

Appendix D

Piping and Tubing Pressure Ratings

This appendix contains the maximum allowable working pressures (MAWP) for pipe and tubing generally available within the Department of Energy complex. The MAWP values shown were obtained using calculation methods and material properties taken from ANSI/B31.1, "Code for Power Piping (1989). A safety factor of 4 (5 for brass) is already calculated in these values.

The listed working pressures are for work temperatures up to 200°C (400°F) for ferrous pipe and tubing, and up to 120°C (250°F) for nonferrous pipe and tubing. These are given in both SI [megapascals (Mpa)] and English units [thousands of pounds per square inch (ksi)].

D.1 Threaded Pipe

Determine the MAWP of straight lengths of 1-in.-diameter, Schedule 40, UNS Alloy C23000, threaded brass pipe for a working temperature of 120°C. Use the following equation (see ANSI B31.1):

$$P = \frac{2 SE (t_m - A)}{D_o - 2y(t_m - A)}$$

where

SE = Allowable stress at 120°C (250°F) [ANSI B31.1, App. A, pp. 182, 183] = 8.0 ksi.

t_m = Minimum wall thickness allowed under the specification = nominal wall thickness less wall tolerance = 0.126 – 0.007 = 0.119 in. (approximate value).

Note: To determine exact values, use the following.

For pipe $t_m = 87.5\% t_n$ (for brass pipe, use 94.5%).

For tubing $t_m = 92.5\% t_n$ (for stainless steel, use 87.5%).

A = Thread depth for 1-in.-o.d. pipe ["Dimension h," ANSI B2.1, Table 2, p. 7] = 80% of thread pitch; 1" pipe has 11.5 threads/in., so 80% (1/11.5) = 0.070 in.

D_o = Tabulated o.d. of 1-in. pipe = 1.315 in.

y = Coefficient for nonferrous pipe [ANSI B31.1] = 0.4. (Also for ferrous pipe.)

Substituting known values, the equation becomes

$$P = \frac{2 \times 8000(0.1190 - 070)}{1.315 - 2 \times 0.4(0.1190 - 070)} = 615 \text{ psig.}$$

In other units, this may be expressed as 0.61 ksi or 4.21 MPa.

D.2 Unthreaded Pipe

If the pipe in the previous example were assembled by brazing ($A = 0.000$), the MAWP would be 10.76 MPa (1.56 ksi).

$$P = \frac{2SE(t_m - A)}{D_o - 2y(t_m - A)},$$

or

$$P = \frac{2 \times 8000(0.1190 - 000)}{1.315 - 2 \times 0.4(0.1190 - 000)} = 1561 \text{ psig,}$$

or 1.56 ksi, or 10.76 MPa, which (in this case) is about 2.5 times its threaded rating.

D.3 Pipe Listing

Table No.	Type of piping
D-1.	Aluminum alloy, Schedule 40
D-2.	Brass, regular strength
D-3.	Brass, extra strength
D-4.	Copper, regular strength
D-5.	Copper, extra strength
D-6.	Black steel, Schedule 40
D-7.	Black steel, Schedule 80
D-8.	Carbon steel
D-9.	Stainless steel, Schedule 40

Aluminum Alloy Pipe

- Drawn, extruded, seamless.
- 6061-T6, Schedule 40 (UNS A96061).
- Per ASTM B241.
- Allowable stress: SE = 10500 psi (less than 1 in. IPS) or 9500 psi (1 in. or greater IPS).

Table D-1. Aluminum alloy, Schedule 40.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/4	0.540	0.088	1.34	9.24	3.38	23.31
3/4	1.050	0.113	0.86	5.93	2.14	14.76
1	1.315	0.133	0.68	4.69	1.80	12.41
1-1/2	1.900	0.145	0.58	4.00	1.34	9.24
2	2.375	0.154	0.53	3.66	1.13	7.79
3	3.500	0.216	0.49	3.38	1.07	7.38
5	5.563	0.258	0.43	2.97	0.79	5.45
6	6.625	0.288	0.42	2.90	0.72	4.97

Brass Pipe

- Seamless, annealed, regular strength.
- CDA Alloy 230 (UNS C23000).
- Per ASTM B43.
- Allowable stress: SE = 8000 psi.

