



Designation: B194 – 22

Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar¹

This standard is issued under the fixed designation B194; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification establishes the requirements for copper-beryllium alloy plate, sheet, strip, and rolled bar. The following alloys are specified:

Copper Alloy UNS No.	Nominal Beryllium Composition, %
C17000	1.7
C17200	1.9

1.2 Unless otherwise specified in the contract or purchase order, Copper Alloy UNS No. C17200 shall be the alloy furnished.

1.3 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 The following safety hazard caveat pertains only to the test method(s) described in this specification:

1.4.1 *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 to determine the applicability of regulatory limitations prior to use.*

1.5 *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*:²

¹ 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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² 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.

- [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 \(Metric\)](#)
- [B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast](#)
- [B820 Test Method for Bend Test for Determining the Formability of Copper and Copper Alloy Strip](#)
- [B846 Terminology for Copper and Copper Alloys](#)
- [E8/E8M Test Methods for Tension Testing of Metallic Materials](#)
- [E18 Test Methods for Rockwell Hardness of Metallic Materials](#)
- [E112 Test Methods for Determining Average Grain Size](#)

3. General Requirements

3.1 The following sections of Specification B248 or B248M constitute a part of this specification:

- 3.1.1 Terminology
- 3.1.2 Materials and Manufacture
- 3.1.3 Dimensions, Weights, 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 Specimen Preparation
- 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 Packaging and Package Marking.

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 that supplement those appearing in Specification B248 or B248M.

4. Terminology

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

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

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,
- 5.1.3 Form of material: plate, sheet, strip, or rolled bar,
- 5.1.4 Temper (Section 7),
- 5.1.5 Dimensions: thickness and width, and length if applicable,
- 5.1.6 How furnished: coils, stock lengths with or without ends, specific lengths with or without ends,
- 5.1.7 Quantity—total weight or total length or number of pieces of each size, and
- 5.1.8 Tension test or hardness as applicable (Section 8).

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

- 5.2.1 Type of edge: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (Specification B248 or B248M, Subsection 5.6),
- 5.2.2 Special width and straightness tolerances: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (Specification B248 or B248M, Subsection 5.3 or 5.5),
- 5.2.3 Special thickness tolerances: (Specification B248 or B248M, Table 3),
- 5.2.4 Bend test (Section 11),
- 5.2.5 Grain size (Section 9),
- 5.2.6 Grain count (Section 10),
- 5.2.7 Certification (Specification B248 or B248M, Section 14),
- 5.2.8 Test Report (Specification B248 or B248M, Section 15),
- 5.2.9 Special tests or exceptions, if any.

5.3 If the product is purchased for agencies of the U.S. Government, see the Supplementary Requirement of Specification B248 or B248M for additional requirements, if specified.

6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements in Table 1 for the Copper Alloy UNS No. designation specified in the ordering information.

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

TABLE 1 Chemical Requirements

Element	Composition, %	
	Copper Alloy UNS No. C17000	Copper Alloy UNS No. C17200
Beryllium	1.60–1.85	1.80–2.00
Additive elements:		
Nickel + cobalt, min	0.20	0.20
Nickel + cobalt + iron, max	0.6	0.6
Aluminum, max	0.20	0.20
Silicon, max	0.20	0.20
Copper	remainder	remainder

6.2 These composition limits do not preclude the presence of other elements. By agreement between 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 1 are determined, the sum of results shall be 99.5 % minimum.

7. Temper

7.1 The standard tempers for products described in this specification are given in Table 2, Table 3, Table 4, and Table 5.

- 7.1.1 Solution Heat Treated TB00.
- 7.1.2 Solution Heat Treated and Cold Worked TD00 to TD04.
- 7.1.3 Solution Heat Treated and Precipitation Heat Treated TF00.
- 7.1.4 Solution Heat Treated, Cold Worked and Precipitation Heat Treated TH01 to TH04.
- 7.1.5 Mill Hardened TM00 to TM08.
- 7.1.6 Plate is generally available in the TB00, TD04, TF00, and TH04 tempers.

8. Mechanical Property Requirements

8.1 Tensile Strength Requirements:

8.1.1 Tensile strength for product less than 0.050 in. (1.27 mm) in thickness shall be the standard test, when tested in accordance with Test Methods E8/E8M.

8.1.2 The tensile strength requirements are given in Table 2, Table 3, and Table 4.

8.1.3 Acceptance or rejection for products less than 0.050 in. (1.27 mm) in thickness shall depend only on tensile properties.

8.2 Rockwell Hardness Requirements:

8.2.1 Rockwell hardness for product 0.050 in. (1.27 mm) and greater in thickness shall be the standard test, when tested in accordance with Test Methods E18.

8.2.2 The Rockwell hardness requirements are given in Table 2, Table 3, and Table 4.

8.2.3 Acceptance or rejection for product 0.050 in. (1.27 mm) and greater in thickness shall depend only on Rockwell hardness.

8.3 In cases of disagreement with Rockwell results, the acceptance or rejection shall be the tensile properties, when tested in accordance with Test Methods E8/E8M.

9. Grain Size

9.1 Acceptance or rejection based upon grain size shall depend on the average grain size of a test specimen from each of two sample portions, and each specimen shall be within the limits prescribed in Table 5 when determined in accordance with Test Methods E112.

9.2 The determinations shall be made on samples in a plane perpendicular to the surface and perpendicular to the direction of rolling.

