



Designation: B96/B96M – 20

# Standard Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels<sup>1</sup>

This standard is issued under the fixed designation B96/B96M; 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 copper-silicon alloy plate, sheet, strip, and rolled bar for drawing, forming, stamping, bending, and general engineering applications, and for pressure vessel applications. The alloys involved are copper alloys UNS Nos. C65100, C65400, and C65500.

1.2 When product is ordered for *ASME Boiler and Pressure Vessel Code* applications, consult the Code<sup>2</sup> for applicable alloys.

1.3 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. 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.

1.4 *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>

[B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar](#)

[B248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar \(Metric\)](#)

[B846 Terminology for Copper and Copper Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes \(Withdrawn 2002\)<sup>4</sup>](#)

[E62 Test Methods for Chemical Analysis of Copper and Copper Alloys \(Photometric Methods\) \(Withdrawn 2010\)<sup>4</sup>](#)

[E118 Test Methods for Chemical Analysis of Copper-Chromium Alloys \(Withdrawn 2010\)<sup>4</sup>](#)

[E478 Test Methods for Chemical Analysis of Copper Alloys](#)

2.2 *ASME Code*:<sup>5</sup>

[ASME Boiler and Pressure Vessel Code](#)

## 3. General Requirements

3.1 The following sections of Specification [B248](#) or Specification [B248M](#) constitute a part of this specification:

3.1.1 Terminology

3.1.2 Materials and Manufacture

3.1.3 Dimensions, Mass, and Permissible Variations

3.1.4 Workmanship, Finish, and Appearance

3.1.5 Sampling

3.1.6 Number of Tests and Retests

3.1.7 Test Specimens

3.1.8 Test Methods

3.1.9 Significance of Numerical Limits

3.1.10 Inspection

3.1.11 Rejection and Rehearing

3.1.12 Certification

3.1.13 Test Reports

3.1.14 Product Identification

3.1.15 Packing and Package Marking

3.1.16 Supplementary Requirements

<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 B05.01 on Plate, Sheet, and Strip.

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<sup>2</sup> For *ASME Boiler and Pressure Vessel Code* applications, see related Specification SB-96 in Section 11 of that Code.

<sup>3</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.

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

<sup>5</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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

3.2 In addition, when a section with a title identical to that referenced in 3.1 above appears in this specification, it contains additional requirements which supplement those appearing in Specification B248 or Specification B248M.

#### 4. Terminology

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

#### 5. Ordering Information

5.1 Include the following specified choices when placing orders for product under this specification, as applicable:

- 5.1.1 ASTM designation and year of issue;
- 5.1.2 Copper [Alloy] UNS No. designation (Section 1);
- 5.1.3 Temper (Section 7);
- 5.1.4 Dimensions, Thickness, Width, and Length (Section 10);
- 5.1.5 How furnished: straight lengths or coils;
- 5.1.6 Quantity—total weight or total length or number of pieces of each size (10.7);
- 5.1.7 Intended application;
- 5.1.8 Finish (11.2); and
- 5.1.9 Type of edge, if required (slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges) (10.6).

5.2 The following options are available but may not be included unless specified at the time of placing of the order when required.

- 5.2.1 Certification;
- 5.2.2 Test Report;
- 5.2.3 If product is purchased for agencies of the U.S. government (see the Supplementary Requirements section of Specification B248 or Specification B248M for additional requirements, if specified);
- 5.2.4 Product identification for ASME Boiler and Pressure Vessel Code applications (Specification B248 or Specification B248M);
- 5.2.5 If product is ordered for ASME Boiler and Pressure Vessel Code applications (see 1.2, 10.1, 10.2.1, and 10.7.2);
- 5.2.6 Whether 0.2 % yield strength is required (Tables 1 and 2); and
- 5.2.7 If specification number must be shown on package marking.

#### 6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements in Table 3 for the copper [alloy] UNS No. designation specified in the ordering information.

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

6.3 For alloys in which copper is listed as “remainder,” copper is the difference between the sum of results of all elements determined and 100 %. When all elements in Table 3 are determined, the sum of results shall be 99.5 % min.

#### 7. Temper

7.1 The standard tempers for products described in this specification are in Tables 1 and 2 and Tables 4 and 5.

- 7.1.1 Hot rolled temper M20.
- 7.1.2 Hot rolled and rerolled temper M25.
- 7.1.3 Cold rolled tempers H01 to H14.
- 7.1.4 Annealed tempers O50 or O61.

#### 8. Grain Size for Annealed Tempers

8.1 The approximate grain size values for annealed tempers given in Tables 1 and 2 and Tables 4 and 5 are for general information and shall not be used as a basis for product rejection.

#### 9. Mechanical Property Requirements

##### 9.1 Tensile Strength Requirements:

9.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in Table 1, Table 2, Table 4, or Table 5, when tested in accordance with Test Methods E8/E8M.

9.1.2 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

9.1.3 The tension test specimens shall be taken so the longitudinal axis of the specimens is parallel to the direction of rolling.

##### 9.2 Yield Strength Requirements:

9.2.1 Product furnished under this specification shall be capable of conforming to the yield strength requirements prescribed in Tables 1 and 2 when tested in accordance with Test Methods E8/E8M. The purchaser must specify at the time of ordering which yield strength method shall be used.

##### 9.3 Elongation Requirements:

9.3.1 Product furnished under this specification shall be capable of conforming to the elongation requirements prescribed in Tables 1 and 2 when tested in accordance with Test Methods E8/E8M.

