Engineering Data

Product Certification

Elkhart Products Corporation manufactures and/or supplies products which meet the following speci cations:

MSS	SP104-1995	*Wrought Copper Solder Joint Pressure Fittings*
ASME	B16.29-1994	*Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV*
ASME	B16.18-1994	*Cast Copper Alloy Solder Joint Pressure Fittings*
ASME	B16.15-1994	*Cast Bronze Threaded Fittings*
ASME	B16.26-1988	*Cast Copper Alloy Fittings for Flared Copper Tube*
ASME	B16.23-1992	*Cast Copper Alloy Solder Joint Drainage Fittings - DWV*
ASME MSS	B16.24-1998 SP106-1991	*Bronze Pipe Flanges and Flanged Fittings*
MSS	SP109-1997	*Welded Fabricated Copper Solder Joint Pressure Fittings*
MSS	SP123-1998	*Non Ferrous Threaded and Solder Joint Unions For Use With Copper Water Tube*

EPC's wrot copper solder joint fittings also are manufactured to comply with the material performance and installation/joining dimensions of ANSI B16.22-1995.

The materials used to manufacture these fittings are also in compliance with the following specifications:

Tubular Wrought Copper:

ASTM B75 Alloy C12200, *Standard Specification for Seamless Copper Tube, or*

Products Made From Sheet:

ASTM B152 Alloy C11000, *Standard Specification for Copper Sheet, Strip, Plate and Rolled Bar.*

Cast Products:

ASTM B584 Alloy C84400, *Standard Specification for Copper Alloy Sand Castings for General Applications. Federal Specification WW-U-516 for Type 111, Class A and Class B Copper Alloy Unions.*

The Advantages of Wrot Copper Fittings From EPC

Elkhart Products Corporation, Plumbing Products Division, manufactures a comprehensive line of Wrot Copper Solder-Joint fittings in sizes ranging from 1/8" to 8", which are shown on the following pages. Wrot Copper fittings have many advantages over their cast brass counterparts and Elkhart Products Corporation, recognizing the high rate of acceptability of the quality and well-designed fittings, is continually adding new items to this line.

These advantages show why EPC Wrot Copper Fittings are rapidly being accepted for copper installations in all parts of the country.

1. Reduced Installation Costs-EPC Wrot Copper Fittings heat up more rapidly than cast and thus effect a savings in time and fuel.
2. Smooth Inside Surface-Being fabricated from copper tube, EPC Wrot Fittings have no rough surfaces to collect waste or deter flow.
3. Full Flow Capacity-EPC Wrot Fittings have the same inside diameters as the rest of the installation.
4. Wrot Copper-The physical properties of copper tube from which EPC Wrot Fittings are made eliminate the danger of leakage from sand holes or poor castings.
5. Less Bulky than Cast-This facilitates handling, particularly on prefab installations, yet EPC Wrot Fittings have the same strength as tube. This can also be a money saver on transportation costs.
6. More Rugged-Due to fabrication processes, EPC Wrot Fittings are stronger and more rugged than tube with which they are used.
7. Priced Competitively-EPC Wrot Fittings cost no more than their cast counterparts.
8. Neat Appearance-In matching the color and appearance of the tube, EPC Wrot Fittings contribute toward a neater and more workman-like installation.
9. Accurate Pitch-EPC Wrot Fittings are made with accurately machined dies which ensure the proper pitch required for installations.
10. Boxed and Labeled-EPC Wrot Fittings are boxed in convenient quantities to facilitate handling and storage, and for protection against damage and dirt. Box contents are easily identified by bar coded, easy-to-read labels.

Working Pressures and Solder

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

Rated Internal Working Pressures of Piping System Made of Copper Water Tube and Soldered Fittings

Solder Used in joints	Service Temp. °F	POUNDS PER SQUARE INCH Water (a) Copper Water Tube-Nominal Sizes			
		⅛" to 1" Incl.	1¼" to 2" Incl.	2½" to 4" Incl.	5" to 8" Incl.
* 50-50 Tin-Lead (b)	100	200	175	150	135
	150	150	125	100	90
	200	100	90	75	70
	250	85	75	50	45
95-5 Tin-Antimony (c) (d)	100	500	400	300	270
	150	400	350	275	250
	200	300	250	200	180
	250	200	175	150	135
Brazing Alloys Melting at or above 1000° F.	Temperature and pressure ratings consistent with the materials and procedures employed.				

