



Designation: **B441–16 B441 – 22**

Standard Specification for ~~Copper-Cobalt-Beryllium, Copper-Nickel-Beryllium, and Copper-Nickel-Lead-Beryllium~~ Copper-Cobalt-Beryllium Alloy, Copper-Nickel-Beryllium Alloy, Copper-Nickel-Lead- Beryllium Alloy, and Copper-Nickel-Cobalt Alloy Rod and Bar (UNS Nos. C17500, C17510, and C17465)¹

This standard is issued under the fixed designation B441; 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-cobalt-beryllium alloy (UNS No. C17500), copper-nickel-beryllium alloy (UNS No. C17510), and copper-nickel-lead-beryllium alloy (UNS No. C17465)~~ Copper Alloy UNS Nos. C17500, C17510, C17540, and C17465 rod and bar in straight lengths.

1.2 *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, which are provided for information only and are not considered standard.

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

1.3.1 *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.*

1.4 *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:²

[B193 Test Method for Resistivity of Electrical Conductor Materials](#)

[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](#)

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

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

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.

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

E18 Test Methods for Rockwell Hardness of Metallic Materials

E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy Current) Method

3. General Requirements

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

3.1.1 ~~Terminology~~, Terminology

3.1.2 Materials and ~~Manufacture~~, Manufacture

3.1.3 Dimensions and Permissible ~~Variations~~, Variations

3.1.4 Workmanship, Finish, and ~~Appearance~~, Appearance

3.1.5 ~~Sampling~~, Sampling

3.1.6 Number of Tests and ~~Retests~~, Retests

3.1.7 Specimen ~~Preparation~~, Preparation

3.1.8 Test ~~Methods~~, Methods

3.1.9 Significance of Numerical ~~Limits~~, Limits

3.1.10 ~~Inspection~~, Inspection

3.1.11 Rejection and ~~Rehearing~~, Rehearing

3.1.12 ~~Certification~~, Certification

3.1.13 Test ~~Report~~, Report

3.1.14 Packaging and Package ~~Marking~~, and Marking

3.1.15 Supplementary ~~Requirements~~, Requirements

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 **B249/B249M**.

4. Terminology

4.1 For definition 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~~]Alloy UNS No. designation,

5.1.3 Temper (Section 7),

5.1.4 Form of product (cross section such as round, hexagonal, octagonal, rectangular, or square),

5.1.5 Dimensions (diameter or distance between parallel surfaces),

5.1.6 Edge contours,

5.1.7 Length,

5.1.8 Quantity—total weight, or total length, or number of pieces for each form, temper, size, and copper alloy,

5.1.9 Intended application.

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 Heat identification or traceability details (~~Specification details~~, [B249/B249M](#)),

5.2.2 Tensile strength test (9.1),

5.2.3 Certification (~~Specification Certification~~, [B249/B249M](#)),

5.2.4 Mill Test Report (~~Specification Report~~, [B249/B249M](#)),

5.2.5 When product is purchased for agencies of the U.S. ~~government~~, see the Supplementary Requirements section of [B249/B249M](#) 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~~ alloy UNS No. designation specified in the ordering information.

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

6.1.2 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.

TABLE 1 Chemical Composition

Element	Concentration, %		
	Copper Alloy UNS No. C17500	Copper Alloy UNS No. C17510	Copper Alloy UNS No. C17465
Beryllium	0.4–0.7	0.2–0.6	0.15–0.50
Cobalt	2.4–2.7	0.3 max	...
Nickel	...	1.4–2.2	1.0–1.4 ^A
Iron, max	0.10	0.10	0.20
Aluminum, max	0.20	0.20	0.20
Silicon, max	0.20	0.20	0.20
Tin, max	...	...	0.25
Zirconium, max	...	...	0.50
Lead	...	...	0.20–0.6
Copper	remainder	remainder	remainder

