Designation: B196/B196M – 07 (Reapproved 2013)ε1

Standard Specification for Copper-Beryllium Alloy Rod and Bar[1]

This standard is issued under the fixed designation B196/B196M; 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.

ε[1] NOTE—Corrections were made in Table 3 and 10.2.1 editorially in September 2015.

1. Scope*

1.1 This specification establishes the requirements for copper-beryllium alloy rod and bar in straight lengths. The following three alloys are included:

Copper Alloy UNS No.	Previously Used Designations	Nominal Beryllium Content, %
C17000	Alloy 165	1.7
C17200	Alloy 25	1.9
C17300		1.9 +0.4 lead

1.2 Unless otherwise required, Copper Alloy UNS No. C17200 shall be the alloy furnished whenever Specification B196/B196Mis specified without any alloy designation.

1.3 The values stated in either inch-pounds or SI units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. 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 nonconformance with the specification.

1.4 *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 The following documents in the current issue of the Book of Standards form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar

B249/B249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

E8 Test Methods for Tension Testing of Metallic Materials

E8M Test Methods for Tension Testing of Metallic Materials [Metric] (Withdrawn 2008)[3]

3. General Requirements

3.1 The following sections of Specification B249/B249M constitute a part of this specification:

3.1.1 Terminology;
3.1.2 Dimensions and Permissible Variations;
3.1.3 Workmanship, Finish, and Appearance;
3.1.4 Sampling;
3.1.5 Number of Tests and Retests;
3.1.6 Specimen Preparation;
3.1.7 Test Methods;
3.1.8 Significance of Numerical Limits;
3.1.9 Inspection;
3.1.10 Rejection and Rehearing;
3.1.11 Certification;
3.1.12 Mill Test Report;
3.1.13 Packaging and Package Marking; and
3.1.14 Heat Identification

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.02 on Rod, Bar, Wire, Shapes and Forgings.

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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.

[3] 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**

3.2 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 B249/B249M.

4. Terminology

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

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1 *Heat*—A heat shall be the result of castings poured simultaneously from the same source of molten metal.

4.2.2 *Lot*—The lot shall be a heat or fraction thereof.

5. Ordering Information

5.1 Orders for products should include the following information, as applicable:

5.1.1 ASTM specification designation and year of issue,

5.1.2 Quantity,

5.1.3 Copper Alloy UNS No. designation (Section 1),

5.1.4 Form of material (rod or bar and cross section, such as round, hexagonal, and so forth),

5.1.5 Temper (Section 8),

5.1.6 Dimensions (diameter or distance between parallel surfaces, and length),

5.1.7 How furnished (stock or specific lengths, with or without ends), and

5.1.8 When material is ordered for agencies of the U.S. government (See Section 11).

5.2 The following options are available and should be specified in the contract or purchase order when required:

5.2.1 Type of edge (square corners, rounded corners, rounded edge, full-rounded edge),

5.2.2 Mechanical properties (tension test and hardness) (Section 10),

5.2.3 Certification, and

5.2.4 Mill Test Report.

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be Copper Alloy UNS No. C17000, C17200, or C17300, cast and worked and of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.1.2 Heat traceability shall be maintained and reported on the Mill Test Report or Certification.

6.2 *Manufacture:*

TABLE 1 Chemical Requirements

Element	Composition,%		
	Copper Alloy UNS No.		
	C17000	C17200	C17300
Beryllium	1.60–1.85	1.80–2.00	1.80–2.00
Nickel + cobalt, min	0.20	0.20	0.20
Nickel + cobalt + iron, max	0.6	0.6	0.6
Aluminum, max	0.20	0.20	0.20
Silicon, max	0.20	0.20	0.20
Lead	...	...	0.20–0.6
Copper	remainder	remainder	remainder

6.2.1 The product shall be produced with a combination hot working, cold working, and thermal processing to produce a uniform wrought structure and the specified temper.

7. Chemical Composition

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

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

7.3 Copper is customarily given as remainder, but may be taken as the difference between the sum of all elements analyzed and 100 %.

7.4 When all the elements in Table 1 are determined, the sum of results shall be 99.5 % min.

8. Temper

8.1 The standard temper designations available under this specification and as specified in Practice B601 are solution heat-treated TB00 (A), and cold-drawn hard TD04 (H), (see Table 2) to be precipitation heat treated by the user. Also available are products already precipitation heat treated by the manufacturer, tempers TF00 (AT) and TH04 (HT). These products meet property requirements in Table 3 and normally require no further heat treatment by the user.