Table D-2. Brass, regular strength.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.062	1.17	8.07	2.58	17.79
1/4	0.540	0.082	1.02	7.03	2.57	17.72
3/8	0.675	0.090	1.02	7.03	2.24	15.45
1/2	0.840	0.107	0.87	6.00	2.12	14.62
3/4	1.050	0.114	0.80	5.52	1.79	12.34
1	1.315	0.126	0.61	4.21	1.56	10.76
1-1/4	1.660	0.146	0.67	4.62	1.42	9.79
1-1/2	1.900	0.150	0.62	4.28	1.27	8.76
2	2.375	0.156	0.53	3.66	1.04	7.17
2-1/2	2.875	0.187	0.43	2.97	1.03	7.10
3	3.500	0.219	0.50	3.45	0.99	6.83
3-1/2	4.000	0.250	0.56	3.86	0.99	6.83
4	4.500	0.250	0.49	3.38	0.87	6.00
5	5.562	0.250	0.39	2.69	0.70	4.83
6	6.625	0.250	0.33	2.28	0.58	4.00

Brass Pipe

- Seamless, annealed, extra strength.
- CDA Alloy 230 (UNS C23000).
- Per ASTM B43.
- Allowable stress: SE = 8000 psi.

Table D-3. Brass, extra strength.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/4	0.540	0.123	2.38	16.41	4.15	28.62
1	1.315	0.182	1.32	9.10	2.33	16.07
2	2.375	0.221	0.98	6.76	1.51	10.41
3	3.500	0.304	0.89	6.14	1.40	9.66

Copper Pipe

- Seamless, drawn, regular strength.
- UNS Alloy C12200.
- Per ASTM B42.
- Allowable stress: SE = 11300 psi (1/8 to 2 in. IPS), 9000 psi (2-1/2 to 12 in. IPS).

Table D-4. Copper, regular strength.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.062	1.64	11.31	3.63	25.03
1/4	0.540	0.082	1.44	9.93	3.62	24.97
3/8	0.675	0.090	1.43	9.86	3.15	21.72
1/2	0.840	0.107	1.23	8.48	2.99	20.62
3/4	1.050	0.114	1.13	7.79	2.52	17.38
1	1.315	0.126	0.86	5.93	2.19	15.10
1-1/4	1.660	0.146	0.95	6.55	2.00	13.79
1-1/2	1.900	0.150	0.87	6.00	1.78	12.28
2	2.375	0.156	0.74	5.10	1.46	10.07
2-1/2	2.875	0.187	0.49	3.38	1.16	8.00
3	3.500	0.219	0.56	3.86	1.11	7.66
3-1/2	4.000	0.250	0.63	4.34	1.12	7.72
4	4.500	0.250	0.55	3.79	0.98	6.76
5	5.562	0.250	0.44	3.03	0.79	5.45
6	6.625	0.250	0.37	2.55	0.66	4.55

Copper Pipe

- Seamless, drawn, extra strength.
- UNS Alloy C12200.
- Per ASTM B42.
- Allowable stress: SE = 11300 psi (1 / 8" to 2" IPS), 9000 psi (2-1/2" to 12" IPS).

Table D-5. Copper, extra strength.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/2	0.840	0.149	2.44	16.83	4.36	30.07
3/4	1.050	0.157	2.09	14.41	3.57	24.62
1	1.315	0.182	1.86	12.83	3.28	22.62
1-1/4	1.660	0.194	1.63	11.24	2.73	18.83
1-1/2	1.990	0.203	1.52	10.48	2.47	17.03
2	2.375	0.221	1.38	9.52	2.13	14.69
2-1/2	2.875	0.280	1.08	7.45	1.79	12.34
3	3.500	0.304	1.01	6.97	1.58	10.90
4	4.500	0.341	0.92	6.34	1.37	9.45

Black Steel Pipe

- Seamless, Schedule 40.
- Carbon steel.
- Per ASTM A53, Grade B.
- Allowable stress: SE = 15000 psi.

