



# Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B 152/B 152M; 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<sup>2</sup> establishes the requirements for copper sheet, strip, plate, and rolled bar produced from the following coppers.

Copper UNS No.	Previous Designation <sup>A</sup>	Type of Copper
C10100	OFE	Oxygen-free electronic
C10200 <sup>B</sup>	OF	Oxygen-free without residual deoxidants
C10300	...	Oxygen-free extra low phosphorus
C10400, C10500, C10700	OFS	Oxygen-free, silver bearing
C10800	...	Oxygen-free low phosphorus
C10910	...	Low oxygen
C11000 <sup>B</sup>	ETP	Electrolytic tough pitch
C11300, C11400, C11600 <sup>B</sup>	STP	Silver bearing tough pitch
C12000	DLP	Phosphorized, low residual phosphorus
C12200 <sup>B</sup>	DHP	Phosphorized, high residual phosphorus
C12300	DPS	Phosphorized, silver bearing
C14200	DPA	Phosphorus deoxidized, arsenical
C14420	...	Tin bearing tellurium copper
C14530	...	Tin tellurium bearing copper

<sup>A</sup>Except Copper UNS No. C10300 (oxygen-free extra low phosphorus), No. C10800 (oxygen-free low phosphorus), and C10910 (low oxygen), these types of copper are classified in Classification B 224.

<sup>B</sup>SAE Specification CA101 conforms to Copper UNS No. C10100; SAE Specification CA102 conforms to the requirements for Copper UNS No. C10200; SAE Specification CA110 conforms to the requirements for Copper UNS No. C11000; SAE Specifications CA113, CA114, and CA116 conform to the requirements for Copper UNS Nos. C11300, C11400, and C11600; SAE Specification CA120 conforms to Copper UNS No. C12000; and SAE Specification CA122 conforms to the requirements for Copper UNS No. C12200.

NOTE 1—Each of the coppers listed has unique properties that can make it suitable for specific applications. The purchaser should consult with the supplier to determine which copper would be best suited for the intended application.

NOTE 2—Copper UNS Nos. C10400, C10500, C10700, C11300, C11400, and C11600 identify coppers with specific silver content (see Table 1).

NOTE 3—This specification is not intended to cover material rolled to

ounce-weight thicknesses. Such material is covered by Specification B 370.

Plates for locomotive fireboxes are covered by Specification B 11.

Flat copper products with finished (rolled or drawn) edges (flat wire and strip) are also covered by Specification B 272.

1.1.1 When no specific copper is identified in the contract or purchase order, the supplier may furnish product from any of the listed coppers.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information only.

1.3 The following safety hazards caveat only pertains to the test method portion, Section 14 of this specification: *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:

- B 11 Specification for Copper Plates for Locomotive Fireboxes<sup>3</sup>
- B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes<sup>4</sup>
- B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>5</sup>
- B 216 Specification for Tough-Pitch Fire-Refined Copper—Refinery Shapes<sup>4</sup>
- B 224 Classification of Coppers<sup>4</sup>
- B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar<sup>4</sup>
- B 248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar [Metric]<sup>4</sup>
- B 272 Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)<sup>4</sup>
- B 370 Specification for Copper Sheet and Strip for Building Construction<sup>4</sup>

<sup>3</sup> Discontinued—see 1980 Annual Book of ASTM Standards, Part 6.

<sup>4</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 02.03.

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

**TABLE 1 Chemical Requirements**

Element	Composition, %																	
	Copper UNS No.																	
	C10100 <sup>A</sup>	C10200	C10300	C10400 <sup>B</sup>	C10500 <sup>B</sup>	C10700 <sup>B</sup>	C10800	C10910	C11000	C11300 <sup>C</sup>	C11400 <sup>C</sup>	C11600 <sup>C</sup>	C12000	C12200	C12300 <sup>D</sup>	C14200	C14420 <sup>E</sup>	C14530 <sup>F</sup>
Copper (incl silver), min	99.99 <sup>G</sup>	99.95	99.95 <sup>H</sup>	99.95	99.95	99.95	99.95 <sup>I</sup>	99.95	99.90	99.90	99.90	99.90	99.90	99.9	99.90	99.4	99.90	99.90
Phosphorus	A	...	0.001–0.005	...	...	...	0.005–0.012	...	...	...	...	0.004–0.012	0.015–0.040	0.015–0.040	0.015–0.040	0.015–0.040	...	0.001–0.010
Arsenic	A	...	...	...	...	...	...	0.0050	...	...	...	...	...	...	0.15–0.50	...	...	...
Oxygen, max	0.0005	0.0010	...	0.0010	0.0010	0.0010	...	...	...	...	...	...	...	...	...	...	...	...
Silver	A	...	...	8 <sup>J</sup>	10 <sup>J</sup>	25 <sup>J</sup>	...	...	...	8 <sup>J</sup>	10 <sup>J</sup>	25 <sup>J</sup>	...	...	4 <sup>J</sup>	...	0.05	...
Selenium + tellurium, max	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.005–0.05	0.003–0.023
Tellurium	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.04–0.15	0.003–0.023
Tin	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.15	0.023