*The data given for 50% tin-50% lead applies also for the 40% tin-60% lead alloy.

The values in this table are based on data in the National Bureau of Standards Publications, Building Materials and Structures Reports BMS 58 and BMS 83.

(a) Including other noncorrosive liquids and gases
(b) ASTM B32, Alloy Grade Sn 50
(c) ASTM B32, Alloy Grade Sb 5
(d) The Safe Drinking Water Act Amendment of 1986 prohibits the use in potable water. Systems of any solder having a lead content in excess of 2%.

NOTE: The table at left is from data published by the Copper and Brass Research Association.

Estimated Quantity of 50-50 Solder Required to Make 100 Joints

Size in Inches	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8
Quantity in Pounds	.5	.75	1.0	1.4	1.7	1.9	2.4	3.2	3.9	4.5	5.5	8	15	32

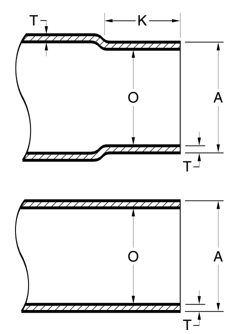
1. The quantity of hard solder used is dependent in the skill of the operator, but for estimating purposes, 75% of the above gures may be used.
2. Two ounces of Solder Flux will be required for each pound of solder.

Wrot Copper and Bronze Solder-Joint Pressure Fittings

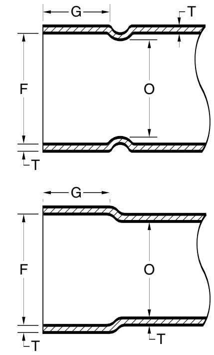
Dimensions of Soldered-Joint Ends (in inches)

Standard Water Tube Size	Male End: Ouside Diameter A		Male End: Length K	Female End: Inside Diameter F		Female End: Depth G	Wall Thickness T	Inside Diameter of Fitting O
	Min.	Max.	Min.	Min,	Max.	Min.	Avg.	Min.
1/8	0.248	0.251	0.31	0.252	0.256	0.25	.019	0.18
1/4	0.373	0.376	0.38	0.377	0.381	0.31	.023	0.30
3/8	0.497	0.501	0.44	0.502	0.506	0.38	.026	0.39
1/2	0.622	0.626	0.56	0.627	0.631	0.50	.029	0.52
5/8	0.747	0.751	0.69	0.752	0.756	0.62	.031	0.63
3/4	0.872	0.876	0.81	0.877	0.881	0.75	.033	0.74
1	1.122	1.127	0.97	1.128	1.132	0.91	.040	0.98
1 1/4	1.372	1.377	1.03	1.378	1.382	0.97	.044	1.23
1 1/2	1.621	1.627	1.16	1.628	1.633	1.09	.051	1.47
2	2.121	2.127	1.41	2.128	2.133	1.34	.059	1.94
2 1/2	2.621	2.627	1.53	2.628	2.633	1.47	.067	2.42
3	3.121	3.127	1.72	3.128	3.133	1.66	.075	2.89
3 1/2	3.621	3.627	1.97	3.628	3.633	1.91	.086	3.37
4	4.121	4.127	2.22	4.128	4.133	2.16	.096	3.84
5	5.121	5.127	2.72	5.128	5.133	2.66	.111	4.70
6	6.121	6.127	3.22	6.128	6.133	3.09	.124	5.72
8	8.119	8.127	4.09	8.128	8.133	3.97	.173	7.55

Male End



Female End



Wrot Copper Solder-Joint Drainage Fittings

Dimensions of Soldered-Joint Ends (in inches) See Diagram Page 39

Size	Male End			Female End			Metal Thickness T	Inside Diameter of Fitting O
	Outside Diameter A		Length K	Inside Diameter F		Depth G		
	Min.	Max.	Min.	Min.	Max.	Min.	Min.	Min.
1 1/4	1.372	1.377	0.56	1.378	1.382	0.50	0.040	1.29
1 1/2	1.621	1.627	0.62	1.628	1.633	0.56	0.042	1.53
2	2.121	2.127	0.69	2.128	2.133	0.62	0.042	2.01
3	3.121	3.127	0.81	3.128	3.133	0.75	1.045	2.98
4	4.121	4.127	1.06	4.128	4.133	1.00	0.058	3.93

Extracted from American National Standard Wrought Copper and Bronze Solder-Joint Drainage Fittings (ANSI B16.29) with permission of the publisher. The American Society of Mechanical Engineers, 3 Park Ave., New York, N.Y. 10016-5990

Wrot Copper Fittings Large Diameter Welded Design

Fitting Material:
Copper Alloy #122, Phosphorus Deoxidized-High Residual Phosphorus (DHP). Composition: 99% Copper; .015-.040% Phosphorus.

