



Designation: B251/B251M – 17

# Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube<sup>1</sup>

This standard is issued under the fixed designation B251/B251M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification covers a group of general requirements common to several wrought product specifications. Unless otherwise specified in the purchase order, or in an individual specification, these general requirements shall apply to copper and copper-alloy tube supplied under Specifications B68/B68M, B75/B75M, B135/B135M, B466/B466M, B643 and B743.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 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:

### 2.2 ASTM Standards:<sup>2</sup>

- B68/B68M Specification for Seamless Copper Tube, Bright Annealed
- B75/B75M Specification for Seamless Copper Tube
- B135/B135M Specification for Seamless Brass Tube
- B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

- B154 Test Method for Mercurous Nitrate Test for Copper Alloys
- B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes
- B193 Test Method for Resistivity of Electrical Conductor Materials
- B428 Test Method for Angle of Twist in Rectangular and Square Copper and Copper Alloy Tube
- B466/B466M Specification for Seamless Copper-Nickel Pipe and Tube
- B643 Specification for Copper-Beryllium Alloy Seamless Tube
- B743 Specification for Seamless Copper Tube in Coils
- B846 Terminology for Copper and Copper Alloys
- E3 Guide for Preparation of Metallographic Specimens
- 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)<sup>3</sup>
- E112 Test Methods for Determining Average Grain Size
- E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
- E478 Test Methods for Chemical Analysis of Copper Alloys

## 3. Terminology

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

## 4. Materials and Manufacture

4.1 The material shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed in the applicable product specification listed in Section 1.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>1</sup> 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.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

4.2 The material shall be produced by either hot or cold working operations, or both. It shall be finished, unless otherwise specified, by such cold working and annealing or heat treatment as necessary to meet the properties specified.

**5. Dimensions and Permissible Variations**

**5.1 General:**

5.1.1 The standard method of specifying wall thickness shall be in decimal fractions of an inch or millimeter.

5.1.2 For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension shall be cause for rejection.

5.1.3 Tolerances on a given tube shall be specified with respect to any two, but not all three, of the following: outside diameter, inside diameter, wall thickness.

5.1.4 When round tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in **Table 1** by more than 50 %.

NOTE 1—Blank spaces in the tolerance tables indicate either that the material is not generally available or that no tolerances have been established.

5.2 *Wall Thickness Tolerances for Copper and Copper-Alloy Tube*—Wall thickness tolerances applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B743** for round tubes only shall be in accordance with **Table 1** or **Table 2**. Wall thickness tolerances for rectangular including square tube applicable to Specifications **B75/B75M** and **B135/B135M** shall be in accordance with **Table 3** or **Table 4**.

5.3 *Diameter or Distance between Parallel Surfaces, Tolerances for Copper and Copper-Alloy Tube*—Diameter tolerances applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B743** for round tubes only shall be in accordance with **Table 5** or **Table 6**. Tolerances on distance between parallel surfaces for rectangular including square tube applicable to Specifications **B75/B75M** and **B135/B135M** shall be in accordance with **Table 7** and **Table 8**.

5.4 *Roundness (Applicable to Specifications B75/B75M, B135/B135M, and B466/B466M)*—For drawn unannealed tube in straight lengths, the roundness tolerances shall be as follows:

<i>t/D</i> (Ratio of Wall Thickness to Outside Diameter)	Roundness Tolerance as Percent of Outside Diameter (Expressed to the Nearest 0.001 in. [0.025 mm])
0.01 to 0.03, incl	1.5 [1.5]
Over 0.03 to 0.05, incl	1.0 [1.0]
Over 0.05 to 0.10, incl	0.8 or 0.002 in. [mm] whichever is greater
Over 0.10	0.7 or 0.002 in. [mm] whichever is greater

5.4.1 Compliance with the roundness tolerances shall be determined by taking measurements on the outside diameter only, irrespective of the manner in which the tube dimensions are specified. The deviation from roundness is measured as the difference between major and minor diameters as determined at any one cross section of the tube. The major and minor diameters are the diameters of two concentric circles just enclosing the outside surface of the tube at the cross section.

5.4.2 No tolerances have been established for as-extruded tube, redraw tube, annealed tube, any tube furnished in coils or drawn tube whose wall thickness is under 0.016 in. [0.4 mm].

**5.5 Length Tolerances:**

5.5.1 *Straight Lengths*—Length tolerances, straight lengths, applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B466/B466M** shall be in accordance with **Table 9** or **Table 10**.