9. Precipitation Heat Treatment

9.1 The precipitation heat treatment is performed on TB00 (A) and TD04 (H) tempers by the purchaser, after machining or forming.

TABLE 2 Solution Heat-Treated and Solution Heat-Treated and Cold-Worked Mechanical Property Requirements

Temper Designation		Diameter or Maximum Distance Between Parallel Surfaces		Tensile Strength, ksi	Tensile Strength, MPa	Yield Strength, min 0.2 % offset, ksi	MPa	Rockwell Hardness, B Scale	Elongation in 4 × D[A], min, %
Standard	Former	in.	mm						
TB00	Solution heat treated (A)	all sizes	all sizes	60–85	410–590	20	140	45–85	20
TD04	Hard (H)	up to ⅜, incl.	up to 10	90–130	620–900	75	520	88–103	8
		over ⅜ to 1 incl.	over 10 to 25 incl.	90–125	620–860	75	520	88–102	8
		over 1 to 3, incl.	over 25 to 75	85–120	590–830	75	520	88–101	8

[A] 4 × *D* = 4 × diameter.

TABLE 3 Precipitation Heat-Treated Mechanical Property Requirements[A]

Temper Designation		Diameter or Maximum Distance Between Parallel Surfaces		Copper Alloy UNS No.									Elongation in 4 × D[B], min, %
				C17000					C17200 and C17300				
Standard	Former	in.	mm	Tensile Strength, ksi	Tensile Strength MPa	Yield Strength, min, 0.2 % offset, ksi	MPa	Rockwell Hardness, C Scale	Tensile Strength, ksi	MPa	Yield Strength, min, 0.2 % offset, ksi	MPa	Rockwell Hardness, C Scale	
TF00	Solution heat treated (AT)	up to 3, incl.	up to 76.2	150–190[C]	1030–1310[C]	125	860	32–39	165–200[C]	1140–1380[C]	145	1000	36–42	4
		over 3	over 76.2	150–190[C]	1030–1310[C]	125	860	32–39	165–200[C]	1140–1380[C]	130	900	36–42	3
TH04	Hard (HT)	up to ⅜, incl.	up to 10†	170–210[C]	1210–1450[C]	145	1000	35–41	185–225[C]	1280–1550[C]	160	1100	39–45	2
		over ⅜ to 1, incl.	over 10† to 25.4, incl.	170–210[C]	1170–1450[C]	145	1000	35–41	180–220[C]	1240–1520[C]	155	1070	38–44	2
		over 1 to 3, incl.	over 25.4 to 76.2, incl.	165–200[C]	1140–1380[C]	135	930	34–39	175–215[C]	1210–1480[C]	145	1000	37–44	4

† Editorially corrected.

[A] These values apply to standard qualification heat treatment, see 8.1.
[B] 4 × *D* = 4 × diameter.
[C] The upper limits in the tensile strength column are for design guidance only.

9.2 Conformance to the TF00 (AT) and TH04 (HT) specification limits shown in Table 3, for products supplied in the TB00 (A) or the TD04 (H) tempers, shall be determined by testing test specimens heat treated at a uniform temperature of 600 to 675°F (316 to 357°C) for the times shown in Table 4.

9.3 End products may be heat treated at other times and temperatures for specific applications. These special combinations of properties such as increased ductility, electrical conductivity, dimensional accuracy, endurance life, and resistance to elastic drift and hysteresis in springs, may be obtained by special precipitation-hardening heat treatments. The mechanical requirements of Table 3 do not apply to such special heat treatments. Specific test requirements as needed shall be agreed upon between the manufacturer or supplier and purchaser of the end product.

9.4 TF00 (AT) and TH04 (HT) tempers as standard mill-hardened products have been precipitation heat treated and tested by the manufacturer for conformance to the specification limits shown in Table 3. Further thermal treatments of these tempers are not normally required.

10. Mechanical Property Requirements

10.1 *Tensile Test Requirements:*

10.1.1 The tension test, in accordance with Test Methods E8 or E8M, shall be the standard test for rod (round, hexagonal, and octagonal) and bar (square) having a nominal diameter or distance between parallel surfaces up to ⅜ in. [10 mm] incl, and other shapes having a nominal cross-sectional area up to 0.141 in.^{2} [100 mm^2], incl. The tensile strength requirements shall be prescribed in Table 2 and Table 3 after precipitation heat treatment in accordance with 8.1.