**TABLE 1 Tensile Strength Requirements and Approximate Rockwell Hardness and Grain Size Values for Pressure Vessel Applications (Inch-Pound Units)**

Temper Designation Code	Temper Designation Name	Tensile Strength, ksi	Yield Strength at 0.5 % Extension Under Load, ksi min	Yield Strength <sup>A</sup> at 0.2 % offset, min, ksi	Elongation, min % <sup>B</sup>	Approximate Rockwell F Hardness	Approximate Grain Size, mm
Copper Alloy UNS No. C65500							
O61	Annealed	50–67	18	18	40	70–82	0.110 max <sup>C</sup>

<sup>A</sup> See 5.2.6.

<sup>B</sup> Elongation in 2 in.

<sup>C</sup> No minimum grain size requirement is specified, but all annealed material shall be fully recrystallized.

**TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness and Grain Size Values for Pressure Vessel Applications (SI Units)**

Temper Designation		Tensile Strength, MPa	Yield Strength at 0.5 % Extension Under Load, MPa min	Yield Strength <sup>A</sup> at 0.2 % offset, min, MPa	Elongation, min % <sup>B</sup>	Approximate Rockwell F Hardness	Approximate Grain Size, mm
Code	Name						
Copper Alloy UNS No. C65500							
O61	Annealed	345–460	125	125	40	70–82	0.110 max <sup>C</sup>

<sup>A</sup> See 5.2.6.

<sup>B</sup> Elongation in 50 mm.

<sup>C</sup> No minimum grain size requirement is specified, but all annealed material shall be fully recrystallized.

**TABLE 3 Chemical Requirements**

Element	Composition, %		
	Copper Alloy UNS No.		
	C65100	C65400	C65500
Copper, incl silver	remainder	remainder	remainder
Silicon	0.8–2.0	2.7–3.4	2.8–3.8
Manganese	0.7 max	...	0.50–1.3
Tin	...	1.2–1.9	...
Chromium	...	0.01–0.12	...
Zinc, max	1.5	0.50	1.5
Iron, max	0.8	...	0.8
Nickel, max <sup>A</sup>	...	...	0.6
Lead, max	0.05	0.05	0.05

<sup>A</sup> Incl cobalt.

#### 9.4 Rockwell Hardness Requirement:

9.4.1 The approximate Rockwell hardness values given in **Tables 1 and 2** and **Tables 4 and 5** are for general information and assistance in testing, and shall not be used as a basis for product rejection.

### 10. Dimensions, Mass, and Permissible Variation

10.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification **B248** or Specification **B248M** with particular reference to the following tables and related paragraphs (exceptions for *ASME Pressure Vessel Code* applications are noted):

#### 10.2 Thickness—Table 2.

10.2.1 *Pressure Vessel Code Applications*—The thickness of any plate or sheet shall not be more than 0.01 in. under the thickness specified.

#### 10.3 Width:

10.3.1 *Slit Metal and Slit Metal with Rolled Edges*—Table 4.

10.3.2 *Square Sheared Metal*—Table 5.

10.3.3 *Sawed Metal*—Table 6.

#### 10.4 Length:

10.4.1 *Length Tolerance for Straight Lengths*—Table 7.

10.4.2 *Schedule for Minimum Lengths and Maximum Weights of Ends for Specific Lengths with Ends, and Stock Lengths with Ends*—Table 8.

10.4.3 *Length Tolerances for Square Sheared Metal*—Table 9.

10.4.4 *Length Tolerances for Sawed Metal*—Table 10.

#### 10.5 Straightness:

10.5.1 *Slit Metal or Slit Metal Either Straightened or Edge Rolled*—Table 11.

10.5.2 *Square Sheared Metal*—Table 12.

10.5.3 *Sawed Metal*—Table 13.

#### 10.6 Edges Contours:

10.6.1 *Square Corners*—Table 14.

10.6.2 *Rounded Corners*—Table 15.

10.6.3 *Rounded Edges*—Table 16.

10.6.4 *Full-Rounded Edges*—Table 17.

#### 10.7 Weight:

10.7.1 *Lot Weight Tolerances for Hot-Rolled Sheet and Plate*—Table 18.

10.7.2 *ASME Pressure Vessel Code Applications*—Table 6 of this specification.

### 11. Workmanship, Finish, and Appearance

11.1 For workmanship and appearance requirements, refer to Specification **B248** or Specification **B248M**.

11.2 *Finish*—The material is supplied regularly in the following finishes:

11.2.1 *Black*—After hot rolling retains all of the oxides.

11.2.2 *Plain Pickled*—Sulfuric acid pickle only, brick red oxide; has cuprous and silicon oxides still adherent.

11.2.3 *Specially Cleaned*—Commercially free of all oxides; has the golden color of the alloy.

11.2.4 *Sand Blasted*—Commercially free of all oxides; has a dull gray color.

### 12. Sampling

12.1 Refer to sampling section in Specification **B248** or Specification **B248M**.

### 13. Test Methods

#### 13.1 Chemical Analyses:

13.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published test methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement.

Element	ASTM Test Method
Copper	E478
Silicon	E54; Perchloric acid dehydration
Manganese	E62
Tin	E478; Titrimetric
Chromium	E118
Zinc	E478; Atomic absorption
Iron	E478
Nickel	E478; Photometric
Lead	E478; Atomic absorption