Designation: B139/B139M – 12 (Reapproved 2017)

# Standard Specification for Phosphor Bronze Rod, Bar, and Shapes[1]

This standard is issued under the fixed designation B139/B139M; 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 phosphor bronze rod, bar, and shapes.

1.2 *Units*—Values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, 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.

1.3 *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]

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

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E478 Test Methods for Chemical Analysis of Copper Alloys

## 3. Terminology

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

## 4. General Requirements

4.1 The following sections of Specification B249/B249M constitute a part of this specification.

4.1.1 Terminology.
4.1.2 Materials and Manufacture.
4.1.3 Workmanship, Finish and Appearance.
4.1.4 Sampling.
4.1.5 Number of Tests and Retests.
4.1.6 Specimen Preparation.
4.1.7 Test Methods.
4.1.8 Significance of Numerical Limits.
4.1.9 Inspection.
4.1.10 Rejection and Rehearing.
4.1.11 Certification.
4.1.12 Mill Test Report.
4.1.13 Packaging and Package Marking.

4.2 In addition, when a section with a title identical to that referenced in 4.1 above appears in this specification, it contains additional information which supplements that appearing in Specification B249/B249M. In case of conflict, this specification shall prevail.

## 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 (for example, C51000),
5.1.3 Temper (for example, H04),
5.1.4 Form of product (rod, bar or shape),
5.1.5 Dimensions and permissible variations,
5.1.6 Edge Contours,
5.1.7 Quantity—total weight of each copper alloy, temper, form, and size,
5.1.8 Intended application.

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

5.2.1 Piston-finish rod or shafting (Other Requirements section),

5.2.2 Certification (Specification B249/B249M), and

5.2.3 Mill test report (Specification B249/B249M).

5.2.4 If product is purchased for agencies of the U.S. Government (see Supplementary Requirements section of Specification B249/B249M).

## 6. Material and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be cast rod, bar, or billets of Copper Alloy UNS Nos. C51000, C52100, C52400, C53400, or C54400 and of such soundness as to be suitable for processing in to the products prescribed herein.

NOTE 1—Copper Alloy UNS Nos. C51000, C52100, and C52400 are suitable for structural applications, pump parts, rods, bolts, gears, and similar applications.

NOTE 2—Copper Alloys UNS Nos. C53400 and C54400 are free machining and are suitable for screw-machine products.

6.2 *Manufacture:*

6.2.1 The product shall be manufactured by such hot-working, cold-working, and annealing processes as to produce a uniform wrought structure in the finished product.

6.2.2 The product shall be hot or cold worked to the finished size and subsequently annealed, when required, to meet the temper properties specified.

## 7. Chemical Composition

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

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 unnamed elements.

7.2 For alloys in which copper is listed as "remainder," copper is the difference between the sum of all elements determined and 100 %.

7.3 When all elements specified in Table 1, for the Copper Alloy UNS No. named in the ordering information are determined, the sum of results shall be 99.5 % min.

## 8. Temper

8.1 *Rod and Bar*—The standard tempers, as defined in Classification B601 for rod and bar produced under this specification are identified in Table 2 or Table 3.

8.1.1 Soft anneal temper (O60),

8.1.2 Hard temper (H04), and

8.1.3 Spring temper (H08).

8.2 *Shapes*—The temper for shapes is subject to agreement between the manufacturer and the purchaser and the agreement shall be a part of the contract or purchase order.

## 9. Mechanical Property Requirements

9.1 *Tensile Strength Requirements:*

9.1.1 *Rod and Bar*—Rod and bar furnished under this specification shall conform to the tensile requirements prescribed in Table 2 or Table 3 for the specified Copper Alloy UNS No. designation, temper, cross-section, and size when tested in accordance with Test Methods E8/E8M.

9.1.2 *Shapes*—The tensile requirements for shapes shall be subject to agreement between the manufacturer and the purchaser and the agreement shall be a part of the contract or purchase order.

## 10. Other Requirements

10.1 *Piston-Finish Rod or Shafting*—When specified in the contract or purchase order, round rod over ½-in. [12–mm] diameter shall be furnished as piston-finish rod or shafting.

10.2 *Purchases for U.S. Government*—When specified in the contract or purchase order, 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.

## 11. Dimensions, Mass, and Permissible Variations

11.1 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 in that specification:

11.1.1 *Diameter or Distance Between Parallel Surfaces:*

11.1.1.1 *Rod: Round, Hexagonal, Octagonal*—Table 2.

11.1.1.2 *Piston-Finish Rod*—Table 3.

11.1.1.3 *Bar: Rectangular and Square*—Tables 9 and 11.