Table D-6. Black steel, Schedule 40.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.068	2.27	15.66	4.94	34.07
1/4	0.540	0.088	1.92	13.24	4.82	33.24
3/8	0.675	0.091	1.67	11.52	3.92	27.03
1/2	0.840	0.109	1.40	9.66	3.73	25.72
3/4	1.050	0.113	1.24	8.55	3.05	21.03
1	1.315	0.133	1.08	7.45	2.84	19.59
1-1/4	1.660	0.140	0.96	6.62	2.34	16.14
1-1/2	1.900	0.145	0.92	6.34	2.11	14.55
2	2.375	0.154	0.83	5.72	1.78	12.28
2-1/2	2.875	0.203	0.83	5.72	1.95	13.45
3	3.500	0.216	0.77	5.31	1.69	11.66
3-1/2	4.000	0.226	0.75	5.17	1.54	10.62
4	4.500	0.237	0.72	4.97	1.43	9.86
5	5.563	0.258	0.69	4.76	1.26	8.69
6	6.625	0.280	0.66	4.55	1.14	7.86

Black Steel Pipe

- Seamless, Schedule 80.
- Carbon steel.
- Per ASTM A53, Grade B.
- Allowable stress: SE = 15000 psi.

Table D-7. Black steel, Schedule 80.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.095	4.38	30.21	7.35	50.69
1/4	0.540	0.119	3.65	25.17	6.83	47.10
3/8	0.675	0.126	3.18	21.93	5.62	38.76
1/2	0.840	0.147	2.76	19.03	5.25	36.21
3/4	1.050	0.154	2.36	16.28	4.29	29.59
1	1.315	0.179	2.09	14.41	3.96	27.31
1-1/4	1.660	0.191	1.83	12.62	3.28	22.62
1-1/2	1.900	0.200	1.73	11.93	2.98	20.55
2	2.375	0.218	1.59	10.97	2.57	17.72
2-1/2	2.875	0.276	1.53	10.55	2.69	18.55
3	3.500	0.300	1.44	9.93	2.38	16.41
3-1/2	4.000	0.318	1.38	9.52	2.20	15.17
4	4.500	0.337	1.34	9.24	2.07	14.28
5	5.563	0.375	1.27	8.76	1.85	12.76
6	6.625	0.432	1.30	8.98	1.79	12.37

Carbon Steel Pipe

- Seamless, cold drawn, stress relieved.
- Carbon steel, AISI MT-1016 1018.
- Per ASTM A106, Grade C.
- Allowable stress: SE = 17500 psi.

Table D-8. Carbon steel.

IPS	o.d.	Nominal wall thickness	MAWP*			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.068	2.71	18.67	5.83	40.18
1/4	0.540	0.088	2.25	15.51	5.63	38.84
3/8	0.675	0.091	1.93	13.30	4.56	31.43
1/2	0.840	0.109	1.66	11.44	4.37	30.14
3/4	1.050	0.113	1.44	9.94	3.56	24.58
1	1.315	0.133	1.27	8.76	3.33	22.98
1-1/4	1.660	0.140	1.14	7.83	2.74	18.93
1-1/2	1.900	0.145	1.07	7.40	2.47	17.02
2	2.375	0.154	0.98	6.73	2.08	14.34
2-1/2	2.875	0.203	0.97	6.66	2.27	15.68
3	3.500	0.216	0.91	6.26	1.98	13.62
3-1/2	4.000	0.226	0.87	6.01	1.80	12.42
4	4.500	0.237	0.85	5.87	1.67	11.55
5	5.563	0.258	0.81	5.56	1.47	10.12
6	6.625	0.280	0.78	5.38	1.33	9.20

* Based on SAE J 1397, MT-1016.