<sup>A</sup>Impurity maximums in ppm of C10100 shall be: antimony 4, arsenic 5, bismuth 1.0, cadmium 1, iron 10, lead 5, manganese 0.5, nickel 10, oxygen 5, phosphorus 3, selenium 3, silver 25, sulfur 15, tellurium 2, tin 2, and zinc 1.

<sup>B</sup>C10400, C10500, and C10700 are oxygen-free coppers with the addition of a specified amount of silver. The compositions of these alloys are equivalent to C10200 plus the intentional addition of silver.

<sup>C</sup>C11300, C11400, C11500, and C11600 are electrolytic tough-pitch copper with silver additions. The compositions of these alloys are equivalent to C11000 plus the intentional addition of silver.

<sup>D</sup>Copper UNS No. C12300 is produced by the addition of silver to phosphorus-deoxidized copper.

<sup>E</sup>Includes Te + Sn.

<sup>F</sup>Includes Cu + Ag + Sn + Te + Se.

<sup>G</sup>Copper shall be determined by difference between impurity total and 100 %.

<sup>H</sup>Copper + silver + phosphorus, min.

<sup>I</sup>Values are minimum silver Troy oz/Avoirdupois ton (1 oz/ton is equivalent to 0.0034 %).



- B 577 Test Methods for Detection of Cuprous Oxide Hydrogen Embrittlement Susceptibility in Copper<sup>4</sup>
  - B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast<sup>6</sup>
  - B 846 Terminology for Copper and Copper Alloys<sup>4</sup>
  - E 3 Practice for Preparation of Metallographic Specimens<sup>6</sup>
  - E 8 Test Methods for Tension Testing of Metallic Materials<sup>6</sup>
  - E 8M Test Methods for Tension Testing of Metallic Materials [Metric]<sup>6</sup>
  - E 53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry<sup>7</sup>
  - E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>7</sup>
  - E 112 Test Methods for Determining Average Grain Size<sup>6</sup>
  - E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>8</sup>
  - E 527 Practice for Numbering Metals and Alloys (UNS)<sup>9</sup>
- 2.2 *ASME Standard:*  
ASME Boiler Pressure Vessel Code<sup>10</sup>

### 3. General Requirements

- 3.1 The following sections of Specification B 248/B 248M constitute a part of this specification.
  - 3.1.1 Terminology.
  - 3.1.2 Materials and Manufacture.
  - 3.1.3 Sampling.
  - 3.1.4 Number of Tests and Retests.
  - 3.1.5 Specimen Preparation.
  - 3.1.6 Test Methods.
  - 3.1.7 Packaging and Package Marking.
  - 3.1.8 Workmanship, Finish, and Appearance.
  - 3.1.9 Significance of Numerical Limits.
  - 3.1.10 Rejection and Rehearing.
- 3.2 In addition, when a section with a title identical to that referenced in 3.1 appears in this specification, it contains additional requirements which supplement those appearing in Specification B 248/B 248M.

### 4. Terminology

4.1 *Definitions*—Terms used in this specification are in accordance with Terminology B 846 and Specifications B 248 and B 248M.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>7</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>8</sup> Annual Book of ASTM Standards, Vol 03.06.

<sup>9</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>10</sup> American Society of Mechanical Engineering, Headquarters, Three Park Ave., New York, NY 10016-5990.

### 4.2 Definitions of Terms Specific to This Standard:

4.2.1 *capable of*—the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements the material shall be subject to rejection.