Weld Material:
Silicon Bronze. Meets speci cation American Welding Society (AWS) A5.7-91R and American Metals Society. (AMS) 4616 B

Weld Specifications:
Tensile Strength-Up to 58,000 PSI
Yield Strength-Up to 25,000 PSI
Elongation in 2"-53% to 55%
Hardness-80 to 100 Brinell (500kg. Load)
Temperature: Melt 1832¡F, Flow 1931¡F.

Method of Joining:
Electric Weld.

Dimensions & Specifications:
EPC Welded ttings are produced in accordance with speci cations shown in Manufactures Standardization Society (MSS) SP-109 for wrought copper, and copper alloy solder-joint pressure ttings.

Testing:
Each tting is individually tested with air under water. The burst pressure of EPC welded ttings exceeds the recommended working pressure of comparable diameter, annealed, straight, seamless ASTM B88-96-A type L copper water tube by a safety factor

Copper Water Tube-Standard Dimensions and Weights

Nominal Tube Size Inches	Outside Dia., In.	Inside Diameter, Inches				Wall Thickness, Inches				†Pounds per Linear Foot			
	Types K-L-M-DWV	Type K	Type L	Type M	Type DWV	Type K	Type L	Type M	Type DWV	Type K	Type L	Type M	Type DWV
1/4	.375	.305	.315	-	-	.035	.030	.025	-	.145	.126	.106	-
3/8	.500	.402	.430	-	-	.049	.035	.025	-	.269	.198	.145	-
1/2	.625	.527	.545	-	-	.049	.040	.028	-	.344	.285	.204	-
5/8	.750	.652	.666	-	-	.049	.042	.030	-	.418	.362	.263	-
3/4	.875	.745	.785	-	-	.065	.045	.032	-	.641	.455	.328	-
1	1.125	.995	1.025	-	-	.065	.050	.035	-	.839	.655	.465	-
1 1/4	1.375	1.245	1.265	1.291	1.295	.065	.055	.042	.040	1.04	.884	.682	.650
1 1/2	1.625	1.481	1.505	1.527	1.541	.072	.060	.049	.042	1.36	1.14	.940	.809
2	2.125	1.959	1.985	2.009	2.041	.083	.070	.058	.042	2.06	1.75	1.46	1.07
2 1/2	2.625	2.435	2.465	2.495	-	.095	.080	.065	-	2.93	2.48	2.03	-
3	3.125	2.907	2.945	2.981	3.035	.109	.090	.072	.045	4.00	3.33	2.68	1.69
3 1/2	3.625	3.385	3.425	3.459	-	.120	.100	.083	-	5.12	4.29	3.58	-
4	4.125	3.857	3.905	3.935	4.009	.134	.110	.095	.058	6.51	5.38	4.66	2.87
5	5.125	4.805	4.875	4.907	4.981	.160	.125	.109	.072	9.67	7.61	6.66	4.43
6	6.125	5.741	5.845	5.881	5.959	.192	.140	.122	.083	13.9	10.2	8.92	6.10
8	8.125	7.583	7.725	7.785	-	.271	.200	.170	-	25.9	19.3	16.5	-

†Slight variations from these weights must be expected in practice.

