Designation: ~~B88M – 05 (Reapproved 2011)~~ B88M – 13

Standard Specification for Seamless Copper Water Tube (Metric)[1]

This standard is issued under the fixed designation B88M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. ~~Scope~~ Scope*

1.1 This specification covers seamless copper water tube suitable for general plumbing, similar applications for the conveyance of fluids, and commonly used with solder, flared, or compression-type fittings. The type of copper water tube suitable for any particular application is determined by the internal or external fluid pressure, by the installation and service conditions, and by local requirements. Means of joining or bending are also factors that affect the selection of the type of tube to be used.[2]

NOTE 1—Annealed tube is suitable for use with flared or compression fittings, and with solder-type fittings, provided rounding and sizing of the tube ends is performed where needed.

~~NOTE 2—Drawn temper tube is suitable for use with solder-type fittings. Types A and B tube, in the drawn temper, are suitable for use with certain types and sizes of compression fittings.~~

~~NOTE 3—This specification is the metric companion of Specification B88.~~

NOTE 2—Drawn temper tube is suitable for use with solder-type fittings. Types A and B tube, in the drawn temper, are suitable for use with certain types and sizes of compression fittings.

1.2 The tube shall be produced from the following coppers, and the manufacturer has the option to supply any one of them, unless otherwise specified:

Copper UNS No.	Previously Used Designation	Description
C10200	OF	Oxygen free without residual deoxidants
C12000	DLP	Phosphorus deoxidized, low residual phosphorus
C12200	DHP	Phosphorus deoxidized, high residual phosphorus

1.3 The assembly of copper plumbing or fire sprinkler systems by soldering is described in Practice B828.

1.4 Solders for joining copper potable water or fire sprinkler systems are covered by Specification B32. The requirements for acceptable fluxes for these systems are covered by Specification B813.

1.5 ~~This specification is the SI companion to Specification~~The values stated in SI units are to be ~~B88.~~regarded as standard. No other units of measurement are included in this standard.

NOTE 3—This specification is the SI companion to Specification B88.

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 15, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

Current edition approved ~~April 1, 2011~~Oct. 1, 2013. Published ~~September 2011~~November 2013. Originally approved in 1983. Last previous edition approved in ~~2005~~2011 as ~~B88M – 05.~~B88M – 05 (2011). DOI: ~~10.1520/B0088M-05R11.~~10.1520/B0088M-13.

[2] The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix is permitted to be used to accommodate composition variations of the base alloy.

***A Summary of Changes section appears at the end of this standard**

2.2 *ASTM Standards:*[3]
B32 Specification for Solder Metal
B88 Specification for Seamless Copper Water Tube
B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
B813 Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
B828 Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
B846 Terminology for Copper and Copper Alloys
B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies
E2 Methods of Preparation of Micrographs of Metals and Alloys (Including Recommended Practice for Photography As Applied to Metallography); Replaced by E 883 (Withdrawn 1983)[4]
E3 Guide for Preparation of Metallographic Specimens
~~E8~~E8/E8M Test Methods for Tension Testing of Metallic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry
E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[4]
E112 Test Methods for Determining Average Grain Size
E243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes
E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

3. Terminology

3.1 *Definitions*—For definitions of terms related to copper and copper alloys, refer to Terminology B846.

3.2 ~~*Definitions:*~~*Definitions of Terms Specific to This Standard:*

~~3.1.1 *coil, n*—a length of the product wound into a series of connected turns. The unqualified term "coil" as applied to tube usually refers to a bunched coil.~~

~~3.1.2 *bunched, n*—a coil in which the turns are bunched and held together such that the cross section of the bunched turns is approximately circular.~~

~~3.1.3 *double layer flat, n*—a coil in which the product is spirally wound into two connected disk-like layers such that one layer is on top of the other. (Sometimes called "double layer pancake coil" or "double layer spirally wound coil.")~~

~~3.1.4 *level or traverse wound, n*—a coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another. (Sometimes called "helical coil.")~~

~~3.1.5 *single layer flat, n*—a coil in which the product is spirally wound into a single disk-like layer. (Sometimes called "pancake coil" or "single layer spirally wound coil.")~~

~~3.1.6 *lengths, n*—straight pieces of the product.~~

~~3.1.7 *standard, n*—uniform lengths recommended in a simplified practice recommendation or established as a commercial standard.~~

~~3.1.8 *tube, seamless, n*—a tube produced with a continuous periphery in all stages of the operations.~~

~~3.1.9 *tube, copper service, n*—a bendable copper water tube for underground water service.~~

3.2.1 *tube, copper water, n*—a seamless copper tube conforming to the particular metric dimensions commercially known as Copper Water Tube and designated as Types A, B, and C.

