



## Designation: **B68/B68M—11 B68/B68M – 19**

# 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the U.S. 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
<del>C10200</del>	Oxygen-free without residual deoxidants
C10200	Oxygen-free
<del>C10300</del>	Oxygen-free, extra-low phosphorus
C10300	Oxygen-free, (OFXLP)
<del>C10800</del>	Oxygen-free, low phosphorus
C10800	Oxygen-free, (OFLP)
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 necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other. ~~Combining other, and values from the two systems may result in non-conformance with the standard; shall not be combined.~~

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

[B153 Test Method for Expansion \(Pin Test\) of Copper and Copper-Alloy Pipe and Tubing](#)

~~[B251/B251M Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube \(Metric\)](#)~~  
~~[B0251-B0251M](#)~~

~~[B251M Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube \(Metric\) \(Withdrawn 2017\)](#)~~<sup>4</sup>

[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](#)

<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.

Current edition approved Feb. 15, 2011 April 1, 2019. Published March 2011 April 2019. Originally approved in 1922. Last previous edition approved in 2002 2011 as B68—02-B68/B68M—11. DOI: 10.1520/B0068-B0068M-11-10.1520/B0068\_B0068M-19.

<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.

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

- 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 Standard Test Method for Determination of Oxygen in Copper and Copper Alloys (Withdrawn 2017)<sup>4</sup>

### 3. General Requirements

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

- 3.1.1 Terminology, ~~General~~; General;
- 3.1.2 Material and ~~Manufacture~~; Manufacture;
- 3.1.3 Workmanship, Finish, and ~~Appearance~~; Appearance;
- 3.1.4 Significance of Numerical ~~Limits~~; Limits;
- 3.1.5 ~~Inspection~~; Inspection;
- 3.1.6 Rejection and ~~Rehearing~~; Rehearing;
- 3.1.7 ~~Certification~~; Certification;
- 3.1.8 Test ~~Reports~~; Reports;
- 3.1.9 Packaging and Package ~~Marking~~; Marking; and
- 3.1.10 Supplementary Requirements.

3.2 In addition, when a section with an identical title to ~~those that~~ referenced in 3.1, above, appears in this specification, ~~such section may contain it~~ contains additional requirements which ~~supersedes~~ supplement those appearing in Specification ~~B251~~B251/B251M ~~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.

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

### 5. Ordering Information

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

- 5.1.1 ASTM designation and year of issue (for example, ~~B68/B68M—HB68/B68M—18~~);
- 5.1.2 Copper [Alloy] UNS copper number (for example, C10200); number designation;
- 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~~; coils;
- 5.1.6 ~~Total length, or~~ Quantity: total weight or length or number of pieces; pieces of each size; size; and
- 5.1.7 ~~Total weight, each size, and~~
- 5.1.7 ~~When product is purchased for agencies of the U.S. Government.~~ Intended application.

5.2 The following options are available ~~and shall be but may not be included unless~~ specified at the time of placing the order, when required:

- 5.2.1 ~~Electromagnetic (eddy-current) test;~~ Heat identification or traceability details,
- 5.2.2 Elongation test when wall thickness is less than 0.020 in. [0.508 mm],
- 5.2.3 Embrittlement test,
- 5.2.4 Expansion test,
- 5.2.5 Flattening test,
- 5.2.6 Certification, and
- 5.2.7 Mill test report.

5.2.8 If product is purchased for agencies of the U.S. Government (see the Supplementary Requirements section of this specification or Specification ~~B251~~B251/B251M, or the general requirements section, if specified).

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

## 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.~~ Copper Alloy UNS Nos. C10200, C10300, C10800, C12000, or C12200 and shall be of such purity and soundness as to be suitable for processing into the tubular products ~~described.~~ described herein.

6.1.2 When specified in the contract or purchase order that heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

### 6.2 Manufacture:

6.2.1 The tube shall be manufactured by such ~~hot- or cold-working~~ hot working, cold working, and annealing 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.~~

6.2.2 The tube shall be cold drawn to the finished size and subsequently bright annealed to meet the temper properties specified.

## 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.

7.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance specified in **Table 1.**

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:~~ standard tempers for product described in this specification are 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.**~~ 19

9.2 Acceptance or rejection based upon grain size shall depend only on the average grain size of a test specimen taken from each of two sample portions, and each specimen shall be within the limits prescribed in **Table 2** when determined in accordance with Test Methods **E112.**

## 10. Mechanical Property Requirements

### 10.1 Tensile Strength:

10.1.1 ~~The tube~~ Product furnished under this specification shall have a minimum tensile strength of 30 ksi (~~210 MPa~~) [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)~~ Product having a wall thickness of 0.020 in. [0.508 mm] or greater shall have an elongation of 40 % minimum (2 in. or 50 mm gage length) when tested in accordance with Test Methods **E8/E8M.**

**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	...	0.001–0.005	0.005–0.012	0.004–0.012	0.015–0.040
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 Test Method **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

10.2.2 When specified in the contract or purchase order, the elongation requirement for product having a wall thickness less than 0.020 in. [0.508 mm] shall be negotiated between the supplier and purchaser.

## 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~~ annealed tube shall be capable of ~~being expanded~~ expansion as follows when tested in accordance with Test Method **B153**.

Outside Diameter, in. (mm)	Expansion, %
Outside Diameter, in. [mm]	Expansion, %
<del>— 3/4 (19) and under</del>	<del>40</del>
<del>— 3/4 [19.1] and under</del>	<del>40</del>
<del>— over 3/4 (19)</del>	<del>30</del>
<del>— over 3/4 [19.1]</del>	<del>30</del>

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; cracking or other defects visible to the unaided eye.~~

11.1.2 A flattening test is an optional alternative to the expansion test for annealed tube over 4 in. ~~(100 mm)~~ [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~~ a flattening test in accordance with the test method described in Test Method 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 3 1/8 in. ~~(80 mm)~~ [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 ~~B25+B251/B251M~~ 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 ~~B25+B251/B251M~~ 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.