5.5.2 *Schedule of Tube Lengths*—Specific and stock lengths of tube with ends, applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B466/B466M**, shall be in accordance with **Table 11** or **Table 12**. Tube in straight lengths shall be furnished in stock lengths with ends, unless the order requires specific lengths or specific lengths with ends.

5.6 *Squareness of Cut (Applicable to Specifications B68/B68M, B75/B75M, B135/B135M, and B466/B466M)*—For tube in straight lengths, the departure from squareness of the end of any tube shall not exceed the following:

**TABLE 1 Wall Thickness Tolerances for Copper and Copper-Alloy Tube—Inch-Pound Values**  
(Applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B743**)

NOTE 1—*Maximum Deviation at Any Point*—The following tolerances are plus and minus; if tolerances all plus or all minus are desired, double the values given.

Wall Thickness, in.	Outside Diameter, in. <sup>A</sup>						
	1/32 to 1/8, incl	Over 1/8 to 5/16, incl	Over 5/16 to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl	Over 4 to 7, incl	Over 7 to 10, incl
Up to 0.017, incl	0.002	0.001	0.0015	0.002	...	...	...
Over 0.017 to 0.024, incl	0.003	0.002	0.002	0.0025	...	...	...
Over 0.024 to 0.034, incl	0.003	0.0025	0.0025	0.003	0.004	...	...
Over 0.034 to 0.057, incl	0.003	0.003	0.0035	0.0035	0.005	0.007	...
Over 0.057 to 0.082, incl	...	0.0035	0.004	0.004	0.006	0.008	0.010
Over 0.082 to 0.119, incl	...	0.004	0.005	0.005	0.007	0.009	0.011
Over 0.119 to 0.164, incl	...	0.005	0.006	0.006	0.008	0.010	0.012
Over 0.164 to 0.219, incl	...	0.007	0.009	0.009	0.011	0.012	0.014
Over 0.219 to 0.283, incl	...	...	0.011	0.012	0.014	0.015	0.016
Over 0.283 to 0.379, incl	...	...	0.014	6 <sup>B</sup> %	6 <sup>B</sup> %	7 <sup>B</sup> %	7 <sup>B</sup> %
Over 0.379	...	...	...	6 <sup>B</sup> %	6 <sup>B</sup> %	7 <sup>B</sup> %	7 <sup>B</sup> %

<sup>A</sup> When round tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in the table by more than 50 %.

<sup>B</sup> Percent of specified wall expressed to the nearest 0.001 in.

**TABLE 2 Wall Thickness Tolerances for Copper and Copper-Alloy Tube—SI Values**  
(Applicable to Specifications **B68/B68M**, **B75/B75M**, and **B135/B135M**)

NOTE 1—*Maximum Deviation at Any Point*—The following tolerances are plus and minus; if tolerances all plus or all minus are desired, double the values given.

Wall Thickness, mm	Outside Diameter, mm <sup>A</sup>						
	0.80 to 3.0, incl	Over 3.0 to 16, incl	Over 16 to 25, incl	Over 25 to 50, incl	Over 50 to 100, incl	Over 100 to 180, incl	Over 180 to 250, incl
Up to 0.40, incl	0.05	0.03	0.04	0.05	...	...	...
Over 0.40 to 0.60, incl	0.08	0.05	0.05	0.06	...	...	...
Over 0.60 to 0.90, incl	0.08	0.06	0.06	0.08	0.10	...	...
Over 0.90 to 1.5, incl	0.08	0.08	0.09	0.09	0.12	0.20	...
Over 1.5 to 2.0, incl	...	0.09	0.10	0.10	0.15	0.20	0.25
Over 2.0 to 3.0, incl	...	0.10	0.12	0.12	0.20	0.20	0.28
Over 3.0 to 4.0, incl	...	0.12	0.15	0.15	0.20	0.25	0.30
Over 4.0 to 5.5, incl	...	0.20	0.20	0.20	0.25	0.30	0.35
Over 5.5 to 7.0, incl	...	...	0.25	0.25	0.30	0.35	0.40
Over 7.0 to 10, incl	...	...	0.30	5 <sup>B</sup> %	5 <sup>B</sup> %	6 <sup>B</sup> %	6 <sup>B</sup> %
Over 10	...	...	...	5 <sup>B</sup> %	5 <sup>B</sup> %	6 <sup>B</sup> %	6 <sup>B</sup> %

<sup>A</sup> When round tube is ordered by outside and inside diameters, the maximum plus and minus deviation of the wall thickness from the nominal at any point shall not exceed the values given in the table by more than 50 %.

