



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

This standard is issued under the fixed designation B 251; 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

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 B 68, B 75, B 135, B 466, and B 743.

NOTE 1—A complete metric companion to Specification B 251 has been developed—B 251M; therefore, no metric equivalents are presented in this specification.

## 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:

- B 68 Specification for Seamless Copper Tube, Bright Annealed<sup>2</sup>
- B 75 Specification for Seamless Copper Tube<sup>2</sup>
- B 135 Specification for Seamless Brass Tube<sup>2</sup>
- B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing<sup>2</sup>
- B 154 Test Method for Mercurous Nitrate Test for Copper and Copper Alloys<sup>2</sup>
- B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes<sup>2</sup>
- B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>3</sup>
- B 428 Test Method for Angle of Twist in Rectangular and Square Copper and Copper Alloy Tube<sup>2</sup>
- B 466 Specification for Seamless Copper-Nickel Pipe and Tube<sup>2</sup>
- B 643 Specification for Copper-Beryllium Alloy Seamless Tube<sup>2</sup>
- B 743 Specification for Seamless Copper Tube in Coils<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

Current edition approved Feb. 10, 1997. Published April 1997. Originally published as B 251 – 51 T. Last previous edition B 251 – 93.

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.03.

- E 3 Methods of Preparation of Metallographic Specimens<sup>4</sup>
- E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>
- E 53 Test Methods for Chemical Analysis of Copper<sup>6</sup>
- E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>6</sup>
- E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>6</sup>
- E 112 Test Methods for Determining Average Grain Size<sup>4</sup>
- E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>7</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *average diameter (for round tubes only)*—the average of the maximum and minimum outside diameters, or maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

3.1.2 *coil*—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.

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

3.1.2.2 *double layer flat*—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.”)

3.1.2.3 *level or traverse wound*—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.”)

3.1.2.4 *level or traverse wound on a reel or spool*—a coil in which the turns are positioned into layers on a reel or spool parallel to the axis of the reel or spool such that successive

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>7</sup> Annual Book of ASTM Standards, Vol 03.06.

turns in a given layer are next to one another.

3.1.2.5 *single layer flat*—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.”)

3.1.2.6 *stagger wound*—a coil in which the turns are positioned into layers approximately parallel to the axis of the coil, but not necessarily with the fixed regularity of a level or traverse wound coil.

3.1.3 *lengths*—straight pieces of the product.

3.1.3.1 *ends*—straight pieces, shorter than the nominal length, left over after cutting the product into mill lengths, stock lengths, or specific lengths. They are subject to minimum length and maximum weight requirements.

3.1.3.2 *mill*—straight lengths, including ends, that are conveniently manufactured in the mills. Full-length pieces are usually 10, 12, or 20 ft and subject to established length tolerances.

3.1.3.3 *multiple*—straight lengths of integral multiples of a base length, with suitable allowance for cutting, if and when specified.

3.1.3.4 *random*—run of mill lengths without any indicated preferred length.

3.1.3.5 *specific*—straight lengths that are uniform in length, as specified, and subject to established length tolerances.

3.1.3.6 *specific with ends*—specific lengths, including ends.

3.1.3.7 *standard*—uniform lengths recommended in a Simplified Practice Recommendation or established as a Commercial Standard.

3.1.3.8 *stock*—straight lengths that are mill cut and stored in advance of orders. They are usually 10, 12, or 20 ft and subject to established length tolerances.

3.1.3.9 *stock with ends*—stock lengths, including ends.

3.1.4 *reel or spool*—a cylindrical device that has a rim at each end and an axial hole for a shaft or spindle, and on which the product is wound to facilitate handling and shipping.

3.1.5 *tube*—a hollow product of round or any other cross section, having a continuous periphery.

3.1.5.1 *tube, automotive and general service*—a seamless copper tube of small diameter conforming to a standard series

of sizes commercially known as Automotive and General Service Tube.

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

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.

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.

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 2—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 B 68, B 75, B 135, and B 743 for round tubes only shall be in accordance with Table 1. Wall thickness tolerances for rectangular including square tube applicable to B 75 and B 135 shall be in accordance with Table 2.