Copper Water Tube-Calculated Bursting Pressure*

Nominal Tube Size, Inches	Outside Diameter, In. Types K-L	Inside Diameter Inches Type K	Inside Diameter Inches Type L	Wall Thickness Inches Type K	Wall Thickness Inches Type L	Bursting Pressure Lb. per Sq. In. Type K Hard (Drawn)	Type K Soft (Annealed)	Type L Hard (Drawn)	Type L Soft (Annealed)
1/4	.375	.305	.315	.035	.030	6,700	5,600	5,800	4,800
3/8	.500	.402	.430	.049	.035	7,100	5,900	5,000	4,200
1/2	.625	.527	.545	.049	.040	5,600	4,700	4,600	3,800
5/8	.750	.652	.666	.049	.042	4,700	3,900	4,000	3,400
3/4	.875	.745	.785	.065	.045	5,300	4,500	3,700	3,100
1	1.125	.995	1.025	.065	.050	4,200	3,500	3,200	2,700
1 1/4	1.375	1.245	1.265	.065	.055	3,400	2,800	2,900	2,400
1 1/2	1.625	1.481	1.505	.072	.060	3,200	2,700	2,700	2,200
2	2.125	1.959	1.985	.083	.070	2,800	2,300	2,400	2,000
2 1/2	2.625	2.435	2.465	.095	.080	2,600	2,200	2,200	1,800
3	3.125	2.907	2.945	.109	.090	2,500	2,100	2,100	1,700
3 1/2	3.625	3.385	3.425	.120	.100	2,400	2,000	2,000	1,700
4	4.125	3.857	3.905	.134	.110	2,300	1,900	1,900	1,600
5	5.125	4.805	4.875	.160	.125	2,200	1,900	1,800	1,500
6	6.125	5.741	5.845	.192	.140	2,300	1,900	1,600	1,400
8	8.125	7.583	7.725	.271	.200	2,400	2,000	1,800	1,500

*Bursting Pressures are calculated from the following formula for thin, hollow cylinders under tension.

$$P = \frac{2tS}{D}$$

where P = Bursting Pressure, Lb. per Sq. In.
t = Wall Thickness, Inches
D = Outside Tube Diameter, Inches
S = Tensile Strength (36,000 Lb. per Sq. In. for hard tubes and 30,000 for soft tubes)

Sizes of Copper Tube

OD Size	Nominal Size
1/8	-
3/16	-
1/4	1/8
5/16	-
3/8	1/4
1/2	3/8
5/8	1/2
3/4	5/8
7/8	3/4
1	7/8
1 1/8	1
1 1/4	1 1/8
1 3/8	1 1/4
1 5/8	1 1/2
2 1/8	2
2 5/8	2 1/2
3 1/8	3
3 5/8	3 1/2
4 1/8	4
5 1/8	5
6 1/8	6
8 1/8	8

Soldering and Brazing Copper Tube

Soldering and Brazing with capillary solder joint fittings is the most common system for joining copper tube. The American Welding Society defines soldering as a joining process which takes place below 840° and brazing as a similar process which occurs above 840°.

The basic theory and technique of soldering and brazing are the same for all diameters...the variables are: the amount of time, heat and filler metal required to complete a designated joint. A good joint is the product of a well trained craftsman who knows and respects the materials and methods he uses.

Basic Steps in Joining Process

Measuring - Measuring the length of the tube must be accurate. If the tube is too short it will not reach all the way into the socket of the fitting and a proper joint cannot be made.

Cutting - Cutting tube can be accomplished in a number of different ways to produce a satisfactory, square-end cut. The tube can be cut with a disc type tube cutter, a hacksaw, abrasive wheels, or stationary and portable bandsaws. Care must be taken that the tube is not deformed while being cut. Regardless of the cutting method used, the cut must be square with the run of the tube so that it will seat properly in the fitting socket.

Reaming - Most methods of cutting leave a small burr on the end of the tube. Unless these rough edges are removed, erosion-corrosion may occur due to local turbulence and increased velocities in the tube. Tools used to ream tube ends include the reaming blade on the tube cutter half-round or round files, a pocket knife, or a suitable deburring tool. With annealed tube, care must be taken not to get the tube end out-of-round by applying too much pressure. Both the inside and the outside of the tube may require removal of the burr. A properly reamed piece of tube will provide a smooth surface for better flow.

Cleaning - Cleaning is quickly and easily done. The removal of oxides and surface soil is crucial if filler metal is to flow properly. Oxides, surface soil and oil can interfere with the strength of the joint and this may result in the joint's failure. Mechanical cleaning is a simple operation. The end of the tube should be cleaned using sand cloth or nylon abrasive pads for a distance only slightly more than the depth of the fitting socket. The socket of the fitting should also be cleaned using sand cloth, abrasive pads, or properly sized fitting brushes. The same precautions, as when reaming the tube, should be observed.

Copper is a soft metal; if too much material is removed, a loose fit will result and interfere with satisfactory capillary action in making the joint. The capillary space between tube and fitting is approximately .004-in. Solder or brazing filler metal can fill this gap by capillary action. This spacing is critical for the filler metal to flow into the gap and form a strong joint. Chemical cleaning may be utilized, providing the tube and fittings are thoroughly rinsed, according to the manufacturer's recommendations furnished with the cleaner. This will help neutralize any acidic conditions that may exist. The surfaces, once cleaned, should not be touched with bare hands or oily gloves. Skin oils, lubricating oils and grease impair solder flow and wetting.

