Table 2 Dimensions and Properties of Copper Tube

(All Types, Except DWV are based on ASTM B-88)

Nominal Size	Type	Diameter OD In.	Diameter ID In.	Wall Thickness In.	Surface Area Sq Ft/Lin Ft OD	Surface Area Sq Ft/Lin Ft ID	Section Area Sq In. OD	Section Area Sq In. ID	Area of Metal Sq In.	Volume Gal/Lin Ft	Weight[a] Lb/Lin Ft	Working Pressure[b] Psig
⅛	K[c]	0.375	0.305	0.035	0.0982	0.0798	0.110	0.0730	0.0374	0.00379	0.145	918
	L[c]	0.375	0.315	0.030	0.0982	0.0825	0.110	0.0779	0.0324	0.00404	0.126	764
¼	K	0.500	0.402	0.049	0.131	0.105	0.196	0.127	0.0695	0.00660	0.269	988
	L	0.500	0.430	0.035	0.131	0.113	0.196	0.145	0.0512	0.00753	0.198	677
⅜	K	0.625	0.527	0.049	0.164	0.138	0.306	0.218	0.0887	0.0113	0.344	779
	L	0.625	0.545	0.040	0.164	0.143	0.306	0.233	0.0735	0.0121	0.285	625
½	K	0.750	0.652	0.049	0.193	0.171	0.441	0.334	0.108	0.0174	0.418	643
	L	0.750	0.666	0.042	0.193	0.174	0.441	0.348	0.0934	0.0181	0.362	547
⅝	K	0.875	0.745	0.065	0.229	0.195	0.601	0.436	0.165	0.0227	0.641	747
	L	0.875	0.785	0.045	0.229	0.206	0.601	0.484	0.117	0.0250	0.455	497
1	K	1.125	0.995	0.065	0.295	0.260	0.994	0.778	0.216	0.0405	0.839	574
	L	1.125	1.025	0.050	0.295	0.268	0.994	0.825	0.169	0.0442	0.655	432
1¼	K	1.375	1.245	0.065	0.360	0.326	1.48	1.22	0.268	0.0634	1.04	466
	L	1.375	1.265	0.055	0.360	0.331	1.48	1.26	0.228	0.0655	0.884	387
	M	1.375	1.291	0.042	0.360	0.338	1.48	1.31	0.176	0.0681	0.682	293
	DWV	1.375	1.295	0.040	0.360	0.339	1.48	1.32	0.163	0.0684	0.650	—
1½	K	1.625	1.481	0.072	0.425	0.388	2.07	1.72	0.351	0.0894	1.36	421
	L	1.625	1.505	0.060	0.425	0.394	2.07	1.78	0.295	0.0925	1.14	359
	M	1.625	1.527	0.049	0.425	0.400	2.07	1.83	0.243	0.0950	0.940	289
	DWV	1.625	1.541	0.042	0.425	0.403	2.07	1.86	0.205	0.0969	0.809	—
2	K	2.125	1.959	0.083	0.556	0.513	3.56	3.01	0.532	0.157	2.06	376
	L	2.125	1.985	0.070	0.556	0.520	3.56	3.10	0.452	0.161	1.75	316
	M	2.125	2.009	0.058	0.556	0.526	3.56	3.17	0.377	0.164	1.46	255
	DWV	2.125	2.041	0.042	0.556	0.534	3.56	3.27	0.288	0.142	1.07	—
2½	K	2.625	2.435	0.095	0.687	0.638	5.41	4.66	0.755	0.242	2.93	352
	L	2.625	2.465	0.080	0.687	0.645	5.41	4.77	0.640	0.247	2.48	295
	M	2.625	2.495	0.065	0.687	0.653	5.41	4.89	0.523	0.254	2.03	234
3	K	3.125	2.907	0.109	0.818	0.761	7.67	6.64	1.03	0.345	4.00	343
	L	3.125	2.945	0.090	0.818	0.771	7.67	6.81	0.858	0.354	3.33	278
	M	3.125	2.981	0.072	0.818	0.780	7.67	6.98	0.691	0.362	2.68	220
	DWV	3.125	3.035	0.045	0.818	0.796	7.67	7.23	0.435	0.376	1.69	—
3½	K	3.625	3.385	0.120	0.949	0.886	10.3	9.00	1.32	0.468	5.12	324
	L	3.625	3.425	0.100	0.949	0.897	10.3	9.21	1.11	0.478	4.29	268
	M	3.625	3.459	0.083	0.949	0.906	10.3	9.40	0.924	0.489	3.58	218
4	K	4.125	3.857	0.134	1.08	1.01	13.3	11.7	1.68	0.607	6.51	135
	L	4.125	3.905	0.110	1.08	1.02	13.3	12.0	1.39	0.623	5.38	256
	M	4.125	3.935	0.095	1.08	1.03	13.3	12.2	1.20	0.634	4.66	217
	DWV	4.125	4.009	0.058	1.08	1.05	13.3	12.6	0.67	0.656	2.87	—
5	K	5.125	4.805	0.160	1.34	1.26	20.7	18.1	2.50	0.940	9.67	307
	L	5.125	4.875	0.125	1.34	1.28	20.7	18.7	1.96	0.971	7.61	234
	M	5.125	4.907	0.109	1.34	1.29	20.7	18.9	1.72	0.981	6.66	203
6	K	6.225	5.741	0.192	1.60	1.50	29.4	25.9	3.50	1.35	13.9	308
	L	6.125	5.845	0.140	1.60	1.53	29.4	26.8	2.63	1.39	10.2	221
	M	6.125	5.881	0.122	1.60	1.54	29.4	27.2	2.30	1.42	8.92	190
	DWV	6.125	5.959	0.083	1.60	1.56	29.4	27.9	1.58	1.55	6.10	—
8	K	8.125	7.583	0.271	2.13	1.99	51.8	45.2	6.69	2.34	25.9	330
	L	8.125	7.725	0.200	2.13	2.02	51.8	46.9	4.98	2.43	19.3	239
	M	8.125	7.785	0.170	2.13	2.04	51.8	47.6	4.25	2.47	16.5	200
10	K	10.125	9.449	0.338	2.65	2.47	70.5	70.1	10.4	3.65	40.3	332
	L	10.125	9.625	0.250	2.65	2.52	80.5	72.8	7.76	3.79	30.1	241
	M	10.125	9.701	0.212	2.65	2.54	80.5	73.9	6.60	3.84	25.6	202
12	K	12.125	11.315	0.405	3.17	2.96	115.	101.	14.9	5.24	57.8	334
	L	12.125	11.565	0.280	3.17	3.03	115.	105.	10.4	5.45	40.4	225
	M	12.125	11.617	0.254	3.17	3.04	115.	106.	9.47	5.50	36.7	204