Stainless Steel Pipe

- Seamless, annealed, Schedule 40.
- CRES, Type 304.
- Per ASTM A312.
- Allowable stress: SE = 18800 psi.

Table D-9. Stainless steel, Schedule 40.

IPS	o.d.	Nominal wall thickness	MAWP			
			Threaded		Plain	
(in.)	(in.)	(in.)	(ksi)	(MPa)	(ksi)	(MPa)
1/8	0.405	0.068	2.84	19.59	6.18	42.62
1/4	0.540	0.088	2.40	16.55	6.03	41.59
3/8	0.675	0.091	2.08	14.34	4.91	33.86
1/2	0.840	0.109	1.76	12.14	4.66	32.14
3/4	1.050	0.113	1.55	10.69	3.82	26.34
1	1.315	0.133	1.35	9.31	3.55	24.48
1-1/4	1.660	0.140	1.20	8.28	2.92	20.14
1-1/2	1.900	0.145	1.15	7.93	2.64	18.21
2	2.375	0.154	1.04	7.17	2.23	15.38
2-1/2	2.875	0.203	1.04	7.17	2.44	16.83
3	3.500	0.216	0.97	6.69	2.11	14.55
3-1/2	4.000	0.226	0.93	6.41	1.93	13.31
4	4.500	0.237	0.90	6.21	1.79	12.34
5	5.563	0.258	0.86	5.93	1.57	10.83

D.4 Tube Listing

Table No.	Type of tubing
D-10.	Aluminum alloy
D-11.	Brass, hard drawn
D-12.	Copper, H58 drawn, 12-ft lengths
D-13.	Copper, annealed, 50-ft coils, general use
D-14.	Copper, annealed, 50-ft coils, refrigeration use
D-15.	Copper, drawn temper, 20-ft lengths
D-16.	Copper, Type K
D-17.	Copper, Type L
D-18.	Copper, Type M
D-19.	Carbon steel
D-20.	Stainless steel

Aluminum Alloy Tubing

- Seamless, drawn.
- 6061-T6 alloy (UNS A96061).
- Per ASTM B210.
- Allowable stress: SE = 10000 psi.

Table D-10. Aluminum alloy.

o.d.	Nominal wall thickness	MAWP		o.d.	Nominal wall thickness	MAWP	
		(ksi)	(MPa)				
(in.)	(in.)						
0.375	0.035	1.79	12.34	1.000	0.065	1.21	8.34
0.375	0.049	2.58	17.79	1.000	0.083	1.60	11.03
0.375	0.058	3.09	21.31	1.125	0.058	0.94	6.48
0.500	0.035	1.32	9.10	1.250	0.049	0.72	4.97
0.500	0.049	1.88	12.97	1.250	0.065	0.96	6.62
0.500	0.065	2.56	17.66	1.250	0.083	1.26	8.69
0.625	0.049	1.48	10.21	1.500	0.065	0.79	5.45
0.625	0.065	2.01	13.86	1.500	0.083	1.04	7.17
0.750	0.035	0.86	5.93	1.625	0.058	0.64	4.41
0.750	0.049	1.22	8.41	2.000	0.049	0.44	3.03
0.750	0.058	1.45	10.00	2.000	0.065	0.59	4.07
0.750	0.065	1.65	11.38	2.500	0.065	0.47	3.24
0.750	0.083	2.18	15.03	3.500	0.065	0.33	2.28
0.875	0.065	1.40	9.66	—	—	—	—

Brass Tubing

- Seamless, hard drawn.
- CDA Alloy 280.
- Per ASTM B111.
- Allowable stress: SE = 10000 psi.

