	93.8	(13.8)	—	—	—	31	98
4.30	197	207	92.8	(12.7)	—	—	—	30	95
4.35	192	202	91.9	(11.5)	—	—	—	29	93
4.40	187	196	90.7	(10.0)	—	—	—	—	90
4.45	183	192	90.0	(9.0)	—	—	—	28	89
4.50	179	188	89.0	(8.0)	—	—	—	27	87
4.55	174	182	87.8	(6.4)	—	—	—	—	85
4.60	170	178	86.8	(5.4)	—	—	—	26	83
4.65	167	175	86.0	(4.4)	—	—	—	—	81
4.70	163	171	85.0	(3.3)	—	—	—	25	79
4.80	156	163	82.9	(0.9)	—	—	—	—	76
4.90	149	156	80.8	—	—	—	—	23	73
5.00	143	150	78.7	—	—	—	—	22	71
5.10	137	143	76.4	—	—	—	—	21	67
5.20	131	137	74.0	—	—	—	—	—	65
5.30	126	132	72.0	—	—	—	—	20	63
5.40	121	127	69.8	—	—	—	—	19	60
5.50	116	122	67.6	—	—	—	—	18	58
5.60	111	117	65.7	—	—	—	—	15	56

NOTE: Values in ( ) are beyond normal range; given for information only.

COATED ARC WELDING ELECTRODES

Types or Styles

A. W. S.
Classification

E 60**10** **Direct Current, Reverse Polarity, All Positions.**
All purpose. Moderately smooth finish. Good penetration.
This is the electrode used for most carbon steel pipe welding.

E 60**11** **Alternating Current, All Positions.**
All purpose. Moderately smooth finish. Good penetration.

E 60**12** **Direct Current, Straight Polarity, All Positions.**
High bead. Smooth. Fast. "Cold rod".

E 60**13** **Alternating Current, All Positions.**
High bead. Smooth. Fast. "Cold rod".

E 60**15** **Direct Current, Reverse Polarity, All Positions.**
"Low hydrogen" electrode.

E 60**16** **Direct Current or Alternating Current, All Positions.**
"Low hydrogen" electrode.

E 60**18** **Direct Current, All Positions.**
"Low hydrogen" iron powder electrodes

E 60**20** **Direct Current, Straight Polarity, Flat Position Only.**
Flat bead. Smooth. Fast. Deep penetration.
Can be used with A.C. also. "Hot rod".

E 60**24** and E 60**27** **Direct Current, Straight Polarity or Alternating Current, Flat Position Only.**
Flat bead. Smooth. Fast. Deep penetration. "Iron powder electrodes".

NOTE:
This information also applies to E 70, E 80, E 90, and E 100 Series.

The last two numbers (in bold type) designate the types or styles and the first two numbers the minimum specified tensile strength in 1000 psi of the weld deposit as welded.

PHYSICAL PROPERTIES OF E60 AND E70 SERIES ELECTRODES

AWS-ASTM ELECTRODE	TENS. STRENGTH	YIELD STRENGTH	ELONGATION	RED. IN AREA MIN. %
TYPICAL VALUES				
E6010	62,000-70,000	52,000-58,000	22 to 28%	35
E6011	62,000-73,000	52,000-61,000		
E6012	68,000-78,000	55,000-65,000	17 to 22%	25
MINIMUM VALUES				
E7010	70,000	57,000	22	
E7011	70,000	57,000	22	
E7015	70,000	57,000	22	
E7016	70,000	57,000	22	
E7020	70,000	52,000	25	

WELDING AND BRAZING TEMPERATURES

Carbon Steel Welding	2700-2790°F
Stainless Steel Welding	2490-2730°F
Cast Iron Welding	1920-2500°F
Copper Welding and Brazing	1980°F
Brazing Copper-Silicon with Phosphor-Bronze	1850-1900°F
Brazing Naval Bronze with Manganese Bronze	1600-1700°F
Silver Solder	1175-1600°F
Low Temperature Brazing	1175-1530°F
Soft Solder	200-730°F
Wrought Iron	2700-2750°F