Notes for Table 2

[a] Weight per foot is based on tube without couplings.

[b] Working pressure is based on the *American Standard Code for Pressure Piping*, published by the *ASME*, 1955 edition for plain end tubing (sweat joints).

$$P = \frac{2st_m}{D_o - 0.8t_m}$$

where P = allowable pressure, pounds per square inch, gage.
s = 6000 psi allowable fiber stress, pounds per square inch.
t_m = minimum wall thickness, inches.
D_o = maximum outside diameter, inches.

[c] Types K and L furnished in both hard and soft tempers, Type M in hard only. Standard straight lengths are 20 ft. Standard coils (34 to 1¼ inch) are 60 ft.

[d] 3½ in. copper pipe is not readily available.

steel, wrought iron, malleable iron, copper, brass and bronze, as specified in the ASA B31.5-1962 *Code for Pressure Piping*.[1] Copper and brass must not be used with ammonia.

Other materials are not barred by the code, provided they are of suitable strength and are chemically suitable for use with the fluid conveyed. The code bars the use of magnesium base alloys with any halogenated hydrocarbon refrigerant, as well as the use of zinc, aluminum, die-castings, and magnesium alloys with methyl chloride.

For temperatures below 0 F, the code provides that materials shall have a Charpy impact value at the operating temperature of not less than 15 ft lb using a keyhole notch, but permits copper, brass and bronze without restrictions; it permits ferrous materials not meeting this requirement down to −100 F, provided the design pressure is increased 2 percent for each degree below 0 F. This permits the ordinary lines of cast iron refrigerant fittings down to −50 F, without penalty, except for refrigeration applications where a volatile type of refrigerant is used. For materials suitable for low temperatures, the code states:

"There is a large and constantly growing list of alloy compositions which meet these requirements, and it has not been deemed advisable to infer any limitation by listing a few materials suitable for this purpose. Depending on composition and heat treatment, some 'carbon steels' meet the requirements for a considerable range of temperatures. In general, the 3 to 4 percent nickel steels are acceptable for quite low temperatures, and the 18 percent chrome-8 percent nickel stainless steels meet requirements to very low temperatures. Various other classes of alloys are also acceptable. Apparently minor variations in composition and heat treatment make large differences in toughness at low temperatures."

A summary of available data on low temperature materials is contained in the publication *Properties of Metals at Subatmospheric Temperatures*, issued in 1941 by the American Society for Testing Materials.