Table D-11. Brass, hard drawn.

o.d.	Nominal wall thickness	MAWP*		o.d.	Nominal wall thickness	MAWP*	
		(ksi)	(MPa)			(ksi)	(MPa)
0.125	0.035	6.53	45.05	2.000	0.125	1.21	8.36
0.188	0.022	2.38	16.39	2.125	0.125	1.14	7.84
0.188	0.035	4.01	27.63	2.250	0.065	0.55	3.77
0.188	0.049	5.99	41.33	2.250	0.125	1.07	7.39
0.250	0.035	2.89	19.92	2.500	0.035	0.26	1.80
0.250	0.065	5.96	41.07	2.500	0.065	0.49	3.38
0.313	0.035	2.26	15.58	2.500	0.125	0.96	6.62
0.375	0.035	1.85	12.79	2.625	0.125	0.91	6.30
0.375	0.065	3.68	25.36	2.750	0.065	0.45	3.07
0.500	0.035	1.37	9.42	2.750	0.125	0.87	6.00
0.500	0.065	2.66	18.35	2.875	0.065	0.43	2.93
0.625	0.035	1.08	7.45	3.000	0.035	0.22	1.50
0.625	0.065	2.08	14.37	3.000	0.065	0.41	2.81
0.625	0.125	4.34	29.94	3.000	0.125	0.80	5.48
0.750	0.035	0.89	6.17	3.000	0.187	1.21	8.34
0.750	0.065	1.71	11.81	3.250	0.065	0.38	2.59
0.750	0.125	3.52	24.25	3.250	0.125	0.73	5.05
0.875	0.035	0.76	5.26	3.500	0.065	0.35	2.40
0.875	0.065	1.45	10.03	3.500	0.125	0.68	4.68
0.875	0.083	1.89	13.01	3.750	0.125	0.63	4.36
1.000	0.035	0.66	4.58	4.000	0.065	0.30	2.10
1.000	0.065	1.26	8.71	4.000	0.125	0.59	4.08
1.000	0.125	2.55	17.57	4.250	0.125	0.56	3.84
1.125	0.035	0.59	4.06	4.500	0.065	0.27	1.86
1.250	0.035	0.53	3.65	4.500	0.125	0.52	3.62
1.250	0.065	1.00	6.90	4.750	0.125	0.50	3.42
1.250	0.125	2.00	13.78	5.000	0.065	0.24	1.67
1.375	0.065	0.91	6.25	5.000	0.125	0.47	3.25
1.375	0.125	1.80	12.43	5.250	0.125	0.45	3.09
1.500	0.035	0.44	3.03	5.500	0.125	0.43	2.95
1.500	0.065	0.83	5.71	6.000	0.125	0.39	2.70
1.500	0.125	1.64	11.33	6.500	0.125	0.36	2.49
1.750	0.035	0.38	2.59	6.750	0.125	0.35	2.39
1.750	0.065	0.71	4.87	7.000	0.125	0.33	2.31
1.750	0.125	1.40	9.62	7.250	0.125	0.32	2.23
2.000	0.035	0.33	2.26	8.250	0.125	0.28	1.95
2.000	0.065	0.62	4.25				

* Based on MIL-T-46072.

Copper Tubing

- Seamless, H58 drawn, 12-ft straight lengths.
- Copper, UNS C12200, general use.
- Per ASTM B75.
- Allowable stress: SE = 9000 psi.

Table D-12. Copper, H58 drawn, 12-ft lengths.

o.d.	Nominal wall thickness	MAWP		o.d.	Nominal wall thickness	MAWP	
		(ksi)	(MPa)			(ksi)	(MPa)
0.125	0.020	2.74	18.90	1.000	0.035	0.58	4.00
0.125	0.032	5.12	35.31	1.000	0.065	1.15	7.93
0.188	0.028	2.73	18.83	1.000	0.129	2.45	16.90
0.188	0.032	3.23	22.28	1.250	0.065	0.91	6.28
0.250	0.035	2.56	17.66	1.500	0.065	0.75	5.17
0.250	0.049	3.88	26.76	1.750	0.065	0.64	4.41
0.250	0.065	5.51	38.00	2.000	0.065	0.56	3.86
0.313	0.035	2.00	13.79	2.000	0.083	0.72	4.97
0.375	0.035	1.64	11.31	2.500	0.065	0.43	2.97
0.375	0.065	3.39	23.38	2.500	0.083	0.56	3.86
0.500	0.035	1.21	8.34	2.500	0.125	0.87	6.00
0.500	0.065	2.45	16.90	3.000	0.083	0.46	3.17
0.625	0.035	0.96	6.62	3.000	0.120	0.69	4.76
0.625	0.065	1.92	13.24	3.500	0.065	0.30	2.07
0.625	0.083	2.53	17.45	4.000	0.125	0.53	3.66
0.750	0.035	0.78	5.38	5.000	0.250	0.88	6.07
0.750	0.065	1.56	10.76	6.000	0.250	0.73	5.03
0.750	0.083	2.04	14.07	—	—	—	—