~~3.2 *Definitions of Terms Specific to This Standard:*~~

~~3.2.1 *capable of*—as used in this specification, the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.~~

4. Ordering Information

4.1 Include the following information for material ordered under this specification.
4.1.1 ASTM designation and year of issue (for example, B88M – 03),

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.
[4] The last approved version of this historical standard is referenced on www.astm.org.

4.1.2 Copper UNS No. (not necessary unless a specific copper is desired),
4.1.3 Nominal or standard size (Column 1 of Table 1) and whether Type A, B, or C (Section 3),
4.1.4 Temper (Section 7),
4.1.5 Length (see 11.5),
4.1.6 How furnished: straight or coils,
4.1.7 Quantity (pieces) of each size and type,
4.1.8 In addition, when material is purchased for agencies of the U.S. Government, it shall conform to the Supplementary Requirements as defined herein when specified in the contract or purchase order.

4.2 The following options are available and shall be specified in the contract or purchase order when required:
4.2.1 Tension test (Section 8),
4.2.2 Grain size determination (Section 8),
4.2.3 Expansion test (9.1), and
4.2.4 Microscopical Examination for Hydrogen ~~Embrittlement,~~Embrittle-ment, Procedure B (9.3.2).

5. Materials and Manufacture

5.1 The material shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification, and shall be cold worked to size.

5.2 The tube shall be finished by such cold-working and annealing operations as are necessary to produce the required temper and surface finish.

5.3 Tube ~~when~~ furnished in coils shall be ~~annealed after coiling.~~annealed.

5.4 Tube ~~when~~ furnished in straight lengths shall normally be in the drawn temper. Upon agreement between the manufacturer or supplier and the purchaser, the manufacturer shall have the option to supply annealed straight length tubing.

6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements in Table 2 for the specific type of copper.

TABLE 1 Dimensions, Mass, and Tolerances in Diameter and Wall Thickness for Metric Copper Water Tube Sizes
(All tolerances are plus and minus except as otherwise indicated.)

Nominal or Standard Size, mm	Outside Diameter, mm	Average Outside Diameter[A] Tolerance, mm		Wall Thickness and Tolerances, mm						Theoretical Mass, kg/m		
				Type A		Type B		Type C				
		Annealed	Drawn	Wall Thickness	Tolerance[B]	Wall Thickness	Tolerance[B]	Wall Thickness	Tolerance[B]	Type A	Type B	Type C
6	6.0	0.05	0.03	0.80	0.08	0.70	0.07	0.60	C	0.117	0.104	0.091
8	8.0	0.05	0.03	0.90	0.09	0.80	0.08	0.60	C	0.179	0.162	0.125
10	10.0	0.05	0.03	0.90	0.09	0.80	0.08	0.60	C	0.230	0.207	0.158
12	12.0	0.06	0.03	1.2	0.1	0.90	0.09	0.60	0.06	0.364	0.280	0.192
15	15.0	0.06	0.03	1.2	0.1	1.0	0.1	0.70	0.07	0.465	0.393	0.281
18	18.0	0.06	0.03	1.2	0.1	1.0	0.1	0.70	0.07	0.566	0.477	0.340
22	22.0	0.06	0.03	1.6	0.15	1.1	0.1	0.80	0.08	0.917	0.646	0.476
28	28.0	0.07	0.04	1.6	0.15	1.2	0.1	0.90	0.09	1.19	0.903	0.685
35	35.0	0.10	0.04	1.6	0.15	1.4	0.15	1.1	0.1	1.50	1.32	1.05
42	42.0	0.10	0.05	1.8	0.2	1.5	0.15	1.2	0.1	2.03	1.71	1.37
54	54.0	0.10	0.05	2.1	0.2	1.7	0.15	1.5	0.15	3.06	2.50	2.21
67	67.0	0.12	0.05	2.4	0.25	2.0	0.2	1.6	0.15	4.35	3.65	2.94
79	79.0	0.12	0.05	2.8	0.3	2.3	0.25	1.8	0.2	5.99	4.95	3.90
105	105.0	0.12	0.05	3.4	0.35	2.8	0.3	2.4	0.25	9.70	8.04	6.92
130	130.0	0.12	0.05	4.0	0.4	3.1	0.3	2.7	0.25	14.2	11.0	9.65
156	156.0	0.12	0.05	4.8	0.5	3.5	0.35	3.1	0.3	20.3	15.0	13.3
~~206~~	~~206.0~~	~~0.15~~	~~+0.05 −0.10~~	~~6.8~~	~~0.7~~	~~5.0~~	~~0.5~~	~~4.3~~	~~0.45~~	~~38.0~~	~~28.2~~	~~24.4~~
206	206.0	0.15	+0.05 −0.10	6.8	0.7	5.0	0.5	4.3	0.45	38.0	28.2	24.4
~~257~~	~~257.0~~	~~0.20~~	~~+0.05 −0.15~~	~~8.5~~	~~0.85~~	~~6.3~~	~~0.65~~	~~5.4~~	~~0.55~~	~~59.3~~	~~44.4~~	~~38.2~~
257	257.0	0.20	+0.05 −0.15	8.5	0.85	6.3	0.65	5.4	0.55	59.3	44.4	38.2
~~308~~	~~308.0~~	~~0.20~~	~~+0.05 −0.15~~	~~10.3~~	~~1.0~~	~~7.1~~	~~0.7~~	~~6.4~~	~~0.65~~	~~86.1~~	~~60.0~~	~~54.2~~
308	308.0	0.20	+0.05 −0.15	10.3	1.0	7.1	0.7	6.4	0.65	86.1	60.0	54.2

