Designation: B 411/B 411M – 01

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

This standard is issued under the fixed designation B 411/B 411M; 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 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 inch-pound or in SI units are to be regarded as 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 standard.

2. Referenced Documents

2.1 *ASTM Standards:*

B 193 Test Method for Resistivity of Electrical Conductor Materials[2]

B 249/B 249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings[3]

B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast[3]

B 846 Terminology for Copper and Copper Alloys[3]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 8M Test Methods for Tension Testing of Metallic Materials (Metric)[4]

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes[5]

E 478 Test Methods for Chemical Analysis of Copper Alloys[6]

3. General Requirements

3.1 The following sections of Specification B 249/B 249M 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 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 B 249/B 249M.

4. Terminology

4.1 For the definition of terms related to copper and copper alloys, refer to Terminology B 846.

4.2 *Definitions of Terms Specific to This Standard:*

4.2.1 *capable of, adj*—possessing the required properties or characteristics, or both, necessary to conform to the specification requirement(s) when subjected to specific test(s).

5. Ordering Information

5.1 Orders for product to this specification shall include the following information:

5.1.1 ASTM designation and year of issue (for example, B 411/B 411M – 01),

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,

5.1.8 Quantity; total weight, length, or number of pieces for each form and size, and

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

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

[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] *Annual Book of ASTM Standards*, Vol 02.03.

[3] *Annual Book of ASTM Standards*, Vol 02.01.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] *Annual Book of ASTM Standards*, Vol 03.06.

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

5.2.1 Certification (Specification B 249/B 249M), and
5.2.2 Mill test report (Specification B 249/B 249M).

6. Material and Manufacture

6.1 *Material*:

6.1.1 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 desired product.

6.2 *Manufacture*:

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

7. Chemical Composition

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

7.1.1 These specification limits do not preclude the presence of unnamed elements. When required, limits shall be established and analysis required for the unnamed elements by agreement between the manufacturer and the purchaser.

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

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

8. Temper

8.1 Tempers are as defined in Classification B 601.

8.2 The standard temper for products under this specification is TF00, precipitation hardened (AT).

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*:

9.1.1 The electrical resistivity of precipitation heat-treated product shall be 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 B 193.

10. Mechanical Property Requirements

10.1 *Tensile Requirements*:

10.1.1 Product furnished in the precipitation-hardened TF00 temper, as normally supplied, shall conform to the requirements specified in Table 2 for each form and size when tested in accordance with Test Methods E 8 or E 8M.

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 E 8 or E 8M.

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.

TABLE 1 Chemical Requirements

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

11. Performance Requirements

11.1 *Heat Treatment*:

11.1.1 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*:

12.1.1 Product purchased for agencies of the U.S. government shall conform to the additional requirements prescribed in the Supplemental Requirements section of Specification B 249/B 249M.

13. Dimensions and Permissible Variations

13.1 The dimensions and tolerances for product under this specification shall be as specified in the following Tables and related paragraphs in Specification B 249/B 249M:

13.1.1 *Diameter or Distance Between Parallel Surfaces*:

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

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

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

13.1.3 *Straightness*—Refer to Table, 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 The product composition shall be determined, in case of disagreement, as follows:

Element	ASTM Test Method
Copper	E 478
Iron	E 478
Lead	E 478 (AA)
Nickel	E 478 (photometric)
Silicon	E 54 (perchloric acid)
Zinc	E 478 (AA)

TABLE 2 Required Mechanical Properties for Material in the TF00 (Precipitation-Hardened (AT)) Condition

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 [5], 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.

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 specification since the last issue (B 411-96) that may impact the use of this standard.

(1) Revised as a combined inch-pound/SI document.
(2) Corrected straightness tolerance reference table.
(3) Added Nickel test method.
(4) Corrected Table 1 to conform to UNS requirements.
(5) Corrected metric dimension error in Table 3.