Copper Tubing

- Seamless, 060 soft annealed, 50-ft coils.
- Copper, UNS C12200, general use.
- Per ASTM B75.
- Allowable stress: SE = 6000 psi.

Table D-13. Copper, annealed, 50-ft coils, general use.

o.d	Nominal wall thickness	MAWP	
		(ksi)	(MPa)
(in.)	(in.)		
0.188	0.032	2.15	14.83
0.250	0.049	2.58	17.79
0.375	0.049	1.63	11.24
0.375	0.065	2.26	15.59
0.500	0.032	0.73	5.03
0.500	0.065	1.63	11.24

Copper Tubing

- Seamless, soft annealed, 50-ft coils.
- Copper, UNS C12200, refrigeration use.
- Per ASTM B280.
- Allowable stress: SE = 6000 psi.

Table D-14. Copper, annealed, 50-ft coils, refrigeration use.

o.d	Nominal wall thickness	MAWP		o.d	Nominal wall thickness	MAWP	
		(ksi)	(MPa)			(ksi)	(MPa)
(in.)	(in.)			(in.)	(in.)		
0.125	0.030	3.13	21.59	0.750	0.035	0.52	3.59
0.187	0.030	2.00	13.79	0.750	0.042	0.64	4.41
0.250	0.030	1.44	9.93	0.875	0.045	0.58	4.00
0.312	0.032	1.22	8.41	1.125	0.050	0.50	3.45
0.375	0.032	1.00	6.90	1.375	0.055	0.45	3.10
0.500	0.032	0.74	5.10	1.625	0.060	0.42	2.90
0.625	0.035	0.64	4.41				

Copper Tubing

- Seamless, drawn temper, 20-ft straight lengths.
- Copper, UNS C12200, air conditioning use.
- Per ASTM B280.
- Allowable stress: SE = 9000 psi.

Table D-15. Copper, drawn temper, 20-ft lengths.

o.d	Nominal wall thickness	MAWP		o.d	Nominal wall thickness	MAWP	
		(ksi)	(MPa)			(ksi)	(MPa)
0.375	0.030	1.34	9.24	1.625	0.060	0.63	4.34
0.500	0.035	1.19	8.21	2.125	0.070	0.55	3.79
0.625	0.040	1.10	7.59	2.625	0.080	0.51	3.52
0.750	0.042	0.96	6.62	3.125	0.090	0.48	3.31
0.875	0.045	0.87	6.00	3.625	0.100	0.47	3.24
1.125	0.050	0.76	5.24	4.125	0.110	0.45	3.10
1.375	0.055	0.68	4.69				

Copper Tubing

- Seamless, hard drawn, 20-ft straight lengths.
- Copper, UNS C12200, Type K, plumbing use.
- Per ASTM B88.
- Allowable stress: SE = 6000 psi.*

Table D-16. Copper, Type K.