11.1.2 *Shapes:*

11.1.2.1 The dimensional tolerances for shapes shall be subject to agreement between the manufacturer and the purchaser and the agreement shall be a part of the contract or purchase order.

11.1.3 *Length:*

11.1.3.1 *Rod, Bar, and Shapes*—Tables 13 and 15.

11.1.4 *Straightness:*

11.1.4.1 *Rod and Bar*—Table 16.

11.1.4.2 *Shafting Rod*—Table 17.

**TABLE 1 Chemical Requirements**

| Element, % | Copper Alloy UNS No. | | | | |
|---|---|---|---|---|---|
| | C51000 | C52100 | C52400 | C53400 | C54400 |
| Tin | 4.2–5.8 | 7.0–9.0 | 9.0–11.0 | 3.5–5.8 | 3.5–4.5 |
| Phosphorus | 0.03–0.35 | 0.03–0.35 | 0.03–0.35 | 0.03–0.35 | 0.01–0.50 |
| Iron, max | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Lead | 0.05 max | 0.05 max | 0.05 max | 0.8–1.2 | 3.0–4.0 |
| Zinc | 0.30 max | 0.20 max | 0.20 max | 0.30 max | 1.5–4.5 |
| Copper | remainder | remainder | remainder | remainder | remainder |

**TABLE 2 Tensile Requirements for Rod and Bar, Inch-Pound**

NOTE 1—For SI values, see Table 3.

| Temper Designation | | Diameter or Distance Between Parallel Surfaces,[A] in. | Tensile Strength, ksi | | Elongation in 4× Diameter or Thickness of Specimen, min, %[B] |
|---|---|---|---|---|---|
| Code | Name | | min | max | |
| | | Copper Alloy UNS No. C51000 | | | |
| O60 | soft anneal | rod: round under ¼ | 40 | 58 | ... |
| H04 | hard | rod: round under ¼ | 80 | 128 | ... |
| | | round and hexagonal: | | | |
| | | ¼ to ½, incl | 70 | ... | 13 |
| | | over ½ to 1, incl | 60 | ... | 15 |
| | | over 1 | 55 | ... | 18 |
| | | bar: square and rectangular: | | | |
| | | ¼ to ⅜, incl | 60 | ... | 10 |
| | | over ⅜ | 55 | ... | 15 |
| H08 | spring | rod: round: | | | |
| | | 0.026 to 1/16, incl | 115 | ... | ... |
| | | over 1/16 to ⅛, incl | 110 | ... | ... |
| | | over ⅛ to ¼, incl | 105 | ... | 3.5 |
| | | over ¼ to ⅜, incl | 100 | ... | 5.0 |
| | | over ⅜ to ½, incl | 90 | ... | 9.0 |
| | | Copper Alloy UNS No. C52100 | | | |
| O60 | soft anneal | rod: round under ¼ | 53 | 68 | ... |
| H04 | hard | rod: round under ¼ | 105 | 150 | ... |
| | | round and hexagonal: | | | |
| | | ¼ to ½, incl | 85 | ... | 12 |
| | | over ½ to 1, incl | 75 | ... | 15 |
| | | over 1 | 60 | ... | 20 |
| | | bar: square and rectangular: | | | |
| | | ¼ to ⅜, incl | 68 | ... | 10 |
| | | over ⅜ | 60 | ... | 15 |
| | | Copper Alloy UNS No. C52400 | | | |
| O60 | soft anneal | rod: round under ¼ | 60 | 75 | ... |
| H04 | hard | rod: round under ¼ | 105 | 160 | ... |
| | | round and hexagonal: | | | |
| | | ¼ to ½, incl | 95 | ... | 10 |
| | | over ½ to 1, incl | 85 | ... | 12 |
| | | over 1 | 70 | ... | 15 |
| | | bar: square and rectangular: | | | |
| | | ¼ to ⅜, incl | 76 | ... | 10 |
| | | over ⅜ | 70 | ... | 15 |
| | | Copper Alloy UNS Nos. C53400 and C54400 | | | |
| H04 | hard | rod: round and hexagonal: | | | |
| | | 1/16 to ¼, incl | 65 | ... | 8 |
| | | over ¼ to ½, incl | 60 | ... | 10 |
| | | over ½ to 1, incl | 55 | ... | 12 |
| | | over 1 | 50 | ... | 15 |
| | | bar: square and rectangular: | | | |
| | | ¼ to ⅜, incl | 55 | ... | 10 |
| | | over ⅜ | 50 | ... | 15 |

[A] For rectangular bar, the Distance Between Parallel Surfaces refers to thickness.
[B] In any case, a minimum gage length of 1 in. shall be used.

