Designation: B 21/B 21M – 01

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

This standard is issued under the fixed designation B 21/B 21M; 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 naval brass rod, bar, and shapes produced from Copper Alloys UNS No. C46200, C46400, C47940, C48200, or C48500.

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 B 124/B 124M.

1.2 *Units*—The values stated in inch-pound units or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values in each system are not 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 **Warning**—Mercury is a definite health hazard in use and disposal (see Performance Requirements).

2. Referenced Documents

2.1 *ASTM Standards:*

B 124/B 124M Specification for Copper and Copper-Alloy Forging Rod, Bar, and Shapes[2]

B 154 Test Method for Mercurous Nitrate Test for Copper and Copper Alloys[2]

B 249/B 249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings[2]

B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast[2]

B 858 Test Method for Determination of Susceptibility to Stress Corrosion Cracking in Copper Alloys Using an Ammonia Vapor Test[2]

E 8 Test Methods for Tension Testing of Metallic Materials[3]

E 8M Test Method for Tension Testing of Metallic Materials (Metric)[3]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[3]

E 478 Test Methods for Chemical Analysis of Copper Alloys[4]

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 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 contains additional requirements which supplement those appearing in Specification B 249/B 249M.

4. Ordering Information

4.1 Include the following when ordering product under this specification:

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 Number of pieces or total weight, for each size and form, and
4.1.9 When product is specified for agencies of the U.S. Government (Purchases for U.S. Government).

[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.

Current edition approved April 10, 2001. Published August 2001. Originally published as B 21 – 18T. Last previous edition B 21 – 00.

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

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

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

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

4.2 The following are options available under this specification and are to be specified in the contract or purchase 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 B 249/B 249M), and

4.2.5 Mill test report (Specification B 249/B 249M).

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 copper alloys in which zinc is specified as the remainder, either copper or zinc is permitted to be taken as the difference between the sum of results of all 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 elements listed in Table 1 for the Copper Alloy UNS No. specified in the ordering information are determined, the sum of results shall be 99.6 % minimum.

TABLE 1 Chemical Requirements

Element, %	Copper Alloy UNS No.				
	C46200	C46400	C47940	C48200	C48500
Copper	62.0–65.0	59.0–62.0	63.0–66.0	59.0–62.0	59.0–62.0
Tin	0.50–1.0	0.50–1.0	1.2–2.0	0.50–1.0	0.50–1.0
Lead	0.20 max	0.20 max	1.0–2.0	0.40–1.0	1.3–2.2
Zinc	remainder	remainder	remainder	remainder	remainder
Iron	0.10 max	0.10 max	0.10–1.0	0.10 max	0.10 max
Nickel[A]	...	...	0.10–0.50	...	...

[A] Including cobalt.

6. Temper

6.1 Tempers, as defined in Practice B 601, available under this specification are shown in Tables 2 and 3.

TABLE 2 Tensile Requirements, in./lb

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 of 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

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 of Thickness of Specimen, min, %[B]
Code	Name				
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. 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
		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

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 of Thickness of Specimen, min, %[B]
Code	Name				
		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

[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.

TABLE 3 Tensile Requirements, SI

Temper Designation		Diameter or Distance Between Parallel[A] Surfaces, mm	Tensile Strength, min, MPa	Yield Strength at 0.5 % Extension Under Load, min, MPa	Elongation in 4× Diameter of Thickness of Specimen, min, %[B]
Code	Name				
		Copper Alloy UNS No. C46200			
M30	as-hot extruded	all forms, all sizes	345	140	30
O60	soft anneal	rods and bars, all sizes	330	110	30
O50	light anneal	rods and bars:			
		12 and under	400	185	22
		over 12 to 25, incl	385	185	25
		over 25 to 50, incl	370	180	25
		over 50 to 75, incl	360	170	27
		over 75 to 100, incl	345	150	30
		over 100	345	140	30
H60	cold heading, forming	rods, all sizes	330	125	22
H02	half-hard	rods and bars:			
		12 and under	400	185	22
		over 12 to 25, incl	385	185	25
		over 25 to 50, incl	370	180	25
		over 50 to 75, incl	360	170	27
		over 75 to 100, incl	345	150	30
		over 100	345	140	30
H04	hard	rods and bars:			
		12 and under	440	275	13
		over 12 to 25, incl	425	260	13
		over 25 to 50, incl	400	235	18
		Copper Alloy UNS No. C46400			
M30	as-hot extruded	all forms, all sizes	360	140	30
O60	soft anneal	rods and bars:			
		25 and under	370	140	30
		over 25 to 50, incl	360	140	30
		over 50	345	140	30
		shapes, all sizes	360	140	30
O50	light anneal	rods and bars:			
		12 and under	415	185	22
		over 12 to 25, incl	415	185	25
		over 25 to 50, incl	400	180	25
		over 50 to 75, incl	370	170	25
		over 75 to 100, incl	370	150	27
		over 100	370	150	30
H50[C]	extruded and drawn[C]	shapes, all sizes	400	170	20
H02	half-hard	rods and bars:			
		12 and under	415	185	22
		over 12 to 25, incl	415	185	25
		over 25 to 50, incl	400	180	25
		over 50 to 75, incl	370	170	25
		over 75 to 100, incl	370	150	27
		over 100	370	150	30
H04	hard	rods and bars:			
		25 and under	460	310	13