Water tube size	o.d	Nominal wall thickness	MAWP		Water tube size	o.d	Nominal wall thickness	MAWP	
			(ksi)	(MPa)				(ksi)	(MPa)
1/4	0.375	0.035	1.06	7.31	2	2.125	0.083	0.44	3.03
3/8	0.500	0.049	1.16	8.00	2-1/2	2.625	0.095	0.41	2.83
1/2	0.625	0.049	0.91	6.28	3	3.125	0.109	0.40	2.76
5/8	0.750	0.049	0.75	5.17	3-1/2	3.625	0.120	0.38	2.62
3/4	0.875	0.065	0.89	6.14	4	4.125	0.134	0.37	2.55
1	1.125	0.065	0.68	4.69	5	5.125	0.160	0.36	2.48
1-1/4	1.375	0.065	0.55	3.79	6	6.125	0.192	0.36	2.48
1-1/2	1.625	0.072	0.51	3.52	8	8.125	0.271	0.38	2.62

* Annealed properties assumed.

Copper Tubing

- Seamless, hard drawn, 20-ft straight lengths.
- Copper, UNS C12200, Type L, plumbing use.
- Per ASTM B88.
- Allowable stress: SE = 6000 psi.*

Table D-17. Copper, Type L.

Water tube size	o.d	Nominal wall thickness	MAWP*		Water tube size	o.d	Nominal wall thickness	MAWP*	
			(ksi)	(MPa)				(ksi)	(MPa)
1/4	0.375	0.030	0.89	6.14	2	2.125	0.070	0.37	2.55
3/8	0.500	0.035	0.79	5.45	2-1/2	2.625	0.080	0.34	2.34
1/2	0.625	0.040	0.67	4.62	3	3.125	0.090	0.32	2.21
5/8	0.750	0.042	0.64	4.41	3-1/2	3.625	0.100	0.31	2.14
3/4	0.875	0.045	0.58	4.00	4	4.125	0.110	0.30	2.07
1	1.125	0.050	0.50	3.45	5	5.125	0.125	0.27	1.86
1-1/4	1.375	0.055	0.45	3.10	6	6.125	0.140	0.25	1.72
1-1/2	1.625	0.060	0.42	2.90	8	8.125	0.200	0.28	1.93

* Annealed properties assumed.

Copper Tubing

- Seamless, hard drawn, 20-ft straight lengths.
- Copper, UNS C12200, Type M, plumbing use.
- Per ASTM B88.
- Allowable stress: SE = 6000 psi.*

Table D-18. Copper, Type M.

Water tube size	o.d	Nominal wall thickness	MAWP*		Water tube size	o.d	Nominal wall thickness	MAWP*	
			(ksi)	(MPa)				(ksi)	(MPa)
3/8	0.500	0.025	0.56	3.86	2-1/2	2.625	0.065	0.27	1.86
1/2	0.625	0.028	0.50	3.45	3	3.125	0.072	0.25	1.72
3/4	0.875	0.032	0.40	2.76	3-1/2	3.625	0.083	0.25	1.72
1	1.125	0.035	0.34	2.34	4	4.125	0.095	0.25	1.72
1-1/4	1.375	0.042	0.34	2.34	5	5.125	0.109	0.23	1.59
1-1/2	1.625	0.049	0.34	2.34	6	6.125	0.122	0.22	1.52
2	2.125	0.058	0.30	2.07	8	8.125	0.170	0.23	1.59

* Annealed properties assumed.

Carbon Steel Tubing

- Seamless, cold drawn, stress relieved.
- Carbon steel, AISI MT-1016/1018.
- Per ASTM A519.
- Allowable stress: SE = 15000 psi.

Table D-19. Carbon steel.

