

TABLE 4. STANDARD DIMENSIONS AND WEIGHTS, AND TOLERANCES IN DIAMETER AND WALL THICKNESS FOR COPPER WATER TUBES^a

(All tolerances in this table are plus and minus except as otherwise indicated)

STANDARD WATER TUBE SIZE, IN.	ACTUAL OUTSIDE DIAMETER IN.	AVERAGE OUT- SIDE DIAMETER		WALL THICKNESS, IN.								THEORETICAL WEIGHT, LB PER FT		
		TOLERANCE, IN. ±		TYPE K		TYPE L		TYPE M		Type K	Type L	Type M		
		Annealed	Drawn Temper	Nominal	Tolerance ±	Nominal	Tolerance ±	Nominal	Tolerance ±					
3/8	0.250	0.002	0.001	0.032	0.003	0.025	0.0025	0.025	0.0025	0.085	0.068	0.068		
1/2	0.375	0.002	0.001	0.032	0.004	0.030	0.0035	0.025	0.0025	0.134	0.126	0.107		
5/8	0.500	0.0025	0.001	0.049	0.004	0.035	0.0035	0.025	0.0025	0.269	0.198	0.145		
3/4	0.625	0.0025	0.001	0.049	0.004	0.040	0.0035	0.028	0.0025	0.344	0.285	0.204		
7/8	0.750	0.0025	0.001	0.049	0.004	0.042	0.0035	0.030	0.0025	0.418	0.362	0.263		
1	0.875	0.003	0.001	0.065	0.0045	0.045	0.004	0.032	0.003	0.641	0.455	0.328		
1 1/4	1.125	0.0035	0.0015	0.065	0.0045	0.050	0.004	0.035	0.0035	0.839	0.655	0.465		
1 1/2	1.375	0.004	0.0015	0.065	0.0045	0.055	0.0045	0.042	0.0035	1.04	0.884	0.682		
1 3/4	1.625	0.0045	0.002	0.072	0.005	0.060	0.0045	0.049	0.004	1.36	1.14	0.940		
2	2.125	0.005	0.002	0.083	0.007	0.070	0.006	0.058	0.006	2.06	1.75	1.46		
2 1/4	2.625	0.005	0.002	0.095	0.007	0.080	0.006	0.065	0.006	2.93	2.48	2.03		
3	3.125	0.005	0.002	0.109	0.007	0.090	0.007	0.072	0.006	4.00	3.33	2.68		
3 1/2	3.625	0.005	0.002	0.120	0.008	0.100	0.007	0.083	0.007	5.12	4.29	3.58		
4	4.125	0.005	0.002	0.134	0.010	0.110	0.009	0.095	0.009	6.51	5.38	4.66		
5	5.125	0.005	0.002	0.160	0.010	0.125	0.010	0.109	0.009	9.67	7.61	6.66		
6	6.125	0.005	0.002	0.192	0.012	0.140	0.010	0.122	0.010	13.9	10.2	8.92		
8	8.125	0.006	+0.002 -0.004	0.271	0.016	0.200	0.014	0.170	0.014	25.9	19.3	16.5		
10	10.125	0.008	+0.002 -0.006	0.338	0.018	0.250	0.016	0.212	0.015	40.3	30.1	25.6		
12	12.125	0.008	+0.002 -0.006	0.405	0.020	0.280	0.018	0.254	0.016	57.8	40.4	36.7		

^aFrom Standard Specifications for Copper Water Tube of the American Society for Testing Materials, A.S.T.M. Designation B88-39.

NOTE 1:—For copper gas and oil burner tubes, the tolerances shown above for various wall thicknesses (type K) apply irrespective of diameter.

NOTE 2:—For tubes other than round no standard tolerances are established. These tolerances do not apply to condenser and heat exchanger tubes.

EXPANSION AND FLEXIBILITY

The increase in temperature of a pipe from room temperature to an operating steam or water temperature 100 F or more above room temperature results in an increase in length of the pipe for which provision must be made. The amount of linear expansion (or contraction in the case of refrigeration lines) per unit length of material per degree change in temperature is termed the *coefficient of linear expansion* of that material, or commonly, the *coefficient of expansion*. This coefficient varies with the material.

The linear expansion of cast-iron, steel, wrought-iron, and copper pipe, the materials most frequently used in heating and ventilating work, can be determined from Table 5, which was computed from Equation 1.

$$L_t = L_o \left[1 + a \left(\frac{t - 32}{1000} \right) + b \left(\frac{t - 32}{1000} \right)^2 \right] \quad (1)$$

where

 L_t = length at temperature t degrees Fahrenheit, feet. L_o = length at 32 F, feet. t = final temperature, degrees Fahrenheit. a and b are constants as given in the tabulation following.

METAL	a	b
Cast-Iron.....	0.005441	0.001747
Steel.....	0.006212	0.001623
Wrought-Iron.....	0.006503	0.001622
Copper.....	0.009278	0.001244

The three methods by which the elongation due to thermal expansion may be taken care of are:

1. Expansion joints.
2. Swivel joints.
3. Inherent flexibility of the pipe itself utilized through pipe bends, right-angle turns, or offsets in the line.

Expansion joints of the slip-sleeve, diaphragm, or corrugated types made of copper, rubber, or other gasket material are all used for taking up expansion, but generally only for low pressures or where the inherent flexibility of the pipe cannot readily be used as in underground steam or hot water distribution lines.

Swivel joints are used extensively in low-pressure steam and hot water heating systems and in hot water supply lines. The swivel joints absorb the expansive movement of the pipe by the turning of threaded joints. In many cases the straight pipe in the offset of a swivel joint is sufficiently flexible to take up the expansion without developing enough thrust to produce swiveling in the threaded joint. This is preferable since continued turning in the threaded joint may in time result in a leak, particularly when the pressure is high. The amount of elongation which a swivel joint can take up is controlled by the length of the swing piece employed and by the lateral displacement which is permissible in the long pipe runs.

Probably the most economical method of providing for expansion of piping in a long run is to take advantage of the directional changes which must necessarily occur in the piping and proportion the offsets so that sufficient flexibility is secured. Ninety-degree bends with long, straight tangents in either a horizontal or a vertical plane are an excellent means for securing adequate flexibility with larger sizes of pipe. When flexibility cannot be obtained in this manner, it is necessary to make use of some type of expansion bend. The exact calculation of the size of expansion bends required to take up a given amount of thermal expansion is relatively complicated¹. The following approximate method, however,

¹See (1) Piping Handbook, by Walker and Crocker (McGraw-Hill Co.); (2) A Manual for The Design of Piping for Flexibility by the Use of Graphs, by E. A. Wert, S. Smith, E. T. Cope, published by The Detroit Edison Company.