TROUBLE-SHOOTING ARC WELDING EQUIPMENT

Trouble	Cause	Remedy
Welder will not start (Starter not operating)	Power circuit dead.	Check voltage.
	Broken power lead.	Repair.
	Wrong supply voltage.	Check nameplate against supply.
	Open power switches.	Close.
	Blown fuses.	Replace.
	Overload relay tripped.	Let set cool. Remove cause of overloading.
	Open circuit to starter button.	Repair.
	Defective operating coil.	Replace.
	Mechanical obstruction in contactor.	Remove.
Welder will not start (Starter operating)	Wrong motor connections.	Check connection diagram.
	Wrong supply voltage.	Check nameplate against supply.
	Rotor stuck.	Try turning by hand.
	Power circuit single-phased.	Replace fuse; repair open line.
	Starter single-phased.	Check contact of starter tips.
	Poor motor connection.	Tighten.
	Open circuit in windings.	Repair.
Starter operates and blows fuse	Fuse too small.	Should be two to three times rated motor current.
	Short circuit in motor connections.	Check starter and motor leads for insulation from ground and from each other.

TROUBLE-SHOOTING ARC WELDING EQUIPMENT

Trouble	Cause	Remedy
Welder runs but soon stops	Wrong relay heaters.	Renewal part recommendations.
	Welder overloaded.	Considerable overload can be carried only for a short time.
	Duty cycle too high.	Do not operate continually at overload currents.
	Leads too long or too narrow in cross section.	Should be large enough to carry welding current without excessive voltage drop.
	Power circuit single-phased.	Check for one dead fuse or line.
	Ambient temperature too high.	Operate at reduced loads where temperature exceeds 100° F.
	Ventilation blocked.	Check air inlet and exhaust openings.
Welding arc is loud and spatters excessively	Current setting too high.	Check setting and output with ammeter.
	Polarity wrong.	Check polarity, try reversing, or an electrode of opposite polarity.
Welding arc sluggish	Current too low.	Check output, and current recommended for electrode being used.
	Poor connections.	Check all electrode-holder, cable, and ground-cable connections. Strap iron is poor ground return.
	Cable too long or too small.	Check cable voltage drop and change cable.
Touching set gives shock	Frame not grounded.	Ground solidly.
Generator control fails to vary current	Any part of field circuit may be short circuited or open circuited.	Find faulty contact and repair.

TROUBLE-SHOOTING ARC WELDING EQUIPMENT

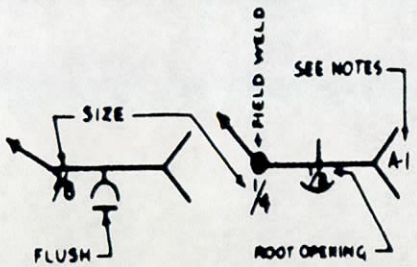
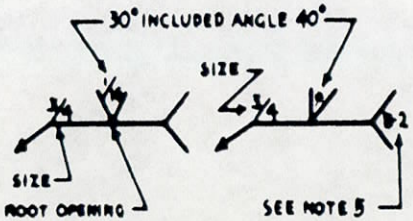
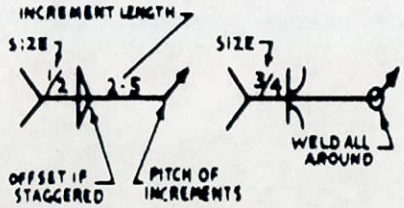
Trouble	Cause	Remedy
Welder starts but will not deliver welding current	Wrong direction of rotation.	See INITIAL STARTING.
	Brushes worn or missing.	Check that all brushes bear on commutator with sufficient tension.
	Brush connections loose.	Tighten.
	Open field circuit.	Check connection to rheostat, resistor, and auxiliary brush studs.
	Series field and armature circuit open.	Check with test lamp or bell ringer.
	Wrong driving speed.	Check nameplate against speed of motor or belt drive.
	Dirt, grounding field coils.	Clean and reinsulate.
	Welding terminal shorted.	Electrode holder or cable grounded.
Welder generating but current falls off when welding	Electrode or ground connection loose.	Clean and tighten all connections.
	Poor ground.	Check ground-return circuit
	Brushes worn off.	Replace with recommended grade. Sand to fit. Blow out carbon dust.
	Weak brush spring pressure.	Replace or readjust brush springs.
	Brush not properly fitted.	Sand brushes to fit.
	Brushes in backwards.	Reverse.
	Wrong brushes used.	Renewal part recommendations.
	Brush pigtails damaged.	Replace brushes.
	Rough or dirty commutator.	Turn down or clean commutator.
	Motor connection single-phased.	Check all connections.

