



Designation: B68/B68M – 11

# Standard Specification for Seamless Copper Tube, Bright Annealed<sup>1</sup>

This standard is issued under the fixed designation B68/B68M; 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.

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

## 1. Scope\*

1.1 This specification establishes the requirements for bright annealed seamless copper tube suitable for use in refrigeration, oil lines, gasoline lines, and so forth, where tube with an interior surface essentially free from scale and dirt is required.

1.1.1 Tubes made from any of the following Copper UNS No. designations shall be supplied, unless otherwise specified in the contract or purchase order:

Copper UNS No. <sup>2</sup>	Type of Copper
C10200	Oxygen-free without residual deoxidants
C10300	Oxygen-free, extra low phosphorus
C10800	Oxygen-free, low phosphorus
C12000	Phosphorus deoxidized, low residual phosphorus
C12200	Phosphorus deoxidized, high residual phosphorus

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *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 ASTM Standards:<sup>3</sup>

- B153** Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing
- B251** Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube

<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> Refer to Practice E527 for explanation of unified numbering system (UNS).

<sup>3</sup> 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.

- B251M** Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric)
- 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
- B846** Terminology for Copper and Copper Alloys
- B968/B968M** Test Method for Flattening of Copper and Copper-Alloy Pipe and Tube
- E3** Guide for Preparation of Metallographic Specimens
- E8/E8M** Test Methods for Tension Testing 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>4</sup>
- 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)
- E2575** Test Method for Determination of Oxygen in Copper and Copper Alloys

## 3. General Requirements

3.1 The following sections of Specification B251 or B251M are a part of this specification.

- 3.1.1 Terminology, General,
- 3.1.2 Material and Manufacture,
- 3.1.3 Workmanship, Finish, and Appearance,
- 3.1.4 Significance of Numerical Limits,
- 3.1.5 Inspection,
- 3.1.6 Rejection and Reheating,
- 3.1.7 Certification,
- 3.1.8 Test Reports,

<sup>4</sup> The last approved version of this historical standard is referenced on www.astm.org.

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

3.1.9 Packaging and Package Marking, and  
3.1.10 Supplementary Requirements.

3.2 In addition, when a section with an identical title to those referenced in 3.1 appears in this specification, such section may contain requirements which supersede those appearing in Specification B251 or B251M. In case of conflict, this specification prevails.

#### 4. Terminology

##### 4.1 Definitions:

4.1.1 See Terminology B846 for definitions of terms related to copper and copper alloys.

4.1.2 *bright anneal, n*—the surface obtained by annealing under conditions of controlled atmosphere to prevent oxidation and to retain the original luster of the product.

#### 5. Ordering Information

5.1 Include the following information when placing orders for products under this specification, as applicable:

5.1.1 ASTM designation and year of issue (for example, B68/B68M – 11),

5.1.2 UNS copper number (for example, C10200),

5.1.3 Temper (Section 8),

5.1.4 Dimensions, diameter, and wall thickness (Section 16),

5.1.5 How furnished: straight lengths or coils,

5.1.6 Total length, or number of pieces, of each size,

5.1.7 Total weight, each size, and

5.1.8 When product is purchased for agencies of the U.S. Government.

5.2 The following options are available and shall be specified at the time of placing the order, when required:

5.2.1 Electromagnetic (eddy-current) test,

5.2.2 Embrittlement test,

5.2.3 Expansion test,

5.2.4 Flattening test,

5.2.5 Certification, and

5.2.6 Mill test report.

#### 6. Materials and Manufacture

##### 6.1 Materials:

6.1.1 The material of manufacture shall be billets, bars, or tube of the Copper UNS No. C10200, C10300, C10800, C12000, or C12200 and shall be of such soundness as to be suitable for processing into the tubular products described.

##### 6.2 Manufacture:

6.2.1 The tube shall be manufactured by such hot- or cold-working processes as to produce a homogeneous uniform wrought structure in the finished product. The tube shall be cold drawn to the finished diameter and wall thickness, and shall be bright annealed to meet the specified temper.

#### 7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements prescribed in Table 1 for the specified copper [alloy] UNS No. designation specified in the ordering information.

7.2 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and the purchaser, limits may be established and analysis required for unnamed elements.

#### 8. Temper

8.1 The tube shall be furnished in either of two annealed tempers as follows:

Annealed (O)	Temper Designation
O50	(Light annealed)
O60	(Soft annealed)

8.1.1 Tempers are defined in Classification B601.

#### 9. Grain Size

9.1 Tube in the tempers O50 (light annealed) and O60 (soft annealed) shall conform to the requirements of Table 2.

#### 10. Mechanical Property Requirements

##### 10.1 Tensile Strength:

10.1.1 The tube shall have a minimum tensile strength of 30 ksi (210 MPa) when tested in accordance with Test Methods E8/E8M.

##### 10.2 Elongation:

10.2.1 The tensile elongation of the tube shall be a minimum 40 % (2-in. or 50 mm gage length) when tested in accordance with Test Methods E8/E8M.

