Designation: B411/B411M – 14

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

This standard is issued under the fixed designation B411/B411M; 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-nickel-silicon alloy rod and bar produced from Copper Alloy UNS No. C64700 in straight lengths.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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 non-conformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

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

B950 Guide for Editorial Procedures and Form of Product Specifications 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E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[3]

E478 Test Methods for Chemical Analysis of Copper Alloys

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 Workmanship, Finish, and Appearance,
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 Significance of Numerical Limits,
3.1.8 Inspection,
3.1.9 Rejection and Rehearing,
3.1.10 Certification,
3.1.11 Mill Test Report,
3.1.12 Packaging and Package Marking, and
3.1.13 Supplementary Requirements.

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 B249/B249M.

4. Terminology

4.1 For the 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 (for example, B411/B411M – 06),
5.1.2 Copper alloy UNS No. designation,
5.1.3 Temper,
5.1.4 Product form (cross section such as round, hexagonal, square, and so forth),
5.1.5 Dimensions (diameter or distance between parallel surfaces, width, thickness),
5.1.6 Edge contours,
5.1.7 Length, nominal, and
5.1.8 Quantity; total weight, length, or number of pieces for each form and size.

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

5.2.1 Certification (Specification B249/B249M),
5.2.2 Mill test report (Specification B249/B249M), and

[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**

5.2.3 When product is purchased for agencies of the U.S. government.

6. Materials and Manufacture

6.1 *Material*—The material of manufacture shall be cast billets or ingots of Copper Alloy UNS No. C64700 of such soundness and structure that they are suitable for processing into the products prescribed herein.

6.2 *Manufacture*—The product shall be manufactured by hot extrusion or rolling and finished by such cold working, annealing, cooling, straightening, and heat treatment as may be necessary to achieve the required properties.

7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements specified in Table 1.

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

7.2 Copper, given as the remainder, is the difference between the sum of results of all elements determined and 100 %.

7.3 When all elements specified in Table 1 are determined, the sum of results shall be 99.5 % minimum.

8. Temper

8.1 The standard temper for product described in this specification is given in Table 2.

8.2 Tempers are as defined in Classification B601.

8.3 Other tempers available when specified are:

8.3.1 TB00 (solution heat-treated).

8.3.2 TD00 (solution heat-treated and cold-worked ⅛ hard).

8.3.3 TD01 (solution heat-treated and cold-worked ¼ hard).

8.3.4 TD02 (solution heat-treated and cold-worked ½ hard).

8.3.5 TD03 (solution heat-treated and cold-worked ¾ hard).

8.3.6 TD04 (solution heat-treated and cold-worked hard).

9. Physical Property Requirements

9.1 *Electrical Resistivity Requirement*—The precipitation heat-treated product furnished shall conform to the electrical mass resistivity of 0.348 36 to 0.589 54 $\Omega \cdot g/m^2$ or conductivity of 44.0 to 26.0 % IACS at 68°F [20°C] when tested in accordance with Test Method B193.

10. Mechanical Property Requirements

10.1 *Tensile Strength Requirements:*

TABLE 1 Chemical Requirements

Element	Composition, %
Nickel, incl cobalt	1.6–2.2
Silicon	0.40–0.8
Lead, max	0.09
Iron, max	0.10
Zinc, max	0.50
Copper, incl silver	remainder

10.1.1 Product furnished in the precipitation-hardened TF00 temper, as normally supplied, shall conform to the tensile requirements prescribed in Table 2, when tested in accordance with Test Methods E8/E8M.

10.1.2 Product furnished in TB00 (solution heat-treated) temper or TD00 through TD02 (solution heat-treated and cold-worked) inclusive, shall be capable of meeting the requirements specified in Table 2 for each size and form after being given a suitable precipitation heat treatment and when tested in accordance with Test Methods E8/E8M.

NOTE 1—The purchaser should consult with the manufacturer for recommended precipitation heat treatment procedures.