Temperature Ranges

Up to this point, the joining process is the same for both soldering and brazing. The choice for soldering or brazing will depend upon operating conditions. Solder joints are generally used where the system temperatures do not exceed 250° F and brazed joints can be used where greater strengths are required, or where system temperatures are as high as 350° F. In actual practice, most soldering is done at temperatures about 350° F to 550° F, while brazing is done at temperatures ranging from 1100° F to 1550° F.

Because of the differences in the soldering and brazing process, each will be discussed separately.

Soldering

Applying Flux - A non-aggressive soldering flux is recommended. Stir the flux before use. A good flux will dissolve and remove traces of residual oxides from the surfaces to be joined, protect the surfaces from re-oxidation during heating and promote the wetting of the surfaces by the solder. A thin, even coating of flux should be applied with a brush to both tube and fitting. Avoid the use of fingers to apply flux. Chemicals in the flux can be harmful if carried to the eyes or open cuts.

Types of Solder - There are a variety of solders available that will produce sound, leak-tight joints. Solders that are used for piping applications contain tin and varying amounts of either antimony, copper, lead or silver. Choice of solder will depend upon application and local codes. For potable water systems, solders which do not contain lead are the best choice.

Assembly - After both surfaces are properly fluxed, they should be assembled by placing the fitting on the tube, making sure the tube seats against the base of the fitting socket. A slight twisting motion is suggested to ensure even coverage by the flux. Remove the excess flux with a rag. Because of the heat that is required during soldering and brazing, only cotton rags should be used. Complete all prepared joints within a single work day. Care must be taken to assure that the tube and fittings are properly supported with a reasonable, uniform capillary space around the entire circumference of the joint. Uniformity of capillary space will ensure good filler metal penetration if the guidelines of successful joint making are followed. Excessive joint clearance can cause the filler metal to crack under stress or vibration.

Heating - Because of the open flame and high temperatures required for soldering and the flammability of the gases used, safety precautions must be observed. The heat is generally applied by use of an air/fuel torch. These torches can cause acetylene or a variety of LP gases. Electric resistance pliers can also be used.

Heating should begin with the flame perpendicular to the tube. This preheat will conduct the initial heat into the socket for even distribution of heat inside and out. Preheating depends upon the size of the joint - experience will indicate the proper amount of time. The flame should not be moved onto the fitting. Move the flame from the fitting socket onto the tube a distance equal to the fitting socket. Touch the solder to the joint. If the solder does not melt, remove it and continue the heating process. Be careful not to overheat or direct the flame into the fitting cup. This action can cause the flux to burn and destroy its effectiveness. When the melting temperature has been reached, heat may be applied to the base of the cup to aid capillary action in drawing the solder into the cup.

Applying Solder - When the tube is in a horizontal position, start applying the solder slightly off-center of the bottom of the joint. Proceed across the bottom of the fitting and up to the top-center position. Return to the point of beginning, overlap the starting point and then proceed up the incompleted side to the top. Again, overlapping the solder. Molten solder will be drawn into the joint by capillary action regardless if the solder is being fed upward, downward or horizontally.

Cooling & Cleaning - After the joint has been completed, natural cooling is best. Shock cooling may cause unnecessary stresses on the joint and may result in eventual failure. Once the fitting is cool, clean off any remaining flux with a wet rag.

Brazing

Applying Flux - The fluxes used for brazing copper joints are different in composition from soldering fluxes. They cannot, and should not, be used interchangeably.

Brazing fluxes are water based. Similar to soldering fluxes, brazing fluxes dissolve and remove residual oxides from the metal surfaces, they protect the metal surfaces from re-oxidation during heating and they promote the wetting of the surfaces to be joined by the brazing filler metal. Fluxes also provide the craftsman with an indication of temperature. Application of the flux is the same as when soldering. If the outside of the fitting and the heat affected area of the tube are covered with flux, it will prevent oxidation and greatly improve the appearance of the joint.

Brazing Filler Metals - There are two general types of brazing filler metal used for joining copper tube: BCuP (Brazing - Copper - Phosphorus) and BAg (Brazing - Silver). These brazing filler metals are classified according to their components.