#### 11. Performance Requirements

##### 11.1 Expansion Test:

11.1.1 When specified in the contract or purchase order, the outside diameter of the tube furnished shall be capable of being expanded as follows when tested in accordance with Test Method B153.

**TABLE 1 Chemical Composition**

Element	Composition, %				
	Copper UNS No.				
	C10200 <sup>A</sup>	C10300	C10800	C12000	C12200
Copper, <sup>B</sup> min	99.95	...	...	99.90	99.9
Copper <sup>B</sup>	...	99.95	99.95	...	...
+ phosphorus, min	...	...	...	...	...
Phosphorus	...	0.001–0.005	0.005–0.012	0.004–0.012	0.015–0.040

<sup>A</sup> Oxygen in C10200 shall be 10 ppm max. in accordance with E2575.

<sup>B</sup> Silver counting as copper.

**TABLE 2 Average Grain Size Requirements**

Temper	Grain Size, mm
O50	0.015 to 0.040
O60	0.040, min

Outside Diameter, in. (mm)	Expansion, %
¾ (19) and under	40
over ¾ (19)	30

11.1.1.1 The expanded tube shall show no cracks or ruptures seen through visual inspection without the use of special equipment or enhancement excepting the use of corrective lenses.

11.1.2 A flattening test is an optional alternative to the expansion test for annealed tube over 4 in. (100 mm) in diameter.

**11.2 Flattening Test:**

11.2.1 When specified in the contract or purchase order, the tube shall be capable of being flattened in accordance with the test method described in **B968/B968M**.

**12. Microscopical Examination**

12.1 Samples of Copper UNS Nos. C10200, C10300, and C12000 shall be free of cuprous oxide as determined by Procedure A of Test Methods **B577**. When Copper UNS Nos. C10800 or C12200 are supplied, examination is not required. In case of a dispute, a referee method shall be used in accordance with Procedure C of Test Methods **B577**.

**13. Hydrogen Embrittlement**

13.1 Samples of Copper UNS Nos. C10200, C12000, and C12200 shall be capable of passing the embrittlement test of Procedure B of Test Methods **B577**. The actual performance of this test is not mandatory under the terms of this specification unless definitely specified in the ordering information. In case of a dispute, a referee method shall be used in accordance with Procedure C of Test Methods **B577**.

**14. Nondestructive Testing**

14.1 Upon agreement between the manufacturer and the purchaser, each tube up to 3½ in. (80 mm) in outside diameter shall be subjected to electromagnetic (eddy-current) test. For this test, the tube shall be examined in the final drawn or annealed temper, before coiling or in straight lengths.

**14.2 Electromagnetic (Eddy-Current) Test:**

14.2.1 When examined in accordance with Practice **E243**, tubes that do not actuate the signaling device of the testing unit shall be considered as conforming to the requirements of the test.

**15. Purchases for U.S. Government Agencies**

15.1 When the contract or purchase order stipulates the purchase is for an agency of the U.S. Government, the tubes furnished shall conform to the conditions specified in the Supplementary Requirements of Specification **B251** or **B251M**.

**16. Dimensions and Permissible Variations**

16.1 The dimensions and tolerances for product covered by this specification shall be as specified in the following tables and related paragraphs of Specification **B251** or **B251M**:

16.1.1 *Wall Thickness Tolerance*—Table 1.

16.1.2 *Diameter Tolerances*—Table 3.

16.1.3 *Length Tolerances*—Tables 5 and 6.

16.1.4 *Squareness of Cut*—Refer to Squareness of Cut section 5.6.

16.2 *Coils, Length Tolerances*—Refer to **Table 3**, **Table 4**, and **Table 5** of this specification.

**17. Workmanship, Finish, and Appearance**

**17.1 Workmanship:**

17.1.1 The tube furnished shall be clean, free of dirt, scale, and other defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

17.1.2 The tube shall be bright annealed after the last drawing operation or, when required, after coiling.

**17.2 Finish and Appearance:**

17.2.1 The interior and exterior surfaces of the tube shall be typical in appearance to that of bright annealed copper.

**18. Sampling**

18.1 The lot size, portion size, and selection of sample portions shall be as follows:

18.1.1 *Lot Size*—The lot size shall be 10 000 lb (5000 kg) or fraction thereof.

18.1.2 *Portion Size*—Sample portions shall be selected as to be representative of the lot according to the following schedule:

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

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

18.1.2.1 In case of tube furnished in coils, a length sufficient for all necessary tests shall be cut from each coil selected for testing. The remaining portion of the selected coils shall be included in the shipment and the permissible variation in length on such coils shall be waived.

**18.2 Chemical Composition:**

**TABLE 3 Coil Length Tolerances (Specific Lengths)**

Tube Outside Diameter, in.	Tolerances, in., All Plus, for Nominal Lengths in Feet	
	Up to 50, incl	Over 50 to 100, incl
Up to 2, incl	12	24
Tube Outside Diameter, mm	Tolerances, mm, All Plus, for Nominal Lengths, mm	
	Up to 15 000, Incl.	Over 15 000 to 30 000, incl.
Up to 50, incl	300	610