11.1.4.3 *Piston-Finish Rod*—The tolerance is subject to agreement between the manufacturer and the purchaser and the agreement shall be a part of the contract or purchase order.

11.1.5 *Edge Contours:*

11.1.5.1 For a description of edge contours, refer to the section titled "Edge Contours" and Figs. 1, 2, and 3 in Specification B249/B249M.

## 12. Test Methods

12.1 *Chemical Analysis:*

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

12.1.2 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.

| Element | Test Method |
|---|---|
| Copper | E478 |
| Iron | E478 |
| Lead | E478 (AA) |
| Zinc <2 % | E478 (AA) |
| >2 % | E478 (titrimetric) |
| Tin | E478 (titrimetric) |
| Phosphorus | E62 |

**TABLE 3 Tensile Requirements for Rod and Bar, SI**

NOTE 1—For inch-pound values, see Table 2.

| Temper Designation | | Diameter or Distance Between Parallel Surfaces,[A] mm | Tensile Strength, MPa | | Elongation in 4× Diameter or Thickness of Specimen, min, %[B] |
|---|---|---|---|---|---|
| Code | Name | | min | max | |
| | | Copper Alloy UNS No. C51000 | | | |
| O60 | soft anneal | rod: round under 6 | 275 | 400 | ... |
| H04 | hard | rod: round under 6 | 550 | 880 | ... |
| | | round and hexagonal: | | | |
| | | 6 to 12 incl | 485 | ... | 13 |
| | | 12 to 25 incl | 415 | ... | 15 |
| | | over 25 | 380 | ... | 18 |
| | | bar: square and rectangular: | | | |
| | | 6 to 9 incl | 415 | ... | 10 |
| | | over 9 | 380 | ... | 15 |
| H08 | spring | rod: round: | | | |
| | | 0.065 to 1.6 incl | 790 | ... | ... |
| | | over 1.6 to 3 incl | 760 | ... | ... |
| | | over 3 to 6 incl | 725 | ... | 3.5 |
| | | over 6 to 9 incl | 690 | ... | 5.0 |
| | | over 9 to 12 incl | 620 | ... | 9.0 |
| | | Copper Alloy UNS No. C52100 | | | |
| O60 | soft anneal | rod: round under 6 | 365 | 470 | ... |
| H04 | hard | rod: round under 6 | 720 | 1030 | ... |
| | | round and hexagonal: | | | |
| | | 6 to 12 incl | 585 | ... | 12 |
| | | over 12 to 25 incl | 515 | ... | 15 |
| | | over 25 | 415 | ... | 20 |
| | | bar: square and rectangular: | | | |
| | | 6 to 9 incl | 470 | ... | 10 |
| | | over 9 | 415 | ... | 15 |
| | | Copper Alloy UNS No. C52400 | | | |
| O60 | soft anneal | rod: round under 6 | 415 | 515 | ... |
| H04 | hard | rod: round under 6 | 725 | 1100 | ... |
| | | round and hexagonal: | | | |
| | | 6 to 12 incl | 655 | ... | 10 |
| | | over 12 to 25 incl | 585 | ... | 12 |
| | | over 25 | 480 | ... | 15 |
| | | bar: square and rectangular: | | | |
| | | 6 to 9 incl | 525 | ... | 10 |
| | | over 9 | 480 | ... | 15 |
| | | Copper Alloy UNS Nos. C53400 and C54400 | | | |
| H04 | hard | rod: round and hexagonal: | | | |
| | | 1.6 to 6 incl | 450 | ... | 8 |
| | | over 6 to 12 incl | 415 | ... | 10 |
| | | over 12 to 25 incl | 380 | ... | 12 |
| | | over 25 | 345 | ... | 15 |
| | | bar: square and rectangular: | | | |
| | | 6 to 9 incl | 380 | ... | 10 |
| | | over 9 | 345 | ... | 15 |

[A] For rectangular bar, the Distance Between Parallel Surfaces refers to thickness.
[B] In any case, a minimum gage length of 25 mm shall be used.

12.1.3 Test method(s) to be followed for the determination of element(s) resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

## 13. Keywords

13.1 phosphor bronze bar; phosphor bronze rod; phosphor bronze shapes; piston-finish rod; shafting; shapes; UNS No. C51000; UNS No. C52100; UNS No. C52400; UNS No. C53400; UNS No. C54400

## SUMMARY OF CHANGES

B05 has identified the principal changes to this specification that have been incorporated since the 2007 issue as follows:

*(1)* Minor Editing to conform to Guide B950. No Technical Changes were made to the tables.