BCuP filler metals are preferred for joining copper tube and fittings. The phosphorus in these filler metals acts as a fluxing agent and the lower percentage of silver makes them relatively low cost filler metals. When using copper tube, wrought copper fittings and BCuP brazing filler metal, fluxing is an option due to the self-fluxing action of the phosphorus present in all components of the brazed joint.

The choice of brazing filler metals depends upon four main factors:

- dimensional tolerance of the joint
- type and material of fitting (cast or wrought)
- desired appearance
- cost

Heating - Oxy/fuel torches are generally used when brazing because of the higher temperatures required. Due to recent innovations in air/fuel torch tip design, they can now be used on a wider variety of size for soldering and brazing.

When working with temperatures this high, safety precautions must be followed and care taken to protect both the operator and the materials being used.

The heating operation is the same as for soldering. First preheat the tube and then the tube and fitting. When the brazing filler metal starts to melt, apply the heat at the base of the fitting socket to help draw the brazing filler metal in by capillary action.

Applying Brazing Filler Metal - Remember to allow the heat of the joint to melt the filler metal. Do not melt the filler metal with the torch. The melted filler metal will be drawn into the joint by capillary action. It is very important that the flame be in continuous motion and should not be allowed to remain on any one point long enough to burn through the tube or fitting. When the joint is complete, a continuous filler should be visible completely around the joint. If the filler metal fails to flow, or has the tendency to ball-up, it indicates oxidation on the metal surfaces or insufficient heat on the parts to be joined. If the filler metal refuses to enter the joint and tends to flow over the outside of either part of the joint, it indicates that this part is overheated or that the other part is underheated.

Cooling and Cleaning - When the joint is complete, allow it to cool naturally. Flux residues can be removed by washing with hot water and brushing with a stainless steel wire brush.

Summary

If the parts to be joined are properly prepared, properly heated and the correct filler metal is used, the finished joint should be sound. Soldered or brazed copper piping systems, when installed properly, will provide years of safe and reliable service. Proper training of the correct installation techniques, such as those just covered, will give the craftsman the ability to achieve consistently reliable soldered and brazed joints in all diameters.

Prepared with technical assistance from the Copper Development Association.

Rated Internal Working Pressures for Copper Tube Types K, L, M and DWV

Size, Inches	Rated Internal Working Pressures, psi.							
	Type K		Type L		Type M		Type DWV	
	Annealed	Drawn	Annealed	Drawn	Annealed	Drawn	Annealed	Drawn
(Service Temperature up to 150°F (S = 5,100 psi, annealed 9,000 psi, drawn)								
1/4	913	2029	775	1722	-	-	-	-
3/8	979	2135	662	1471	485	1077	-	-
1/2	769	1683	614	1362	420	932	-	-
5/8	633	1389	536	1192	-	-	-	-
3/4	735	1609	495	1099	346	769	-	-
1	563	1236	420	933	286	636	-	-
1 1/4	456	1003	373	823	287	638	280	621
1 1/2	424	933	347	771	281	625	249	552
2	372	820	309	686	254	563	185	410
2 1/2	341	751	286	633	233	517	-	-
3	330	579	269	476	215	380	135	239
3 1/2	313	549	258	456	214	378	-	-
4	308	540	249	440	313	377	128	225
5	295	517	229	404	198	349	128	227
6	296	520	213	376	185	328	126	223
8	315	554	230	406	195	344	124	219
10	315	554	230	407	196	345	-	-
12	316	555	213	375	196	345	-	-
(Service Temperature up to 200°F (S = 4,800 psi, annealed 9,000 psi, drawn)								
1/4	860	2029	730	1722	-	-	-	-
3/8	921	2135	623	1471	456	1077	-	-
1/2	724	1683	578	1362	395	932	-	-
5/8	596	1389	505	1192	-	-	-	-
3/4	691	1609	466	1099	326	769	-	-
1	530	1236	395	933	270	636	-	-
1 1/4	429	1003	351	828	270	638	264	621
1 1/2	399	933	326	771	265	625	235	552
2	350	820	291	686	239	563	174	410
2 1/2	321	751	269	633	219	517	-	-
3	310	579	254	476	202	380	127	239
3 1/2	294	549	243	456	202	378	-	-
4	290	540	234	440	201	377	120	225
5	278	517	215	404	186	349	121	227
6	278	520	201	376	174	328	118	223
8	297	554	216	406	183	344	117	219
10	297	554	217	407	184	345	-	-
12	298	555	200	375	184	345	-	-
(Service Temperature up to 300°F (S = 4,700 psi, annealed 8,700 psi, drawn)								
1/4	842	1974	714	1676	-	-	-	-
3/8	902	2077	610	1431	446	1048	-	-
1/2	709	1638	565	1325	387	907	-	-
5/8	583	1351	494	1160	-	-	-	-
3/4	662	1566	456	1069	319	748	-	-
1	520	1203	387	908	264	619	-	-
1 1/4	420	976	344	806	265	621	258	604
1 1/2	391	908	319	750	359	608	230	537
2	343	798	285	667	234	548	170	399
2 1/2	314	731	263	616	215	503	-	-
3	304	560	248	449	198	367	124	231
3 1/2	288	531	238	441	197	366	-	-
4	283	522	229	425	197	365	117	218
5	272	500	211	391	182	337	118	220
6	272	502	197	364	171	317	116	216
8	290	535	211	393	179	333	114	209
10	290	535	212	394	180	334	-	-
12	291	536	196	363	180	334	-	-