TABLE 1 Wall Thickness Tolerances for Copper and Copper-Alloy Tube (Applicable to Specifications B 68, B 75, B 135, and B 743)

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 0.017–0.024, incl	0.003	0.002	0.002	0.0025	...	...	...
Over 0.024–0.034, incl	0.003	0.0025	0.0025	0.003	0.004	...	...
Over 0.034–0.057, incl	0.003	0.003	0.0035	0.0035	0.005	0.007	...
Over 0.057–0.082, incl	...	0.0035	0.004	0.004	0.006	0.008	0.010
Over 0.082–0.119, incl	...	0.004	0.005	0.005	0.007	0.009	0.011
Over 0.119–0.164, incl	...	0.005	0.006	0.006	0.008	0.010	0.012
Over 0.164–0.219, incl	...	0.007	0.009	0.009	0.011	0.012	0.014
Over 0.219–0.283, incl	...	...	0.011	0.012	0.014	0.015	0.016
Over 0.283–0.379, 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 percent.

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

**TABLE 2 Wall Thickness Tolerances for Copper and Copper-Alloy Rectangular and Square Tube**  
(Applicable to Specifications B 75, B 135, and B 743)

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 0.017–0.024, incl	0.003	0.0025	0.003	0.0035	...	...	...
Over 0.024–0.034, incl	0.0035	0.0035	0.0035	0.004	0.006	...	...
Over 0.034–0.057, incl	0.004	0.004	0.0045	0.005	0.007	0.009	...
Over 0.057–0.082, incl	...	0.005	0.006	0.007	0.008	0.010	0.012
Over 0.082–0.119, incl	...	0.007	0.008	0.009	0.010	0.012	0.014
Over 0.119–0.164, incl	...	0.009	0.010	0.011	0.012	0.014	0.016
Over 0.164–0.219, incl	...	0.011	0.012	0.013	0.015	0.017	0.019
Over 0.219–0.283, 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.

5.3 *Diameter or Distance between Parallel Surfaces, Tolerances for Copper and Copper-Alloy Tube*—Diameter tolerances applicable to Specifications B 68, B 75, B 135, and B 743 for round tubes only shall be in accordance with Table 3. Tolerances on distance between parallel surfaces for rectangular including square tube applicable to Specifications B 75 and B 135 shall be in accordance with Table 4.

5.4 *Roundness (Applicable to Specifications B 75, B 135, and B 466)*—For drawn unannealed tube in straight lengths, the roundness tolerances shall be as follows:

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

5.5 *Length Tolerances:*

**TABLE 3 Average Diameter Tolerances for Copper and Copper-Alloy Tube<sup>A</sup>**  
(Applicable to Specifications B 68, B 75, B 135, and B 743)

Specified Diameter, in.	Tolerance, Plus and Minus, in.
Up to 1/8, incl	0.002
Over 1/8–5/16, incl	0.002
Over 5/16–1, incl	0.0025
Over 1–2, incl	0.003
Over 2–3, incl	0.004
Over 3–4, incl	0.005
Over 4–5, incl	0.006
Over 5–6, incl	0.007
Over 6–8, incl	0.008
Over 8–10, incl	0.010

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

5.5.1 *Straight Lengths*—Length tolerances, straight lengths, applicable to Specifications B 68, B 75, B 135, and B 466 shall be in accordance with Table 5.

5.5.2 *Schedule of Tube Lengths*—Specific and stock lengths of tube with ends, applicable to Specifications B 68, B 75, B 135, and B 466, shall be in accordance with Table 6. 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 B 68, B 75, B 135, and B 466)*—For tube in straight lengths, the departure from squareness of the end of any tube shall not exceed the following:

5.6.1 *Round Tube:*

Specified Outside Diameter, in.	Tolerance
Up to 5/8, incl	0.010 in.
Over 5/8	0.016 in./in. of diameter

5.6.2 *Rectangular and Square Tube:*

Specified Distance Between Major Outside Parallel Surfaces, in.	Tolerance
Up to 5/8, incl	0.016 in.
Over 5/8	0.025 in./in. 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. in outside diameter, inclusive, but not redraw tube, extruded tube, or any annealed tube, the straightness tolerances applicable to Specifications B 75, B 135, and B 466 shall be in accordance with Table 7.

5.7.2 *Rectangular and Square Tubes*—For rectangular and square tubes of any drawn temper, the straightness tolerance applicable to Specifications B 75 and B 135 shall be 1/2 in. maximum curvature (depth of arc) in any 6-ft 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 B 75 and B 135 shall be in accordance with Table 8.

5.9 *Twist Tolerances, Rectangular and Square Tubes*—The maximum twist about the longitudinal axis of drawn temper