<sup>B</sup> Percent of specified wall expressed to the nearest 0.025 mm.

**TABLE 3 Wall Thickness Tolerances for Copper and Copper-Alloy Rectangular and Square Tube—Inch-Pound Values**  
(Applicable to Specifications **B75/B75M**, **B135/B135M**, and **B743**)

NOTE 1—*Maximum Deviation at Any Point*—The following tolerances are plus and minus; if tolerances all plus or all minus are desired, double the values given.

Wall Thickness, in.	Distance Between Outside Parallel Surface, in. <sup>A</sup>						
	1/32 to 1/8, incl	Over 1/8 to 5/16, incl	Over 5/16 to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl	Over 4 to 7, incl	Over 7 to 10, incl
Up to 0.017, incl	0.002	0.002	0.0025	0.003	...	...	...
Over 0.017 to 0.024, incl	0.003	0.0025	0.003	0.0035	...	...	...
Over 0.024 to 0.034, incl	0.0035	0.0035	0.0035	0.004	0.006	...	...
Over 0.034 to 0.057, incl	0.004	0.004	0.0045	0.005	0.007	0.009	...
Over 0.057 to 0.082, incl	...	0.005	0.006	0.007	0.008	0.010	0.012
Over 0.082 to 0.119, incl	...	0.007	0.008	0.009	0.010	0.012	0.014
Over 0.119 to 0.164, incl	...	0.009	0.010	0.011	0.012	0.014	0.016
Over 0.164 to 0.219, incl	...	0.011	0.012	0.013	0.015	0.017	0.019
Over 0.219 to 0.283, incl	...	...	0.015	0.016	0.018	0.020	0.022

<sup>A</sup> In the case of rectangular tube the major dimension determines the thickness tolerance applicable to all walls.

### 5.6.1 Round Tube:

Specified Outside Diameter, in. [mm]	Tolerance
Up to 5/8 [16], incl	0.010 in. [0.25 mm]
Over 5/8 [16]	0.016 in./in. [mm/mm] of diameter

### 5.6.2 Rectangular and Square Tube:

Specified Distance Between Major Outside Parallel Surfaces, in. [mm]	Tolerance
Up to 5/8 [16], incl	0.016 in. [0.40 mm]
Over 5/8 [16]	0.025 in./in. [mm/mm] of distance between outside parallel surfaces

### 5.7 Straightness Tolerances:

5.7.1 *Round Tubes*—For round tubes of any drawn temper, 1/4 to 3 1/2 in. [6 to 100 mm] in outside diameter, inclusive, but not redraw tube, extruded tube, or any annealed tube, the straightness tolerances applicable to Specifications **B75/B75M**,

**B135/B135M**, and **B466/B466M** shall be in accordance with **Table 13** or **Table 14**.

5.7.2 *Rectangular and Square Tubes*—For rectangular and square tubes of any drawn temper, the straightness tolerance applicable to Specifications **B75/B75M** and **B135/B135M** shall be 1/2 in. [12 mm] maximum curvature (depth of arc) in any 6-ft [2000-mm] portion of the total length. (Not applicable to extruded tube, redraw tube, or any annealed tube.)

5.8 *Corner Radius, Rectangular and Square Tubes*—The permissible radii for commercially square corners applicable to Specifications **B75/B75M** and **B135/B135M** shall be in accordance with **Table 15** or **Table 16**.

5.9 *Twist Tolerances, Rectangular and Square Tubes*—The maximum twist about the longitudinal axis of drawn temper rectangular and square tubes applicable to Specifications **B75/**

**TABLE 4 Wall Thickness Tolerances for Copper and Copper-Alloy Rectangular and Square Tube—SI Values**  
(Applicable to Specifications **B75/B75M** and **B135/B135M**)

NOTE 1—*Maximum Deviation at Any Point*—The following tolerances are plus and minus; if tolerances all plus or all minus are desired, double the values given.

