Designation: B21/B21M – 18 (Reapproved 2019)

# Standard Specification for Naval Brass Rod, Bar, and Shapes[1]

This standard is issued under the fixed designation B21/B21M; 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 naval brass rod, bar, and shapes produced from Copper Alloy UNS Nos. C46200, C46400, C46750, C47940, C48200, C48500, or C48640.

1.1.1 For piston-finish rod or shafting refer to the Other Requirements Section.

1.1.2 For hot forging material, refer to Specification B124/B124M.

1.2 *Units*—The 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 are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other and values from the two systems shall not be combined.

1.3 **Warning—**Mercury is a definite health hazard in use and disposal (see Performance Requirements).

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

B124/B124M Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes

B154 Test Method for Mercurous Nitrate Test for Copper Alloys

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

B858 Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness 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. General Requirements

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

3.1.1 Terminology;
3.1.2 Materials and Manufacture;
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 Product Marking; and
3.1.14 Supplementary Requirements.

3.2 In addition, when a section with a title identical to that referenced in 3.1, above, appears in this specification, it

[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**

contains additional requirements which supplement those appearing in Specification B249/B249M.

## 4. Ordering Information

4.1 Include the following specified choices when placing orders for product under this specification, as applicable:

4.1.1 ASTM designation and year of issue;

4.1.2 Copper Alloy UNS No. designation (Scope);

4.1.3 Temper (Temper Section and related Tables);

4.1.4 Form—cross-section such as round, hexagonal, square, and so forth;

4.1.5 Diameter or distance between parallel surfaces, width and thickness (Dimensions and Permissible Variations);

4.1.6 Length (Dimensions and Permissible Variations);

4.1.7 Edge contours (Dimensions and Permissible Variations);

4.1.8 Quantity—number of pieces or total weight, for each size and form; and

4.1.9 Intended application.

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

4.2.1 Tensile test for product ½ in. [12 mm] and over, for the alloys and tempers listed in Table 4;

4.2.2 Residual stress test (Performance Requirements section);

4.2.3 Piston finish rod or shafting (Other Requirements section);

4.2.4 Certification (Specification B249/B249M);

4.2.5 Mill test report (Specification B249/B249M);

4.2.6 Heat identification or traceability details (Specification B249/B249M); and

4.2.7 If product is purchased for agencies of the U.S. Government (Other Requirements—Purchases for U.S. Government).

## 5. Chemical Composition

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

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

5.3 For alloys in which zinc is listed as the "remainder," either copper or zinc may be taken as the difference between the sum of the results of all other elements determined and 100 %. When copper is so determined, that difference value shall conform to the requirements given in Table 1.

5.4 When all the elements listed in Table 1 for the Copper Alloy No. are determined, the sum of the results shall be 99.6 % minimum except for C46750 and C48640, which shall be 99.5 % minimum.

## 6. Temper

6.1 The standard tempers for products described in this specification, as defined in Classification B601, are shown in Tables 2 and 3.

## 7. Mechanical Property Requirements

7.1 Product furnished under this specification shall conform to the mechanical property requirements prescribed in Tables 2-4.

7.1.1 *Rockwell Hardness Requirements*—For the alloys and tempers listed, the product ½ in. [12 mm] and over in diameter or distance between parallel surfaces should conform with the requirements prescribed in Table 4, when tested in accordance with Test Methods E18.

7.1.1.1 For the alloys, tempers, and sizes listed in Table 4, Rockwell hardness may be used as the basis of acceptance or rejection for mechanical properties except when the tensile test is specified in the contract or purchase order.

7.1.1.2 Hardness test results outside the ranges of Table 4 shall not be cause for rejection if the tensile property requirements of Tables 2 and 3 are met.

7.1.2 *Tensile Strength Requirements*—The product shall conform with the requirements of Tables 2 and 3, when tested in accordance with Test Methods E8/E8M. Whenever tensile test results are obtained from both full-size and from machined test specimens and they differ, the results obtained from full-size test specimens shall be used to determine conformance to the requirements of this specification.

## 8. Performance Requirements

8.1 *Residual Stress Test:*

8.1.1 When specified in the contract or purchase order, product in drawn tempers shall be tested for residual stress according to the requirements of Test Method B154 or Test Method B858 and show no signs of cracking.



**TABLE 1 Chemical Requirements**

| Element, % | Copper Alloy UNS No. | | | | | | |
|---|---|---|---|---|---|---|---|
| | C46200 | C46400 | C46750 | C47940 | C48200 | C48500 | C48640 |
| Copper | 62.0–65.0 | 59.0–62.0 | 59.2–62.5 | 63.0–66.0 | 59.0–62.0 | 59.0–62.0 | 59.0–62.0 |
| Tin | 0.50–1.0 | 0.50–1.0 | 1.00–1.80 | 1.2–2.0 | 0.50–1.0 | 0.50–1.0 | 0.50–2.0 |
| Lead | 0.20 max | 0.20 max | 0.25 max | 1.0–2.0 | 0.40–1.0 | 1.3–2.2 | 1.0–3.0 |
| Zinc | remainder | remainder | remainder | remainder | remainder | remainder | remainder |
| Iron | 0.10 max | 0.10 max | 0.10 max | 0.10–1.0 | 0.10 max | 0.10 max | 0.40 max |
| Nickel[A] | ... | ... | 0.50 max | 0.10–0.50 | ... | ... | 0.30 max[B] |
| Antimony | ... | ... | 0.05–0.15 | ... | ... | ... | ... |
| Phosphorus | ... | ... | 0.05–0.15 | ... | ... | ... | 0.05–0.25 |

[A] Including cobalt.
[B] Not including Co.