TABLE 3 *Continued*

Temper Designation		Diameter or Distance Between Parallel[A] Surfaces, mm	Tensile Strength, min, MPa	Yield Strength at 0.5 % Extension Under Load, min, MPa	Elongation in 4× Diameter of Thickness of Specimen, min, %[B]
Code	Name				
		over 25 to 50, incl	425	255	18
		Copper Alloy UNS No. C47940			
M30	as-hot extruded	all forms, all sizes	345	140	30
O60	soft anneal	rods and bars, all sizes	330	140	30
O50	light anneal	rods and bars:			
		12 and under	400	210	18
		over 12 to 25, incl	390	210	20
		over 25 to 50, incl	375	175	22
		over 50	345	175	25
H50[C]	extruded and drawn[C]	shapes, all sizes	390	175	20
H02	half-hard	rods and bars:			
		12 and under	400	210	18
		over 12 to 25, incl	390	210	20
		over 25 to 50, incl	375	175	22
		over 50	345	175	25
H04	hard	rods and bars:			
		12 and under	485	380	10
		over 12 to 25, incl	450	360	13
		over 25 to 50, incl	430	310	15
		Copper Alloy UNS No. C48200			
M30	as-hot extruded	all forms, all sizes	360	140	25
O60	soft anneal	rods and bars:			
		25 and under	370	140	25
		over 25 to 50, incl	360	140	25
		over 50	345	140	25
		shapes, all sizes	360	140	25
O50	light anneal	rods and bars:			
		25 and under	415	185	18
		over 25 to 50, incl	400	180	20
		over 50 to 75, incl	370	170	20
		over 75 to 100, incl	370	150	20
		over 100	370	150	25
H50[C]	extruded and drawn[C]	shapes, all sizes	400	170	15
H02	half-hard	rods and bars:			
		25 and under	415	185	18
		over 25 to 50, incl	400	180	20
		over 50 to 75, incl	370	170	20
		over 75 to 100, incl	370	150	20
		over 100	370	150	25
H04	hard	rods and bars:			
		25 and under	460	310	11
		over 25 to 50, incl	425	255	15
		Copper Alloy UNS No. C48500			
M30	as-hot extruded	all forms, all sizes	360	140	20
O60	soft anneal	rods and bars:			
		25 and under	370	140	20
		over 25 to 50, incl	360	140	20
		over 50	345	140	20
		shapes, all sizes	360	140	20
O50	light anneal	rods and bars:			
		25 and under	415	185	12
		over 25 to 50, incl	400	180	20
		over 50 to 75, incl	370	170	20
		over 75 to 100, incl	370	150	20
		over 100	370	150	20
H50[C]	extruded and drawn[C]	shapes, all sizes	400	170	15
H02	half-hard	rods and bars:			
		25 and under	415	185	12
		over 25 to 50, incl	400	180	20
		over 50 to 75, incl	370	170	20
		over 75 to 100, incl	370	150	20
		over 100	370	150	20

TABLE 3 *Continued*

Temper Designation		Diameter or Distance Between Parallel[A] Surfaces, mm	Tensile Strength, min, MPa	Yield Strength at 0.5 % Extension Under Load, min, MPa	Elongation in 4× Diameter of Thickness of Specimen, min, %[B]
Code	Name				
H04	hard	rods and bars:			
		25 and under	460	310	10
		over 25 to 50, incl	425	255	13

[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.
[C]This temper does not apply to hollow shapes.

7. Mechanical Property Requirements

7.1 The product shall conform to the mechanical property requirements given in Tables 2-4 for the Copper Alloy UNS No. designation specified in the ordering information.

7.1.1 *Rockwell Hardness*—For the alloys and tempers listed, the product ½ in. [12 mm] and over in diameter or distance between parallel surfaces shall conform with the requirements given in Table 4, when tested in accordance with Test Methods E 18.

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

7.1.2 *Tensile Strength*—The product shall conform with the requirements of Tables 2 and 3, when tested in accordance with Test Methods E 8 and E 8M.