BASIC WELDING SYMBOLS

ARC AND GAS WELDING

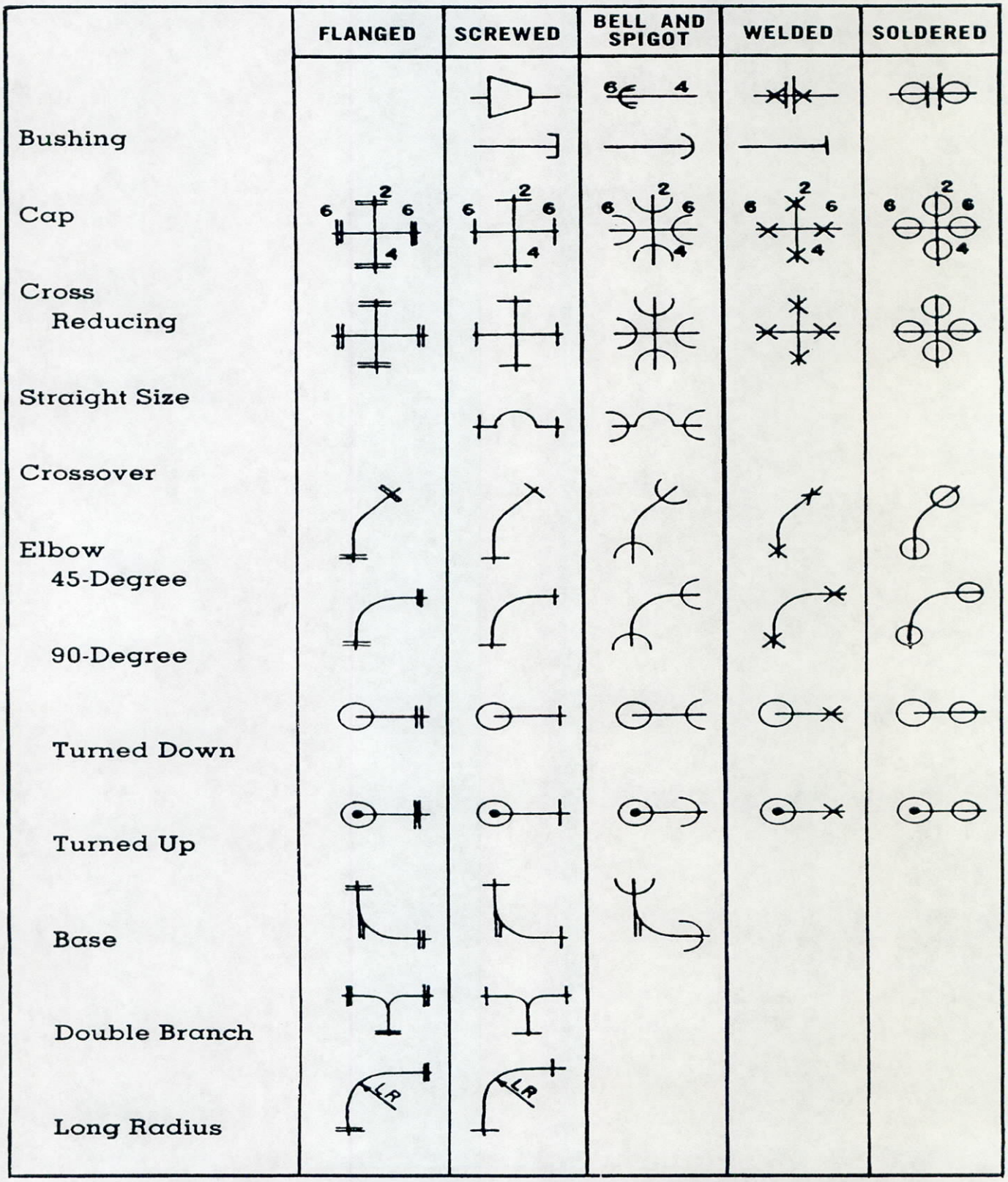
TYPE OF WELD										
BEAD	FILLET	GROOVE					PLUG AND SLOT	FIELD WELD	WELD ALL AROUND	FLUSH
		SQUARE	V	BEVEL	U	J				
										