### 5. Ordering Information

- 5.1 Orders for products under this specification shall include the following:
  - 5.1.1 ASTM specification designation and year of issue,
  - 5.1.2 Quantity,
  - 5.1.3 Copper UNS No. (Section 1). When Alloys C10400, C10500, C10700, C11300, C11400, C11600, or C12300, the amount of silver in ounces per ton,
  - 5.1.4 Temper (Section 7),
  - 5.1.5 Dimensions: thickness, width, and weight (Section 13),
  - 5.1.6 How furnished (straight lengths or coils),
  - 5.1.7 Length (Section 13),
  - 5.1.8 Weight of coils: coil weights or coil size limitations, if required,
  - 5.1.9 When the product is purchased for agencies of the U.S. Government,
- 5.2 The following requirements shall be specified if applicable:
  - 5.2.1 Certification, if required (Section 16),
  - 5.2.2 Mill test report, if required (Section 17),
  - 5.2.3 Resistivity test for Copper UNS Nos. C10100, C10200, C10300, C11000, or C12000 (Section 12),
  - 5.2.4 Embrittlement test for C10100, C10200, C10300, C11000, C12000 (Section 11),
  - 5.2.5 Type of edge, if other than slit,
  - 5.2.6 Supplemental requirements for agencies of the U.S. Government as given in Specification B 248/B 248M.

### 6. Chemical Composition

- 6.1 The materials shall conform to the chemical requirements prescribed in Table 1.
- 6.2 These limits do not preclude the presence of other elements. Limits for unnamed elements may be established and analysis required by agreement between manufacturer and the purchaser.

### 7. Temper

7.1 *Rolled Material (H)*—The standard tempers of cold-rolled sheet, strip, plate, and rolled bar copper of all types are designated as follows (see Practice B 601):

Standard	Temper Designation	Former
H00		eight-hard,
H01		quarter-hard,
H02		half-hard <sup>A</sup>
H03		three-quarter-hard <sup>A</sup>
H04		hard <sup>A</sup>
H06		extra-hard <sup>A</sup>
H08		spring <sup>A</sup>
H10		extra-spring <sup>A</sup>

<sup>A</sup> Consult suppliers to determine the availability of sheet, plate, and rolled bar in these tempers.

NOTE 4—Any product produced in a temper other than those listed will be produced and sold by contract and cannot be said to be produced under this specification.

### 7.2 As Hot-Rolled Temper (M20):

7.2.1 The temper of hot-rolled copper sheet and plate shall be that produced by hot rolling.

7.2.1.1 Plate not specified for ASME Boiler Pressure Vessel Code applications are generally available in the M20 temper.

### 7.3 Annealed Temper (O):

7.3.1 The temper of hot-rolled and annealed copper sheet and plate shall be that produced by hot rolling and subsequent annealing (O25).

7.3.1.1 Plates specified for ASME Boiler Pressure Vessel Code applications shall be furnished in the O25 temper.

7.3.2 The standard tempers of cold-rolled annealed copper sheet, strip, and plate are designated as follows: O60, soft anneal and O68, deep drawing anneal.

NOTE 5—Soft-anneal temper is suitable for most industrial users of copper such as forming, spinning, and simple drawing operations in which close control of temper is not essential. Deep-drawing anneal temper is especially suited for very severe drawing and forming operations in which maximum ductility and close control of temper is required.

## 8. Mechanical Property Requirements

### 8.1 Tensile Requirements:

8.1.1 The tension test shall be the standard test for all tempers of cold-rolled, hot-rolled, and hot-rolled and annealed

copper sheet, strip, plate, and rolled bar. Rejection for mechanical properties shall depend on the tensile properties shown in Table 2 or the elongation values required in 8.1.3 when tested in accordance with Test Methods E 8 and E 8M.

8.1.2 Test specimens shall be taken to conform, where applicable, to Section 6 of Test Methods E 8 and E 8M. Tension test specimens shall be taken so that the longitudinal axis of such specimens is parallel to the direction of rolling. Plate item test—five specimens shall be taken either from the excess portion of the plate or from separate pieces produced under the same specification and temper.

8.1.3 Hot-rolled and hot-rolled and annealed plates of Copper UNS Nos. C11000 and C12200 shall have 40 % minimum elongation in 2 in., and hot-rolled and hot-rolled and annealed plates of Copper UNS No. C14200 shall have 45 % minimum elongation in 2 in. [50 mm].