Specific minimum requirements for refrigerant pipe and tubing are set forth in the ASA B9.1-1964 *Safety Code for Mechanical Refrigeration*, as follows:

9.3 Specific Minimum Requirements for Refrigerant Pipe and Tubing

9.3.1 No less than Schedule 80 wall thickness carbon steel or wrought iron pipe shall be used for Group II and Group III refrigerant liquid lines for sizes 1¼ in. and smaller.

No less than Schedule 40 wall thickness carbon steel or wrought iron pipe shall be used for Group I refrigerant liquid lines sizes 6 in. and smaller, Group II and Group III refrigerant liquid lines sizes 2 in. through 6 in., and Group I, Group II, and Group III refrigerant vapor lines 6 in. and smaller.

Butt-welded carbon steel and butt-welded wrought iron pipe shall not be used for refrigerant liquid lines.

Cast iron pipe shall not be used for Group I, Group II, or Group III refrigerant lines.

9.3.2 Standard iron pipe size copper and red brass (not less than 80 percent copper) pipe may be used and shall conform to ASTM Specification B-42 for copper pipe and ASTM Specification B-43 for red brass pipe.

Table 3 Table of Availability for Steel Pipe

Material	Specification	Available Sizes (Inclusive) Inches Dia	Allowable Fiber Stress S[a] psi
Butt-weld	A-120	⅛ to 4	6,225
	A-53	⅛ to 4	6,750
Lap-weld	A-120	2 to 12	8,400
	A-53	2 to 24	9,000
Electric-resistance	A-53 Grade A	2 to 24	10,200[b]
	A-53 Grade B	2 to 24	12,750[b]
Seamless	A-53 Grade A	2 to 24	12,000
	A-53 Grade B	2 to 24	15,000
	A-120	2 to 12	10,400

[a] For use in the equation $P = \frac{2S(t_m - c)}{D_o - 0.8(t_m - c)}$

where P = working pressure, pounds per square inch.
S = fiberstress, pounds per square inch.
t_m = 0.875 x wall thickness, inches.
D_o = outside diameter, inches.
c = joint factor = 0.05 for 1-in. and smaller size or 0.065 for larger than 1-in. size.

See *American Standard Code for Pressure Piping*, published by ASME, 1955 edition.

[b] For electric resistance welded pipe for applications where the temperature is below 650 F, and where pipe furnished under this classification is subjected to supplemental tests and/or heat treatments as agreed to by the supplier and the purchaser, and whereby such supplemental tests and/or heat treatments demonstrate the strength characteristics of the weld to be equal to the minimum tensile strength specified for the pipe, the S values equal to the corresponding seamless grades may be used.

9.3.3 Watertube size hard copper tubing used for refrigerant piping erected on the premises shall conform to ASTM Specifications B88-62 Types K or L, for dimensions and specifications, except that copper tubing with outside diameters, of ½ in. and ⅝ in. shall have a minimum nominal wall thickness of not less than 0.030 in. and 0.032 in., respectively.

9.3.4 Soft annealed copper tubing used for refrigerant piping erected on the premises shall not be used in sizes larger than 1⅛ in. standard size (1.375 OD). Mechanical joints shall not be used on soft annealed copper tubing on sizes larger than ⅞ in. standard size (0.875 OD). It shall conform to ASTM Specifications B280-62. Minimum nominal wall thickness of soft annealed copper tubing shall be as follows:

Standard Size, In.	Outside Diameter, In.	Wall Thickness, In.	Standard Size, In.	Outside Diameter, In.	Wall Thickness, In.
½	0.250	0.030	⅞	0.875	0.045
⅜	0.375	0.032	1	1.000	0.050
½	0.500	0.032	1¼	1.125	0.050
⅝	0.625	0.035	1½	1.250	0.055
¾	0.750	0.042	1¾	1.375	0.055

THREADING PRACTICE

In all threaded pipe for heating and ventilating installations the American Standard taper pipe thread, ASA B2.1-1960 is used. This thread is cut with a taper of 1 in 16 measured on the diameter of the pipe so as to secure a tight joint. The number of threads per inch varies with the pipe size. Threads for fittings are the same, except that it is regular practice to furnish straight tapped couplings for Schedule 40 pipe 2 in. and smaller. For steam pressures in excess of 25 psi, it is recommended that taper-tapped couplings be used to obtain a tight joint. These may be secured by ordering *line* pipe[2] which is used for oil piping, the couplings of which are provided with taper-tapped threads and may be used with regular mill-threaded standard weight pipe. Thread lengths should be in accordance with