TABLE 2 Mechanical Property Requirements for Material in the Solution-Heat-Treated or Solution-Heat-Treated and Cold-Worked Condition

Temper Designation ^A		Material Thickness, in. (mm)		Tensile Strength, ksi ^B (MPa) ^C	Elongation ^D in 2 in. or 50 mm, min, %	Rockwell Hardness ^E		
Code	Name	Over	To (incl)			B Scale	30T Scale	15T Scale
TB00	A	...	...	60–78 (415–540)	35	45–78	46–67	75–85
TD01	¼ H	...	0.188 (4.78)	75–88 (520–610)	15	68–90	62–75	83–89
TD02	½ H	...	0.188 (4.78)	85–100 (585–690)	9	88–96	74–79	88–91
TD04	H	...	0.188 (4.78)	100–130 (690–895)	2	96–104	79–83	91–94
TD04	H	0.188 (4.78)	0.375 (9.53)	90–130 (620–895)	...	91–103	77 min	90 min
TD04	H	0.375 (9.53)	1.000 (25.4)	90–120 (620–825)	...	90–102	...	...
TD04	H	over 1.000 (25.4)	...	85–115 (585–790)	8	88–102	...	...

^A Standard designations defined in Classification B601.

^B ksi = 1000 psi.

^C See Appendix X1.

^D Elongation requirement applies to material 0.004 in. (0.102 mm) and thicker.

^E The thickness of material that may be tested by use of the Rockwell hardness scales is as follows:

B Scale.....0.040 in. (1.016 mm) and over

30T Scale.....0.020 in. to 0.040 in. (0.508 mm to 1.016 mm), excl.

15T Scale.....0.015 in. to 0.020 in. (0.381 mm to 0.508 mm), excl.

Hardness values shown apply only to direct determinations, not converted values.

TABLE 3 Mechanical Property Requirements After Precipitation Heat-Treatment^A

Temper Designation		Material Thickness, in. (mm)		Tensile Strength, ksi ^B (MPa) ^C	Yield Strength, ksi (MPa), min, 0.2 % Offset	Elongation in 2 in. (50 mm), min, % ^D	Rockwell Hardness, ^E min		
Code	Name	Over	To (incl)				C Scale	30N Scale	15N Scale
Copper Alloy UNS No. C17000									
TF00	AT	...	0.188 (4.78)	150–180 ^F (1035–1240)	130 (895)	3	33	53	76.5
TF00	AT	0.188 (4.78)	...	165–195 ^F (1140–1345)	130 (895)	3	36	56	78
TH01	¼ HT	...	...	160–190 ^F (1105–1310)	135 (930)	2.5	35	55	77
TH02	½ HT	...	...	170–200 ^F (1170–1380)	145 (1000)	1	37	57	78.5
TH04	HT	...	...	180–210 ^F (1240–1450)	155 (1070)	1	38	58	79.5
Copper Alloy UNS No. C17200									
TF00	AT	...	...	165–195 ^F (1140–1345)	140 (965)	3	36	56	78
TH01	¼ HT	...	0.188 (4.78)	175–205 ^F (1205–1415)	150 (1035)	2.5	36	56	79
TH02	½ HT	...	0.188 (4.78)	185–215 ^F (1275–1480)	160 (1105)	1	38	58	79.5
TH04	HT	...	0.188 (4.78)	190–220 ^F (1310–1520)	165 (1140)	1	38	58	80
TH04	HT	0.188 (4.78)	0.375 (9.53)	180–215 ^F (1240–1480)	160 (1105)	1	38	58	80
TH04	HT	0.375 (9.53)	1.000 (25.4)	180–210 ^F (1240–1450)	155 (1070)	1	38	...	...
TH04	HT	1.000 (25.4)	2.000 (50.8)	175–205 ^F (1205–1415)	150 (1035)	2	37	...	...
TH04	HT	over 2.000 (50.8)	...	165–200 ^F (1140–1380)	130 (895)	2	36	...	...

^A These values apply to mill products (Section 14). See 12.3 for exceptions in end products.

^B ksi = 1000 psi.

^C See Appendix X1.

^D Elongation requirement applies to material 0.004 in. (0.102 mm) and thicker.

^E The thickness of material that may be tested by use of the Rockwell Hardness scales is as follows:

C Scale.....0.040 in. (1.016 mm) and over

30N Scale.....0.020 in. to 0.040 in. (0.508 mm to 1.016 mm), excl.

15N Scale.....0.015 in. to 0.02 in. (0.381 mm to 0.508 mm), excl.

Hardness values shown apply only to direct determinations, not converted values.

^F The upper limits in the tensile strength column are for design guidance only.

10. Grain Count

10.1 The grain count of a sample of material, in any temper, over 0.004 in. to 0.010 in. (0.102 mm to 0.254 mm), inclusive, in thickness shall not be less than the limits specified in Table 6.

10.2 Grain count is the number of grains per stock thickness, averaged for five locations one stock thickness apart. Grain count shall be determined in a plane perpendicular to the surface and perpendicular to the direction of rolling.

11. Bend-Test Requirements

11.1 When specified in the contract or purchase order (see 5.2.4), the material shall conform to requirements agreed upon between manufacturer or supplier and purchaser when tested in accordance with Test Method B820.

11.2 The bend test is a method for evaluating formability. It applies to the product 0.004 in. to 0.020 in. thick (0.102 mm to 0.508 mm) inclusive in Table 2 and Table 4.

12. Precipitation Heat-Treatment

12.1 Solution-heat-treated or solution-heat-treated and cold-worked material is normally precipitation hardened by the purchaser after forming or machining. For the purpose of determining conformance to specified mechanical properties of Table 3, a sample of the as-supplied material shall be heat treated as shown in Table 7. Other heat treating temperatures and times may be preferred for end products of this material.

12.2 The solution-heat-treated and cold-worked test specimens shall be heat treated at a uniform temperature of 600 °F to 675 °F (316 °C to 357 °C) for the time shown in Table 7.