**TABLE 2 Tensile Requirements, Inch-pound**

| Temper Designation | | Diameter or Distance Between Parallel[A] Surfaces, in. | Tensile Strength, min, ksi | Yield Strength at 0.5 % Extension Under Load, min, ksi | Elongation in 4 × Diameter or Thickness of Specimen, min, %[B] |
|---|---|---|---|---|---|
| Code | Name | | | | |
| | | Copper Alloy UNS No. C46200 | | | |
| M30 | as-hot extruded | all forms, all sizes | 50 | 20 | 30 |
| O60 | soft anneal | rods and bars, all sizes | 48 | 16 | 30 |
| O50 | light anneal | rods and bars: | | | |
| | | 0.500 and under | 58 | 27 | 22 |
| | | over 0.500 to 1.000, incl | 56 | 27 | 25 |
| | | over 1.000 to 2.000, incl | 54 | 26 | 25 |
| | | over 2.000 to 3.000, incl | 52 | 25 | 27 |
| | | over 3.000 to 4.000, incl | 50 | 22 | 30 |
| | | over 4.000 | 50 | 20 | 30 |
| H60 | cold heading, forming | rods, all sizes | 48 | 18 | 22 |
| H02 | half-hard | rods and bars: | | | |
| | | 0.500 and under | 58 | 27 | 22 |
| | | over 0.500 to 1.000, incl | 56 | 27 | 25 |
| | | over 1.000 to 2.000, incl | 54 | 26 | 25 |
| | | over 2.000 to 3.000, incl | 52 | 25 | 27 |
| | | over 3.000 to 4.000, incl | 50 | 22 | 30 |
| | | over 4.000 | 50 | 20 | 30 |
| H04 | hard | rods and bars: | | | |
| | | 0.500 and under | 64 | 40 | 13 |
| | | over 0.500 to 1.000, incl | 62 | 38 | 13 |
| | | over 1.000 to 2.000, incl | 58 | 34 | 18 |
| | | Copper Alloy UNS No. C46400 | | | |
| M30 | as-hot extruded | all forms, all sizes | 52 | 20 | 30 |
| O60 | soft anneal | rods and bars: | | | |
| | | 1.000 and under | 54 | 20 | 30 |
| | | over 1.000 to 2.000, incl | 52 | 20 | 30 |
| | | over 2.000 | 50 | 20 | 30 |
| | | shapes, all sizes | 52 | 20 | 30 |
| O50 | light anneal | rods and bars: | | | |
| | | 0.500 and under | 60 | 27 | 22 |
| | | over 0.500 to 1.000, incl | 60 | 27 | 25 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 25 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 25 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 27 |
| | | over 4.000 | 54 | 22 | 30 |
| H50[C] | extruded and drawn[C] | shapes, all sizes | 58 | 25 | 20 |
| H02 | half-hard | rods and bars: | | | |
| | | 0.500 and under | 60 | 27 | 22 |
| | | over 0.500 to 1.000, incl | 60 | 27 | 25 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 25 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 25 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 27 |
| | | over 4.000 | 54 | 22 | 30 |
| H04 | hard | rods and bars: | | | |
| | | 1.000 and under | 67 | 45 | 13 |
| | | over 1.000 to 2.000, incl | 62 | 37 | 18 |
| | | Copper Alloy UNS No. C46750 | | | |
| M30 | as hot extruded | all forms, all sizes | 48 | 20 | 15 |
| O60 | soft annealed | rod and bar, all sizes | 49 | 20 | 15 |
| O61 | annealed | rod and bar, all sizes | 49 | 20 | 15 |
| H50 | hot extruded and drawn | rod and bar: | | | |
| | | over 0.300 to .500 | 48 | 20 | 5 |
| | | over 0.500 to 1.000 | 48 | 20 | 10 |
| | | over 1.000 | 48 | 20 | 15 |
| | | Copper Alloy UNS No. C47940 | | | |
| M30 | as-hot extruded | all forms, all sizes | 50 | 20 | 30 |
| O60 | soft anneal | rods and bars, all sizes | 48 | 20 | 30 |
| O50 | light anneal | rods and bars: | | | |
| | | 0.500 and under | 58 | 30 | 18 |
| | | over 0.500 to 1.000, incl | 56 | 30 | 20 |
| | | over 1.000 to 2.0, incl | 54 | 25 | 22 |
| | | over 2.000 | 50 | 25 | 25 |
| H50[C] | extruded and drawn[C] | shapes, all sizes | 56 | 25 | 20 |
| H02 | half-hard | rods and bars: | | | |
| | | 0.500 and under | 58 | 30 | 18 |
| | | over 0.500 to 1.000, incl | 56 | 30 | 20 |
| | | over 1.000 to 2.000, incl | 54 | 25 | 22 |
| | | over 2.000 | 50 | 25 | 25 |
| H04 | hard | rods and bars: | | | |
| | | 0.500 and under | 70 | 55 | 10 |
| | | over 0.500 to 1.000, incl | 65 | 52 | 13 |
| | | over 1.000 to 2.000, incl | 62 | 45 | 15 |