8.2 Rockwell Hardness—The approximate Rockwell hardness values for each temper are given in Table 2 or Table 3 for general information and assistance in testing.

NOTE 6—Rockwell hardness tests offer a quick and convenient method of checking copper of any temper for general conformity to the requirements for tensile strength or grain size.

## 9. Grain Size for Cold-Rolled Annealed Tempers

9.1 Grain size shall be the standard test for cold-rolled annealed copper sheet and strip, and acceptance or rejection shall depend only on the grain size. The test specimen shall be prepared in accordance with Practice E 3. The average grain size of each of two samples of annealed material, as determined on a plane parallel to the surface of the sheet or strip, shall be within the limits prescribed in Table 3 when tested in accordance with Test Method E 112.

## 10. Microscopical Examination

10.1 Samples of Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, and C12000 shall be substantially free of cuprous oxide as determined by Procedure A of Test Methods B 577. In case of a dispute, a referee method

**TABLE 2 Tensile Strength Requirements and Approximate Hardness Values for the Tempers Given**

Temper Designation		Tensile Strength, ksi <sup>A</sup> [MPa]		Approximate Rockwell Hardness	
Standard	Former	Min	Max	F Scale <sup>B</sup>	Superficial 30T
	Cold-rolled tempers:				
H00	Eighth hard	32 [220]	40 [275]	54–82	up to 49
H01	Quarter hard	34 [235]	42 [296]	60–84	18–51
H02	Half hard	37 [255]	46 [315]	77–89	43–57
H03	Three-quarter-hard	41 [285]	50 [345]	82–91	47–59
H04	Hard	43 [295]	52 [360]	86–93	54–62
H06	Extra hard	47 [325]	56 [385]	88–95	56–64
H08	Spring	50 [345]	58 [400]	91–97	60–66
H10	Extra spring	52 [360]	...	92 and over	61 and over
	Hot-rolled tempers:				
M20 <sup>C</sup>	Hot-rolled	30 <sup>E</sup> [205]	38 [260]	up to 75	up to 41
O25 <sup>D</sup>	Hot-rolled and annealed	30 <sup>E</sup> [205]	38 [260]	up to 65	up to 31

<sup>A</sup>ksi = 1000 psi.

<sup>B</sup>Rockwell values apply as follows: The F scale applies to metal 0.020 in. [0.50 mm] and over in thickness. The Superficial 30-T scale applies to metal 0.012 in. [0.30 mm] and over in thickness.

<sup>C</sup>See Section 7.2.1.1.

<sup>D</sup>See Section 7.3.1.1.

<sup>E</sup>When material is specified to meet the requirements of ASME Boiler Pressure Vessel Code, the minimum yield strength at 0.5 % extension under load or at 0.2 % offset shall be 10 ksi [70 MPa].

**TABLE 3 Grain Size Requirements and Approximate Rockwell Hardness Values for Cold-Rolled Annealed Tempers**

Temper Designation		Grain Size, mm		Approximate Rockwell Hardness <sup>A</sup>	
Standard	Former	Min	Max	F Scale	
				Min	Max
O60	Soft anneal	<sup>B</sup>			65
OS025	Deep-drawing anneal	<sup>B</sup>	0.050	30	75

<sup>A</sup>Rockwell hardness values apply as follows: The F scale applies to metal 0.020 in. (0.5 mm) and over in thickness.

<sup>B</sup>Although no minimum grain size is required, this material must be fully recrystallized.

in accordance with Procedure C of Test Methods B 577 shall be used.

10.2 When Copper UNS Nos. C10800, C12200, or C12300 are supplied, microscopical examination for cuprous oxide is not required.

### 11. Hydrogen Embrittlement Susceptibility Test

11.1 Samples of Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10800, C12000, C12200, and C12300 shall be capable of passing the embrittlement test of Procedure B of Test Methods B 577. 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 in accordance with Procedure C shall be used.