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Size, Inches	Rated Internal Working Pressures, psi							
	Type K		Type L		Type M		Type DWV	
	Annealed	Drawn	Annealed	Drawn	Annealed	Drawn	Annealed	Drawn
(Service Temperature up to 400°F (S = 4,700 psi, annealed 8,700 psi, drawn)								
1/4	537	771	456	654	-	-	-	-
3/8	576	811	390	559	285	409	-	-
1/2	453	640	361	518	247	354	-	-
5/8	373	528	316	453	-	-	-	-
3/4	432	611	291	418	204	292	-	-
1	331	470	247	355	169	242	-	-
1 1/4	268	381	220	315	169	242	165	236
1 1/2	250	355	204	293	166	238	147	210
2	219	312	182	261	150	214	109	156
2 1/2	201	285	168	241	137	196	-	-
3	194	527	159	520	127	346	80	218
3 1/2	184	500	152	415	126	344	-	-
4	181	492	147	401	126	343	75	205
5	174	471	135	368	117	318	76	207
6	174	474	126	343	109	299	74	203
8	186	505	135	370	115	313	73	200
10	186	505	136	371	115	314	-	-
12	186	506	125	342	115	314	-	-

Fractional Inch/Decimal Inch/Millimeters Conversion Chart

Fractional Inch	Decimal Inch	Millimeters	Fractional Inch	Decimal Inch	Millimeters	Fractional Inch	Decimal Inch	Millimeters
1/64	.0156	.396	23/64	.3593	9.128	45/64	.7031	17.859
1/32	.0312	.793	3/8	.375	9.525	23/32	.7187	18.256
3/64	.0468	1.190	25/64	.3906	9.921	47/64	.7343	18.653
1/16	.0625	1.587	13/32	.4062	10.318	3/4	.750	19.050
5/64	.0781	1.984	27/64	.4218	10.715	49/64	.7656	19.446
3/32	.0937	2.381	7/16	.4375	11.112	25/32	.7812	19.843
7/64	.1093	2.778	29/64	.4531	11.509	51/64	.7968	20.240
1/8	.125	3.175	15/32	.4687	11.906	13/16	.8125	20.637
9/64	.1406	3.571	31/64	.4843	12.303	53/64	.8281	20.034
5/32	.1562	3.968	1/2	.500	12.700	27/32	.8437	21.431
11/64	.1718	4.365	33/64	.5156	13.096	55/64	.8593	21.828
3/16	.1875	4.762	17/32	.5312	13.493	7/8	.875	22.225
13/64	.2031	5.159	35/64	.5468	13.890	57/64	.8906	22.621
7/32	.2187	5.556	9/16	.5625	14.287	29/32	.9062	23.018
15/64	.2343	5.953	37/64	.5781	14.684	59/64	.9218	23.415
1/4	.250	6.350	19/32	.5937	15.081	15/16	.9375	23.812
17/64	.2656	6.746	39/64	.6093	15.478	61/64	.9531	24.209
9/32	.2812	7.143	5/8	.625	15.875	31/32	.9687	24.606
19/64	.2968	7.540	41/64	.6406	16.271	63/64	.9843	25.003
5/16	.3125	7.937	21/32	.6562	16.668	1	1.000	25.400
21/64	.3281	8.334	43/64	.6718	17.065			
11/32	.3437	8.731	11/16	.6875	17.462			