**TABLE 2** *Continued*

| Temper Designation | | Diameter or Distance Between Parallel[A] Surfaces, in. | Tensile Strength, min, ksi | Yield Strength at 0.5 % Extension Under Load, min, ksi | Elongation in 4 × Diameter or Thickness of Specimen, min, %[B] |
|---|---|---|---|---|---|
| Code | Name | | | | |
| | | Copper Alloy UNS No. C48200 | | | |
| M30 | as-hot extruded | all forms, all sizes | 52 | 20 | 25 |
| O60 | soft anneal | rods and bars: | | | |
| | | 1.000 and under | 54 | 20 | 25 |
| | | over 1.000 to 2.000, incl | 52 | 20 | 25 |
| | | over 2.000 | 50 | 20 | 25 |
| | | shapes, all sizes | 52 | 20 | 25 |
| O50 | light anneal | rods and bars: | | | |
| | | 1.000 and under | 60 | 27 | 18 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 20 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 20 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 20 |
| | | over 4.000 | 54 | 22 | 25 |
| H50[C] | extruded and drawn[C] | shapes, all sizes | 58 | 25 | 15 |
| H02 | half-hard | rods and bars: | | | |
| | | 1.000 and under | 60 | 27 | 18 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 20 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 20 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 20 |
| | | over 4.000 | 54 | 22 | 25 |
| H04 | hard | rods and bars: | | | |
| | | 1.000 and under | 67 | 45 | 11 |
| | | over 1.000 to 2.000, incl | 62 | 37 | 15 |
| | | Copper Alloy UNS No. C48500 | | | |
| M30 | as-hot extruded | all forms, all sizes | 52 | 20 | 20 |
| O60 | soft anneal | rods and bars: | | | |
| | | 1.000 and under | 54 | 20 | 20 |
| | | over 1.000 to 2.000, incl | 52 | 20 | 20 |
| | | over 2.000 | 50 | 20 | 20 |
| | | shapes, all sizes | 52 | 20 | 20 |
| O50 | light anneal | rods and bars: | | | |
| | | 1.000 and under | 60 | 27 | 12 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 20 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 20 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 20 |
| | | over 4.000 | 54 | 22 | 20 |
| H50[C] | extruded and drawn[C] | shapes, all sizes | 58 | 25 | 15 |
| H02 | half-hard | rods and bars: | | | |
| | | 1.000 and under | 60 | 27 | 12 |
| | | over 1.000 to 2.000, incl | 58 | 26 | 20 |
| | | over 2.000 to 3.000, incl | 54 | 25 | 20 |
| | | over 3.000 to 4.000, incl | 54 | 22 | 20 |
| | | over 4.000 | 54 | 22 | 20 |
| H04 | hard | rods and bars: | | | |
| | | 1.000 and under | 67 | 45 | 10 |
| | | over 1.000 to 2.000, incl | 62 | 37 | 13 |
| | | Copper Alloy UNS No. C48640 | | | |
| M30 | as hot-extruded | all forms, all sizes | 45.7 | 18 | 15 |
| H02 | half-hard | rod and bar: | | | |
| | | 0.300 to 0.500, incl | 45.7 | 18 | 5 |
| | | over 0.500 to 1.00, incl | 45.7 | 18 | 10 |
| | | over 1.000 | 45.7 | 18 | 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.
[C] This temper does not apply to hollow shapes.



8.1.2 Unless otherwise agreed upon between the manufacturer or supplier and the purchaser, the manufacturer shall have the option of using either the Mercurous Nitrate Test or the Ammonia Vapor Test. When the Ammonia Vapor Test is used, the test pH value appropriate for the intended application shall be 10 unless otherwise specified by the purchaser. (**Warning—** Mercury has been designated by many regulatory agencies as a hazardous substance that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Use caution when handling mercury and mercury-containing products. See the applicable product Safety Data Sheet (SDS) for additional information. The potential exists that selling mercury or mercury-containing products, or both, is prohibited by local or national law. Users must determine legality of sales in their location.)

NOTE 1—A residual stress test provides information about the adequacy of the stress relief of the material. Bar straightening is a method of mechanical stress relief. Stress relief annealing is a method of thermal stress relief.