LOCATION OF WELDING

ARROW (OR NEAR) SIDE OF JOINT	OTHER (OR FAR) SIDE OF JOINT	BOTH SIDES OF JOINT
		

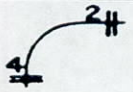
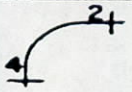
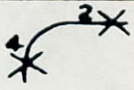
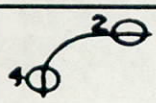
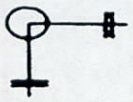
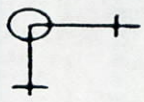
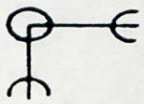
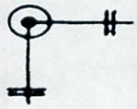
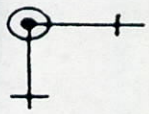
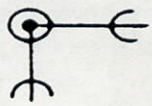
1. In plan or elevation, near, far, and both sides, locations refer to nearest member parallel to plane of drawing and not to others farther behind.
2. In section or end views only, when weld is not drawn, the side to which arrow points is considered near side.
3. Welds on both sides are of same size unless otherwise shown.
4. Symbols govern to break in continuity of structure or to extent of hatching or dimension lines.
5. Tail of arrow used for specification reference.
6. All welds are continuous and of user's standard proportions and all except V- and bevel-grooved welds are closed unless otherwise shown.
7. When welds are drawn in section or end views, obvious information is not given by symbol.
8. In joints in which one member only is to be grooved, arrows point to that member.

SYMBOLS FOR PIPE FITTINGS COMMONLY USED IN DRAFTING PRACTICE



Symbols courtesy of **Mechanical Contractors Association of America, Inc.**

SYMBOLS FOR PIPE FITTINGS COMMONLY USED IN DRAFTING PRACTICE

	FLANGED	SCREWED	BELL AND SPIGOT	WELDED	SOLDERED
Elbow (Cont'd) Reducing					
Side Outlet (Outlet Down)					
Side Outlet (Outlet Up)					
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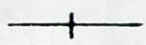
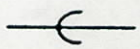
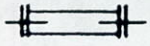
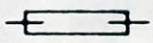
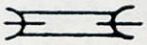
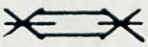
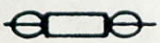
Joint Connecting Pipe					
Expansion					
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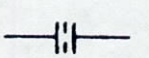
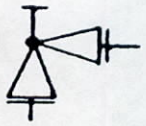
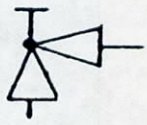
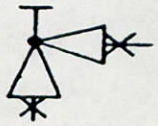
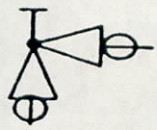
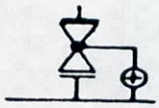
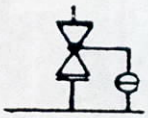
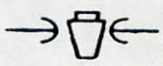
Reducing Flange					
Plugs Bull Plug					
Pipe Plug					
Reducer Concentric					
Eccentric					