10.2 *Rockwell Hardness Requirements:*

10.2.1 Hardness shall be the standard test for round, hexagonal, octagonal, and square rod larger than ⅜ in. [10 mm] nominal diameter or distance between parallel surfaces and other shapes having a nominal cross-sectional area exceeding 0.141 in.^{2} [3.6 mm]. The hardness requirements shall be as prescribed in Table 2 for solution heat treated or solution heat treated and cold worked and in Table 4 after prescribed heat treatment. The tension test should not be made except when indicated by the purchaser.

10.2.2 Where agreement on Rockwell hardness tests cannot be reached, the tensile strength requirements of Tables 2 and 3 shall be the basis for acceptance or rejection.

11. Purchases for U. S. Government

11.1 When specified in the contract or purchase order, product purchased for an agency of the U. S. government shall conform to the special government requirements specified in the Supplementary Requirements section of Specification B249/B249M.

12. Dimensions and Permissible Variations

12.1 The dimensions and tolerances for material covered by this specification shall be as prescribed in the current edition of Specification B249/B249M:

12.2 *Diameter or Distance Between Parallel Surfaces:*
12.2.1 *Rod, Round, Hexagonal, Octagonal*
12.2.2 *Rod, Hot-Rolled, Round*
12.2.3 *Rod, As-Extruded*
12.2.4 *Bar, Rectangular and Square*
12.2.5 *Bar, As-Extruded*

12.3 *Length*

12.4 *Straightness*

12.5 *Edge Contours*

13. Workmanship, Finish, and Appearance

13.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

14. Sampling

14.1 Sampling shall be in accordance with Specification B249/B249M, except that the heat size is defined as 12 000 lbs (5455 kg) or fraction thereof.

14.2 Sample pieces shall be taken from a heat and lot of material processed simultaneously in the same equipment, as follows:

15. Number of Tests and Retests

15.1 Section 9 of Specification B249/B249M constitutes a part of this specification.

15.2 Test specimens shall be taken from the sample pieces selected in accordance with 14.1.

15.2.1 In the case of product shipped in the TB00 or TD04 condition, two test specimens shall be taken from each sample piece. One is to be tested in the as-sampled condition, and one in the precipitation heat-treated condition.

15.2.2 In the case of product shipped in the precipitation heat-treated condition, one specimen from each sample shall be tested.

15.3 *Retests*—If any lot of material fails to conform to the requirements of this specification as a result of inaccurate heat

TABLE 4 Standard Precipitation Heat Treatment Time for Acceptance Tests

Temper Designation		Diameter or Distance Between Parallel Surfaces, in.		Time at 600 to 675°F, h
Standard	Former	in.	mm	
TB00	Solution heat treated (A)	all sizes	all sizes	3
TD04	Hard (H)	up to ¾, incl.	up to 19.1, incl.	2
		over ¾	over 19.1	3

treatment, new samples of material may be resubmitted for test after proper heat treatment. Only two such reheat treatments shall be permitted.

16. Specimen Preparation

16.1 Section 10 of Specification B249/B249M constitutes a part of this specification.

16.2 *Test Specimens*—Tension test specimens, when required, shall be prepared in a full cross-sectional area if practicable and in the direction of final working unless otherwise specified. Full cross section or machined specimens shall be as specified in Test Methods E8 or E8M.

NOTE 1—Mechanical property data determined on other than round cross sections, for sizes under 0.125 in., may be compromised and be inaccurate as a result of the stress riser effect on the corner.

17. Test Methods

17.1 Section 11 of Specification B249/B249M constitutes a part of this specification.

17.2 *Chemical Analysis*—The Chemical Composition section is amended to include in the group of chemical analysis techniques, Specification B194 Annex.

17.3 Test methods to be followed for the determination of element(s) resulting from contractural or purchase order agreement shall be agreed upon between the supplier and the purchaser.

18. Keywords

18.1 beryllium copper bar; beryllium copper rod; copper beryllium bar; copper beryllium rod; UNS Alloy No. C17000; UNS Alloy No. C17200; UNS Alloy No. C17300

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B196/B196M – 03) that may impact the use of this standard. (Approved April 1, 2007.)

(1) Corrected the metric values in Section 10, Table 2, and Table 3 and changed the chemistry in Table 1 to correspond to the CDA chemistry.
(2) In 4.2.1 the definition for *grain count* was eliminated as it does not appear in the standard.
(3) Definitions for *Heat* and *Lot* in Section 14 were moved to Section 4, but no change was made to definitions.
(4) Section 18 was a redundant portion of Section 3 and was removed. The following section was renumbered.
(5) In Table 2 there was an overlap in the metric equivalent values 10 to 26 (incl.) and over 25 to 75 mm. This was corrected to the proper 10 – 25 incl. and over 25 to 75.