### 12. Electrical Resistivity

12.1 When specified in the order, the electrical resistivity determined on representative samples of Copper UNS Nos. C10100, C10200, and C11000 shall not exceed the following limits when tested at a temperature of 20°C:

Condition	Electrical Resistivity, max, $\Omega \cdot \text{g}/\text{m}^2$
Soft (annealed)—C10100	0.151 76
Cold-rolled tempers—C10100	0.156 14
Soft (annealed)—C10200, C11000	0.153 28
Cold-rolled tempers—C10200, C11000	0.157 75

12.2 When specified in the order, the electrical resistivity determined on representative samples of Copper UNS No. C12000 shall not exceed the following limits when tested at a temperature of 20°C:

Temper	Electrical Resistivity, max, $\Omega \cdot \text{g}/\text{m}^2$
Annealed tempers	0.170 31
Rolled or drawn tempers	0.174 18

NOTE 7—The International Annealed Copper Standard electrical conductivity equivalents are as follows:

Electrical Resistivity, $\Omega \cdot \text{g}/\text{m}^2$	Conductivity, % IACS
0.151 76	101.00
0.153 28	100.00
0.156 14	98.16
0.157 75	97.16
0.170 31	90
0.174 18	88

12.3 Copper UNS Nos. C10300, C14420, and C14530 when specified at the time of purchase for electrical conductor use

shall meet resistivity requirements as agreed upon between the manufacturer or supplier and the purchaser.

12.4 The electrical resistivity of the material shall be determined in accordance with Test Method B 193.

### 13. Dimensions, Mass, and Permissible Variations

13.1 The dimensions and tolerances for material covered by this specification shall be as prescribed in the current edition of Specification B 248 or B 248M, with particular reference to the dimensions, weights, and permissible variations section and the following tables of that specification.

13.1.1 *Thickness Tolerances.*

13.1.2 *Width Tolerances.*

13.1.2.1 *Slit Metal and Slit Metal with Rolled Edges.*

13.1.2.2 *Square-Sheared Metal.*

13.1.2.3 *Sawed Metal.*

13.1.3 *Length Tolerances.*

13.1.3.1 *Specific and Stock Lengths With and Without Ends—See 5.4, Table 7.*

13.1.3.2 *Schedule of Lengths (Specific and Stock) With Ends.*

13.1.3.3 *Length Tolerances for Square-Sheared Metal.*

13.1.3.4 *Length Tolerances for Sawed Metal.*

13.1.4 *Straightness:*

13.1.4.1 *Slit Metal and Slit Metal Either Straightened or Edge-Rolled.*

13.1.4.2 *Square-Sheared Metal.*

13.1.4.3 *Sawed Metal.*

13.1.5 *Weight: Hot-Rolled Sheet and Plate.*

13.1.6 *Edges.*

13.1.6.1 *Square Edges.*

13.1.6.2 *Rounded Corners.*

13.1.6.3 *Rounded Edges.*

13.1.6.4 *Full-Rounded Edges.*

### 14. Test Methods

14.1 Refer to Specification B 248 for the appropriate mechanical test method.

14.2 Chemical composition shall, in case of disagreement be determined as follows:

Element	ASTM Test Method
Copper	E 53
Phosphorus	E 62
Selenium	Refer to Annex, Specification B 216
Silver	E 478
Tellurium	Refer to Annex, Specification B 216
Arsenic	E 62

14.2.1 For Copper No. C10100, refer to the Annex of Specification B 170 for test methods.

14.2.2 Test method(s) for the determination of elements resulting from contractual or purchaser order shall be as agreed upon between the manufacture and the purchaser.

### 15. Inspection

15.1 The manufacturer shall inspect and make tests necessary to verify that the product furnished conforms to the specified requirements.

15.2 The manufacturer and the purchaser, by mutual agreement, may accomplish the final inspection simultaneously.

**16. Certification**

16.1 When specified on the purchase order, the manufacturer shall furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification and has met the requirements.

16.2 When material is specified to meet the requirements of ASME Boiler Pressure Vessel Code, the certification requirements are mandatory.

**17. Mill Test Report**

17.1 When specified on the purchase order, the manufacturer shall furnish to the purchaser a test report showing results of tests required by the specification.

**18. Keywords**

18.1 copper bars; rolled; copper plate; copper sheet; copper strip

**SUMMARY OF CHANGES**

This section identifies the principal changes to this specification that have been incorporated since the 1997a issue as follows:

- (1) Deleted mercury in Footnotes E and G in Table 1.
- (2) Combined B 152M into this standard.
- (3) Editorial revisions and clarification of requirements were made throughout.
- (4) Renaming Section 11 from Embrittlement Test to Hydro-

- gen Embrittlement Susceptibility Test to reflect the terminology used in Test Methods B 577.
- (5) Revised Table 1 to remove unneeded elements, add required footnotes, and made footnotes match those in comparable tables.

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