o.d	Nominal wall thickness	MAWP*		o.d	Nominal wall thickness	MAWP*	
		(ksi)	(MPa)			(ksi)	(MPa)
0.250	0.065	8.93	61.60	2.500	0.120	1.40	9.66
0.500	0.035	2.02	13.93	2.500	0.3125	3.88	26.76
0.500	0.049	2.88	19.86	2.500	0.375	4.76	32.83
0.500	0.065	3.93	27.10	2.750	0.120	1.27	8.76
0.625	0.065	3.08	21.24	3.000	0.120	1.16	8.00
0.750	0.035	1.32	9.10	3.000	0.313	3.18	21.93
0.750	0.065	2.53	17.45	3.000	0.438	4.61	31.79
0.750	0.1875	8.38	57.79	3.125	0.120	1.11	7.66
0.875	0.065	2.15	14.83	3.250	0.065	0.57	3.93
0.875	0.120	4.17	28.76	3.750	0.250	1.97	13.59
1.000	0.035	0.98	6.76	3.750	0.375	3.04	20.97
1.000	0.065	1.87	12.90	3.750	0.625	5.36	36.97
1.000	0.1875	5.96	41.10	4.000	0.065	4.90	33.80
1.125	0.065	1.65	11.38	4.000	0.120	0.86	5.93
1.250	0.065	1.48	10.21	4.000	0.188	1.315	9.48
1.375	0.065	1.34	9.24	4.000	0.250	1.84	12.69
1.375	0.120	2.55	17.59	4.000	0.500	3.88	26.76
1.500	0.065	1.22	8.41	4.250	0.250	1.73	11.93
1.500	0.120	2.33	16.07	4.750	0.120	0.72	4.97
1.500	0.1875	3.77	26.00	5.000	0.250	1.46	10.07
1.625	0.065	1.12	7.72	5.250	0.250	1.39	9.59
1.750	0.250	4.37	30.14	5.500	0.120	0.62	4.28
2.000	0.065	0.93	6.41	5.500	0.250	1.32	9.10
2.000	0.375	6.04	41.06	6.000	0.188	0.90	6.21
2.250	0.120	1.56	10.76	6.000	0.375	1.84	12.69
2.250	0.250	3.41	23.52	6.750	0.250	1.07	7.38
2.375	0.4375	5.92	40.81	8.000	0.375	1.37	9.45
2.500	0.049	0.55	3.79	10.000	0.250	0.71	4.90

* Based on SAE J 1397, MT-1016.

Stainless Steel Tubing

- Seamless, annealed, cold drawn, pickled.
- Type TP 304, UNS S30400.
- Per ASTM A213.
- Allowable stress: SE = 18800 psi.

Table D-20. Stainless steel.

o.d	Nominal wall thickness	MAWP		o.d	Nominal wall thickness	MAWP	
		(ksi)	(MPa)			(ksi)	(MPa)
0.125	0.016	4.63	31.89	1.000	0.065	2.24	15.45
0.188	0.016	2.98	20.53	1.250	0.049	1.33	9.14
0.250	0.020	2.79	19.22	1.250	0.065	1.78	12.24
0.250	0.035	5.11	35.21	1.500	0.049	1.10	7.58
0.250	0.049	7.47	51.53	1.500	0.065	1.47	10.14
0.250	0.065	10.46	72.10	1.500	0.083	1.89	13.06
0.313	0.020	2.20	15.20	1.500	0.095	2.18	15.03
0.313	0.035	4.00	27.57	1.625	0.065	1.35	9.34
0.313	0.049	5.31	36.62	1.750	0.065	1.23	8.65
0.375	0.020	1.82	12.57	2.000	0.035	0.58	4.02
0.375	0.035	3.29	22.65	2.000	0.065	1.09	7.54
0.375	0.049	4.73	32.63	2.000	0.109	1.86	12.85
0.375	0.065	6.49	44.75	2.000	0.120	2.06	14.21
0.500	0.035	2.42	16.70	2.500	0.035	0.47	3.21
0.500	0.049	3.46	23.87	2.500	0.065	0.87	6.01
0.500	0.065	4.71	32.44	2.500	0.120	1.63	11.27
0.500	0.109	8.46	58.36	3.000	0.065	0.72	4.99
0.625	0.065	3.69	25.44	3.000	0.120	1.35	9.34
0.750	0.035	1.59	10.94	4.000	0.065	0.54	3.73
0.750	0.049	2.25	15.53	4.000	0.083	0.69	4.78
0.750	0.065	3.04	20.93	6.000	0.083	0.46	3.17
1.000	0.049	1.67	11.51				