SYMBOLS FOR PIPE FITTINGS COMMONLY USED IN DRAFTING PRACTICE

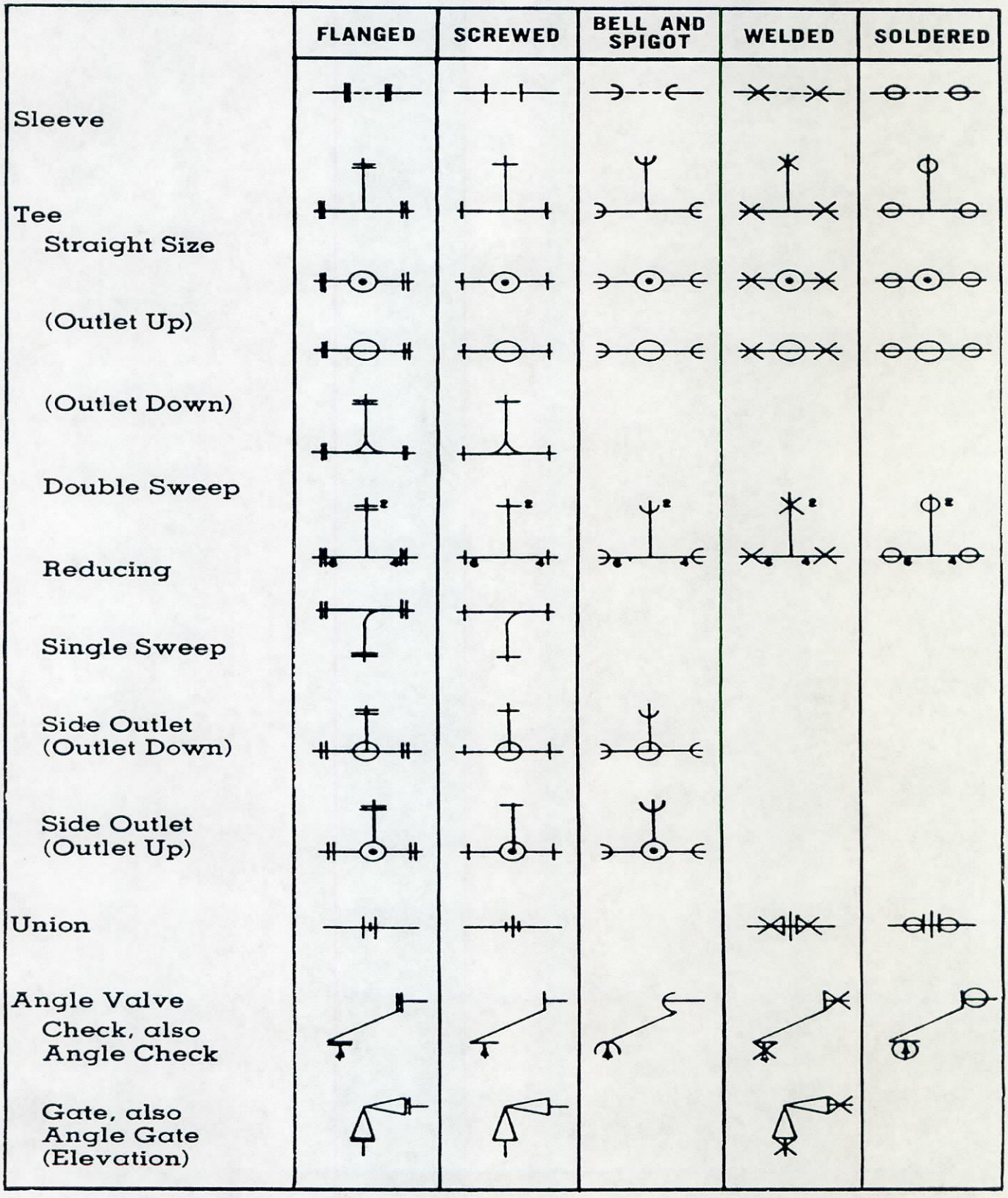
	FLANGED	SCREWED	BELL AND SPIGOT	WELDED	SOLDERED
Gate, also Angle Gate (Plan)					
Globe, also Angle Globe (Elevation)					
Globe (Plan)					
Automatic Valve By-Pass					
Governor-Operated					
Reducing					
Check Valve (Straight Way)					
Cock					
Diaphragm Valve					
Float Valve					
Gate Valve*					

*Also used for General Stop Valve Symbol when amplified by specification.

SYMBOLS FOR PIPE FITTINGS COMMONLY USED IN DRAFTING PRACTICE

	FLANGED	SCREWED	BELL AND SPIGOT	WELDED	SOLDERED
Motor-Operated					
Globe Valve					
Motor-Operated					
Hose Valve, also Hose Globe					
Angle, also Hose Angle					
Gate					
Globe					
Lockshield Valve					
Quick Opening Valve					
Safety Valve					

SYMBOLS FOR PIPE FITTINGS COMMONLY USED IN DRAFTING PRACTICE



WIRE ROPE

Wire rope has largely displaced manila rope in hauling and hoisting heavy loads. As with manila rope, the care of wire rope has a direct bearing on its safe use.