[A] The average outside diameter of a tube is the average of the maximum and minimum outside diameter, as determined at any one cross section of the tube.
[B] Maximum deviation at any one point.
[C] Indicates that the material is not generally available or that no tolerance has been established.

TABLE 2 Chemical Composition—Weight %

Element	Copper UNS No.		
	C10200[A]	C12000	C12200
Copper,[B] min	99.95	99.90	99.9
Phosphorus	...	0.004–0.012	0.015–0.040

[A] Oxygen shall be 10 ppm max.
[B] Copper + silver.

6.2 These specification limits do not preclude the presence of other elements. When included in the contract or purchase order, and agreed upon by the manufacturer or supplier and the purchaser, limits shall be established and analysis required for unnamed elements.

7. Temper

7.1 The copper water tube shall be furnished in the tempers designated below. Current designations as defined in Classification B601 are as follows:

Annealed-O
Drawn-H

8. Mechanical Properties

8.1 The tube shall conform to the mechanical property requirements prescribed in Table 3. Tension tests and ~~grainsize~~ grain size determinations need not be made except when indicated by the purchaser at the time of placing the order. A convenient method of indicating that these tests are to be made is to state that "Test Procedure T is required" (see 4.2.1). Where agreement on the Rockwell hardness tests cannot be reached, the tensile strength and grain-size requirements of Table 3 shall be the basis for acceptance or rejection.

9. Performance Requirements

9.1 *Expansion Test*—The annealed (O) tube shall be capable of being expanded in accordance with Test Method B153 with an expansion of the outside diameter in the following amount:

Nominal or Standard Size, mm	Expansion of Outside Diameter, %
15 and under	40
Over 15	30

The expanded tube shall show no cracking or rupture visible to the unaided eye.

~~NOTE 4—The term "unaided eye" as used herein permits the use of corrective spectacles necessary to obtain normal vision.~~

9.2 *Flattening Test*—As an alternative to the expansion test for tube standard sizes 105 mm and over in the annealed condition, a section 100 mm in length shall be cut from the end of one of the lengths for a flattening test. ~~This100-mm~~ This 100-mm test specimen shall be flattened so that a gage set at three times the wall thickness will pass over the tube freely throughout the flattened part. The tube so tested shall develop no cracks or flaws visible to the unaided eye as a result of this test. In making the flattening test the elements shall be slowly flattened by one stroke of the press.

9.3 *Microscopical Examination for Susceptibility to Hydrogen Embrittlement:*

9.3.1 Tubes furnished in Copper UNS No. C10200 and C12000 shall be essentially free of cuprous oxide as determined by Procedure A of Test Methods B577. When Copper UNS No. C12200 is supplied, examination is not required. In case of a dispute, Procedure C of Test Methods B577 shall be used as the referee method.

9.3.2 Tubes furnished in all coppers shall be capable of passing the embrittlement test specified in Procedure B of Test Methods B577. The actual performance of the test is not required unless specifically requested in the ordering document. In case of a dispute, Procedure C of Test Methods B577 shall be used as the referee method.

TABLE 3 Mechanical Property Requirements

Temper Designation		Form	Rockwell Hardness[A]		Tensile Strength, min, MPa	Average Grain Size, mm
Standard	Former		Scale	Value		
OS060	annealed	coils	F	50 max	200	0.040 min
OS035	annealed	straight lengths	F	55 max	200	0.025 min
H58	drawn	drawn	30 T	30 min	250	...

[A] Rockwell hardness tests shall be made on the inside surfaces of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values shall be specified subject to agreement between the purchaser and the supplier.