10.1.3 The tensile requirements for as supplied rod and bar in sizes and tempers other than the standard, shall be as agreed between the supplier or manufacturer and the purchaser.

11. Performance Requirements

11.1 *Heat Treatment*—For purchaser's product acceptance only, the information shown in Table 3 shall be considered suitable for precipitation heat treatment.

12. Other Requirements

12.1 *Purchases for the U.S. Government*—Product purchased for agencies of the U.S. government shall conform to the additional requirements prescribed in the Supplementary Requirements section of Specification B249/B249M.

13. Dimensions and Permissible Variations

13.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification B249/B249M with particular reference to the following tables and related paragraphs:

13.1.1 *Diameter or Distance Between Parallel Surfaces:*

13.1.1.1 *Rod: Round, Hexagonal, Octagonal*—Refer to Table 2, Tolerances for Diameter of Cold-Drawn Rod.

13.1.1.2 *Bar: Rectangular and Square*—Refer to Table 9, Thickness Tolerances for Rectangular and Square Bar for thickness and Table 11, Width Tolerances for Rectangular Bar for width.

13.1.2 *Length*—Refer to Table 13, Length Tolerances for Rod, Bar, and Shapes for length tolerance and Table 15, Schedule of Lengths for schedule of lengths with ends.

13.1.3 *Straightness*—Refer to Table 16, Straightness Tolerances for Rod, Bar, and Shapes.

13.1.4 *Edge Contours*—Refer to the section entitled, "Edge Contours" and Fig. 1, Fig. 2, and Fig. 3.

14. Test Methods

14.1 *Chemical Analysis:*

14.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between manufacturer or supplier and the purchaser.

14.1.2 The following table is a list of published test methods, some of which are considered by ASTM as no longer viable. These and others not listed may be used subject to agreement.

TABLE 2 Required Tensile Properties for Product in the TF00 (Precipitation-Hardened (AT)) Temper

Form	Diameter or Distance Between Parallel Surfaces,[A]		Tensile Strength, min		Yield Strength at 0.5 % Extension Under Load, min		Elongation,[B] in 4*D*, min, %
	in.	mm	ksi	MPa	ksi	MPa	
Rod:							
Round	3⁄32 to 1½, incl	2.4 to 38, incl	90	620	75	515	8
	Over 1½ to 2, incl	Over 38 to 50, incl	80	550	70	485	8
Hexagonal and	⅛ to 1½, incl	3 to 38, incl	90	620	75	515	8
Octagonal	Over 1½ to 2, incl	Over 38 to 50, incl	80	550	70	485	8
Bar:							
Square	Over 0.188 to 1, incl	5 to 25, incl	90	620	75	515	8
	Over 1 to 1½, incl	Over 25 to 38, incl	80	550	70	485	8
Rectangular	Over 0.188 to 1½ thick and up to 2½ wide, incl	Over 5 to 38 thick and up to 65 wide, incl	80	550	70	485	8

[A] For rectangular bar the thickness dimension applies.
[B] Elongation in 4× diameter or thickness, but in any case, a minimum gage length of 1 in. [25 mm] shall be used.

TABLE 3 Precipitation-Hardening Heat Treatment

Forms	Diameter or Distance Between Parallel Surfaces,[A]		Temperature		Time at Temperature, min
	in.	mm	°F	°C	
All	Under 0.050	Under 1.3	800	427	90
	0.050 to 1.000, incl	1.3 to 25, incl	850	454	90
	Over 1.000	Over 25	850	454	120

[A] For rectangular bar, the thickness dimension applies.

Element	ASTM Test Method
Copper	E478
Iron	E478
Lead	E478 (AA)
Nickel	E478 (photometric)
Silicon	E54 (perchloric acid)
Zinc	E478 (AA)

15. Keywords

15.1 copper-nickel-silicon alloy bar; copper-nickel-silicon alloy rod; UNS C64700 bar; UNS C64700 rod

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B411/B411M – 08) that may impact the use of this standard. (Approved April 1, 2014.)

(1) Minor editing to conform to editorial Guide B950.