Some of the reasons responsible for the use of wire rope in place of manila are:

1. Greater strength for equal diameter and weight.
2. Equal strength either wet or dry.
3. Constant length regardless of weather conditions.
4. Greater uniformity in strength throughout.
5. Greater number of types for various uses.
6. Lower cost per unit of strength.
7. Greater durability, with equal care in use.

Strength of wire ropes vary, depending on the material from which the individual strands are made and the method used in forming the cable, ranging between 30 and 100 tons per square inch.

Primarily there are 3 classes of wire rope: (1) iron, (2) cast steel, and (3) plow steel.

Iron wire is soft and of low tensile strength, around 30 to 40 tons per square inch. Commonly used for drum type elevator cables and to some extent for derrick guys; being replaced by low-carbon steel wire in these uses.

Cast steel may have a tensile strength up to 90 tons per square inch and because of its greater strength is generally used for hoisting purposes. To check quickly whether a piece of wire is iron or cast steel, bend it. Iron will bend easily and take a long time to regain its original shape, while cast steel will be harder to bend and will snap back to its original shape very quickly.

Plow steel wire rope is made from high grade, open hearth furnace steel and has an average tensile strength of 110 tons per square inch. This is the best and safest wire rope for cranes, derricks, dredges and slings or straps for heavy loads.

Lubrication — Wire Rope

All wire rope, whether used indoors or out, should in the course of regular work be considered as a group of moving wires constantly rubbing against one another, with friction resulting. This friction causes incessant wear on the moving parts of the wire rope or cable and will shorten its life very rapidly unless lubricants are used to overcome the friction.

Cable or wire rope should be treated at regular intervals with a lubricant to prevent rusting and to overcome the friction. Lubricating intervals will depend on the types and amount of work encountered. Under average conditions, if worked steadily on equipment, wire rope or cable will require lubrication once every 3 weeks. Where heavy abrasive dusts exist, more frequent lubrication is in order. Rusty ropes may break without warning.

Sheaves

The life of wire rope or cable is directly affected by the condition and size of the sheaves over which it is used. Sheaves should be at least 16 x the diameter of the rope or cable that is used over them. In passing over a sheave, the inside portion of the cable, which is against the sheave, is shortened and compression is developed in that section of the cable. The outside portion (away from the sheave) is lengthened or stretched, causing tension in that section. These compressive and tensional

stresses combine to create bending stresses which increase rapidly as the diameter of the sheaves decrease. As these bending stresses cause much undue wear and directly shorten the safe working life of the rope or cable, the ratio mention between sheaves and rope should be maintained.

New wire rope may be badly injured and will not work properly in sheaves that have become worn or in which the grooves have become irregular in shape. When sheaves are worn or damaged, it is more economical to renew the sheaves rather than to allow excessive wear on the cable.

One cause of very severe wear in wire rope or cables is reverse bending, which will shorten the life of the rope by approximately ½. Reverse bending refers to the bending of a cable or rope over sheaves, first in one direction then in another.

Another cause of severe rope wear is twisting of the fall rope. When the fall rope is twisted and a hoist is made, the wear produced is equal to more than that resulting from weeks of normal use. The man in charge of lifting operations should guard against twisting of the fall rope and should not allow a lift to be made if the fall rope is twisted.

Handling Cable or Wire Rope

Cable or wire rope cannot and must not be coiled or uncoiled like manila rope. Cable or wire rope must be taken off the reel in a straight line, avoiding kinking. The reel may be mounted on a heavy pipe or roller to facilitate unwinding. If space is limited, the cable as it comes off the reel may be layed out in a figure 8, after which it can be reeved into the line for which it is intended.

Clamp Fastenings

When it is necessary to make a short bend, as in attaching wire rope or when it is to be looped, thimbles should always be used. U BOLTS OF ALL CLAMPS MUST BE ON THE DEAD END OF THE ROPE. In clamping a strap or an eye, the loose or "dead" end is clamped against the main part of the rope, with the clamps spaced apart a distance equal to 6 x diameter of the rope. Clamp fastenings seldom develop more than 4/5 of rope strength at best.