8. Performance Requirements

8.1 *Residual Stress Test*:

8.1.1 When specified in the contract or purchase order, the product shall pass a test for residual stress according to the requirements of Test Method B 154 or Test Method B 858.

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 shall be 10 unless otherwise specified by the purchaser. (**Warning:** Mercury is a definite health hazard, and therefore equipment for the detection and removal of mercury vapor produced in volatilization is recommended. The use of rubber gloves in testing is recommended.

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.

9. Other Requirements

9.1 *Piston-Finish Rod and Shafting*:

9.1.1 When so specified in the contract or order, round rods over ½-in. [12 mm] diameter shall be furnished as piston-finish rods or shafting.

9.1.2 Piston-finish rods shall have a special surface produced by turning or grinding and shall comply with the special diameter tolerances specified in Piston-Finish Rod Section under Dimensions and Permissible Variations.

9.1.3 The straightness tolerances for piston-finish rod are subject to agreement between the manufacturer or supplier and the purchaser.

9.2 *Purchases for U.S. Government*:

9.2.1 Product purchased for agencies of the U.S. Government shall conform to the additional requirements prescribed in the Supplementary Requirements section of Specification B 249/B 249M.

10. Dimensions and Permissible Variations

10.1 The dimensions and tolerances for product covered by this specification shall be as specified in the current edition of Specification B 249/B 249M, with particular reference to the following Tables and related paragraphs in that specification:

TABLE 4 Rockwell Hardness Requirements

NOTE 1—Rockwell Hardness Requirements are not established for diameters less than ½ in. [12 mm].

Copper Alloy UNS No.	Temper Designation		Diameter or Distance Between Parallel Surfaces[A],		Rockwell B Hardness Determined on the Cross Section Modway Between Surface and Center
	Code	Name	in.	mm	
C46400	H02	half-hard	0.500 to 1.000, incl	12 to 25, incl	60–80
			over 1.000	over 25	55–80
	H04	hard	0.500 to 1.000, incl	12 to 25, incl	70–90
			over 1.000	over 25	65–90
C48200	H02	half-hard	0.500 to 1.000, incl	12 to 25, incl	65–85
			over 1.000	over 25	60–85
	H04	hard	0.500 to 1.000, incl	12 to 25, incl	70–90
			over 1.000	over 25	65–90
C48500	H02	half-hard	0.500 to 1.000, incl	12 to 25, incl	65–85
			over 1.000	over 25	60–85
	H04	hard	0.500 to 1.000, incl	12 to 25, incl	70–90
			over 1.000	over 25	65–90

[A]For rectangular bar, the Distance Between Parallel Surfaces refers to thickness.

10.2 *Diameter or Distance Between Parallel Surfaces*:
10.2.1 *Rod: Round, Hexagonal, Octagonal*—See Table 1.
10.2.2 *Rod, M30 (As-Hot Extruded)*—See Table 4.
10.2.3 *Piston-Finish Rod*—See Table 3.
10.2.4 *Bar: Rectangular and Square*—See Tables 8 and 10.
10.2.5 *Bar, M30 (As-Hot Extruded)*—See Table 4.
10.3 *Shapes*—The dimensional tolerances for shapes shall be as agreed upon by the manufacturer or supplier and the purchaser, and shall be specified in the order.
10.4 *Length of Rod, Bar, and Shapes*—See Tables 13 and 14.
10.5 *Straightness*:
10.5.1 *Rod and Bar*—See Table 16.
10.5.2 *Shafting Rod*—See Table 17.
10.5.3 *M30 (As-Hot Extruded)*—Rod, bar, and shapes shall be commercially straight.
10.6 *Edge Contours*—See Edge Contours Section.

11. Specimen Preparation

11.1 In the tension test all material shall be pulled in full size when practicable. Full-size or machined test specimens shall be as specified in the Test Specimen Section of Test Methods E 8 and E 8M. Whenever tension 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.

11.2 Residual stress test specimens shall be of the full size of the product, and tested without bending, springing, polishing, or any other preparation.

12. Test Methods

12.1 *Chemical Analysis*:
12.1.1 Chemical 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
Tin	E 478 (titrimetric)
Zinc	E 478 (titrimetric)

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

13. Keywords

13.1 C46200; C46400; C47940; C48200; C48500; naval brass; naval brass bar; naval brass rod; piston-finish rod; piston-finish shafting

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 21 – 96 and B 21M – 96) that may impact the use of this standard.

(*1*) The Scope and applicable sections and tables were changed to reflect the combination of the inch-pound and SI versions of B 21 and B 21M.

(*2*) The addition of Test Method B 858 as an optional test for residual stress.