Wall Thickness, mm	Distance Between Outside Parallel Surface, mm <sup>A</sup>						
	0.80 to 3.0, incl	3.0 to 16, incl	16 to 25, incl	25 to 50, incl	50 to 100, incl	100 to 180, incl	180 to 250, incl
Up to 0.40, incl	0.05	0.05	0.06	0.08	...	...	...
Over 0.40 to 0.60, incl	0.08	0.06	0.08	0.09	...	...	...
Over 0.60 to 0.90, incl	0.09	0.09	0.09	0.10	0.15	...	...
Over 0.90 to 1.5, incl	0.10	0.10	0.12	0.12	0.20	0.25	...
Over 1.5 to 2.0, incl	...	0.12	0.15	0.20	0.20	0.25	0.30
Over 2.0 to 3.0, incl	...	0.20	0.20	0.25	0.25	0.30	0.35
Over 3.0 to 4.0, incl	...	0.25	0.25	0.28	0.30	0.36	0.40
Over 4.0 to 5.5, incl	...	0.28	0.30	0.33	0.38	0.45	0.50
Over 5.5 to 7.0, incl	...	...	0.38	0.40	0.45	0.50	0.55

<sup>A</sup> In the case of rectangular tube, the major dimension determines the thickness tolerance applicable to all walls.

**TABLE 5 Average Diameter Tolerances for Copper and Copper-Alloy Tube<sup>A</sup>—Inch-Pound Values**  
(Applicable to Specifications **B68/B68M**, **B75/B75M**, **B135/B135M**, and **B743**)

Specified Diameter, in.	Tolerance, Plus and Minus, in.
Up to 1/8, incl	0.002
Over 1/8 to 3/8, incl	0.002
Over 3/8 to 1, incl	0.0025
Over 1 to 2, incl	0.003
Over 2 to 3, incl	0.004
Over 3 to 4, incl	0.005
Over 4 to 5, incl	0.006
Over 5 to 6, incl	0.007
Over 6 to 8, incl	0.008
Over 8 to 10, incl	0.010

<sup>A</sup> Applicable to inside or outside diameter.

**TABLE 6 Average Diameter Tolerances for Copper and Copper-Alloy Tube<sup>A</sup>—SI Values**  
(Applicable to Specifications **B68/B68M**, **B75/B75M**, and **B135/B135M**)

Specified Diameter, mm	Tolerance, Plus and Minus, mm
Up to 3.0, incl	0.05
Over 3.0 to 16, incl	0.05
Over 16 to 25, incl	0.06
Over 25 to 50, incl	0.08
Over 50 to 75, incl	0.10
Over 75 to 100, incl	0.12
Over 100 to 125, incl	0.15
Over 125 to 150, incl	0.18
Over 150 to 200, incl	0.20
Over 200 to 250, incl	0.25

<sup>A</sup> Applicable to inside or outside diameter.

**B75M** and **B135/B135M** shall not exceed 1°/ft [1°/300 mm] of length, measured to the nearest degree, and the total angle of twist shall not exceed 20° when measured in accordance with Test Method **B428**. The requirement is not applicable to tubes in the annealed temper or to tubes whose specified major dimension is less than 1/2 in. [12 mm].

## 6. Workmanship, Finish, and Appearance

6.1 The material shall be free of defects of a nature that interfere with normal commercial applications. It shall be well cleaned and free of dirt.

## 7. Sampling

7.1 *Sampling*—The lot, size, portion size, and selection of sample pieces shall be as follows:

7.1.1 *Lot Size*—For tube, the lot size shall be 10 000 lb [5000 kg] or fraction thereof.

7.1.2 *Portion Size*—Sample pieces shall be taken for test purposes from each lot according to the following schedule:

Number of Pieces in Lot	Number of Sample Pieces to be Taken <sup>A</sup>
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of total number of pieces in the lot, but not to exceed 10 sample pieces

<sup>A</sup> Each sample piece shall be taken from a separate tube.

## 8. Number of Tests and Retests

8.1 *Chemical Analysis*—Samples for chemical analysis shall be taken in accordance with Practice **E255**. Drillings, millings, etc., shall be taken in approximately equal weight from each of the sample pieces selected in accordance with 7.1.2 and combined into one composite sample. The minimum weight of the composite sample that is to be divided into three equal parts shall be 150 g.

8.1.1 Instead of sampling in accordance with Practice **E255**, the manufacturer shall have the option of determining conformance to chemical composition as follows: Conformance shall be determined by the manufacturer by analyzing samples taken at the time the castings are poured or samples taken from the semi-finished product. If the manufacturer determines the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product. The number of samples taken for determination of chemical composition shall be as follows:

8.1.1.1 When samples are taken at the time the castings are poured, at least one sample shall be taken for each group of castings poured simultaneously from the same source of molten metal.