The point of greatest fatigue and/or wear in a rope usually develops at or near the end where it is clamped around the boom or where attached to the becket on the block. Clamps should be inspected at least once weekly and tightened if they show signs of loosening. All clamped or spliced fastenings, especially those on cranes or derricks, should be shifted and changed at least once every six months.

Number of Crosby or Safety Clips and Distance Between Clips Needed for Safety

Diameter of Rope, Inches	Number of Clips	Distance Between Clips, Inches
1/4 – 3/8	3	2 1/4
7/16 – 5/8	3	3 3/4
3/4 – 1 1/8	4	6 3/4
1 1/4 – 1 1/2	5	9
1 5/8 – 1 3/4	6	10 1/2
2 and over	7	6 times diam. of cable

Right

U-Bolts of clips on short end of rope. (No distortion on live end of rope.)

Wrong

U-Bolts on live end of rope. (This will cause mashed spots on live end of rope.)

Wrong

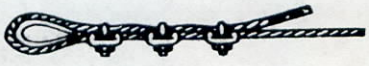
Thimble should be used to increase strength of eye and reduce wear on rope.

Wrong

Wire rope knot with clip efficiency 50% or less

Wrong

Staggered clips: two correct and one wrong. (This will cause a mashed spot in live end of rope due to wrong position of center clip.)



Right

Right

Use of thimble in eye splice.

Kinks in Wire Rope

Badly kinked wire rope

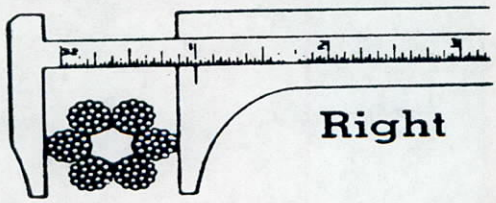
Wire rope with kink partially removed

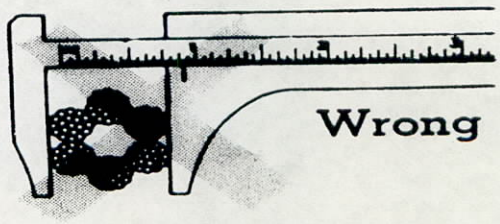
Typical failure of a kinked wire rope

Safe Load (in Pounds) on Improved Plow Steel Wire Rope

6 Strands, 19 or 37 Wires per Strand, Hempcore

Diam. Inches	Circum. Inches	Single Vertical Wirerope	Two Part Sling 60°	Two Part Sling 45°	Two Part Sling 30°	Weight Per Foot, Lbs.	Breaking Strength Tons, (2000 lbs)
1/4	3/4	1,100	1,900	1,550	1,100	.10	2.74
3/8	1 1/8	2,500	4,230	3,460	2,450	.23	6.10
1/2	1 1/2	4,300	7,450	6,080	4,300	.40	10.70
5/8	2	6,600	11,600	9,430	6,670	.63	16.70
3/4	2 1/4	9,400	16,500	13,450	9,520	.90	23.8
7/8	2 3/4	12,800	22,300	18,200	12,800	1.23	32.2
1	3	16,000	29,000	23,690	16,790	1.60	41.8
1 1/8	3 1/2	21,000	36,450	29,780	21,040	2.03	52.6
1 1/4	4	26,000	44,700	36,570	25,870	2.50	64.6
1 3/8	4 1/4	31,000	53,800	43,900	31,050	3.03	77.7
1 1/2	4 3/4	37,000	63,700	52,000	36,800	3.60	92.0
1 5/8	5	43,000	74,400	60,700	42,900	4.23	107.0
1 3/4	5 1/2	49,600	86,000	70,260	49,700	4.90	124.0
2	6 1/4	64,000	110,700	90,400	64,000	6.40	160.0
2 1/8	6 5/8	63,000	125,200	102,200	72,200	7.22	181.0
2 1/4	7 1/8	81,000	140,300	114,600	79,000	8.10	202.0
2 1/2	7 7/8	98,000	170,000	139,100	98,400	10.00	246.0
2 3/4	8 5/8	117,600	203,500	166,700	117,700	12.1	294.0





Wire rope is usually manufactured slightly larger than the nominal diameter. The diameter of a new rope may exceed the nominal diameter by the amounts shown in the United States Federal Specification for Wire Rope.

NOTES

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