TABLE 1 Chemical Requirements

Element	Composition, % Copper Alloy UNS No.			
	C17500	C17510	C17540	C17465
Beryllium	0.4–0.7	0.2–0.6	0.4–0.7	0.15–0.50
Cobalt	2.4–2.7	0.3 max	0.8–1.3	...
Nickel	...	1.4–2.2	0.8–1.3	1.0–1.4 ^A
Iron, max	0.10	0.10	0.2	0.20
Aluminum, max	0.20	0.20	...	0.20
Silicon, max	0.20	0.20	0.2	0.20
Tin, max	...	...	...	0.25
Zirconium, max	...	...	...	0.50
Lead	...	...	...	0.20–0.6
Copper	remainder	remainder	remainder	remainder

^A Incl. Co.

TABLE 4 Precipitation Heat-Treatment Time for Acceptance Tests

Temper Designation		Copper Alloy UNS No. C17500 at 900 °F (482 °C), h	Copper Alloy UNS Nos. C17510, C17540, and C17465
Standard	Former		at 850 °F (454 °C) ^A or 900 °F (482 °C), ^A h
TB00	Solution Heat-Treated (A)	3	3
TD04	Solution Heat-Treated and Cold-Worked: Hard (H)	2	2

^A Specific temperature used must conform with supplier's certification.

6.2 For the alloys in which copper is listed as the “remainder,” copper is the difference between the sum of results for of all elements determined and 100 %. When all elements specified in **Table 1** 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 given in **Table 2**, **Table 3**, and **Table 43**.

7.1.1 TB00 (solution heat treated (A));

7.1.2 TF00 (precipitation hardened (AT));

7.1.3 TD04 (solution heat treated and cold worked: hard (H));

7.1.4 TH04 (hard and precipitation heat treated (HT)).

Note 1—Although not produced under this specification, non-standard tempers are available by special order and the properties of such product are subject to negotiation between the manufacturer and the purchaser.

8. Physical Property Requirements

8.1 ~~Electrical Conductivity: Conductivity Requirement:~~

8.1.1 Electrical conductivity shall be the product accept/reject criterion when tested in accordance with Test Method **E1004** for product equal to or larger than $\frac{3}{8}$ in. (9.5 mm) in nominal diameter or distance between parallel surfaces and other shapes having a nominal cross-sectional area equal to or exceeding 0.141 in.² (91 mm²).

8.1.2 The electrical conductivity requirements are given in **Table 2** and **Table 3**.

8.1.3 ~~The product furnished shall conform to the electrical conductivity requirement prescribed in~~ Electrical resistivity shall be the product acceptance criterion **Table 2** and **Table 4** for the applicable temper, when tested in accordance with Test Method **E1004B193** for product equal to and greater smaller than $\frac{3}{8}$ in. in. (9.5 mm) in nominal diameter or distance between parallel

TABLE 2 Tensile Strength and Rockwell Hardness Mechanical and Physical Property Requirements for Rod and Bar (C17500, C17510, and C17540)^A

Temper Designation		As Supplied		
Standard Code	Former Name	Tensile Strength, ksi ^B (MPa ^C)	Rockwell Hardness, B Scale	Electrical Conductivity IACS min, %
TB00	solution heat treated (A)	35–55 (240–380)	50 max	20
TB00	Solution Heat-Treated (A)	35–55 (240–380)	50 max	20
TD04	solution heat treated and cold worked: hard (H)	65–80 (450–550)	60–80	20
TD04	Solution Heat-Treated and Cold-Worked: Hard (H)	65–80 (450–550)	60–80	20
After Precipitation Heat Treatment				
TF00	precipitation hardened (AT)	100–130 (690–905)^D	92–100	45
TF00	Precipitation Hardened (AT)	100–130 (690–900) ^D	92–100	45
TH04	hard and precipitation heat treated (HT)	110–140 (760–965)^D	95–102	48
TH04	Hard and Precipitation Heat-Treated (HT)	110–140 (760–970) ^D	95–102	48

^A These values apply to mill products. See Section **810** for exceptions in end products.

^B ksi = 1000 psi.

^C See Appendix.

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