Designation: B249/B249M – 17

Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings[1]

This standard is issued under the fixed designation B249/B249M; 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[2] establishes the general requirements common to wrought copper and copper alloy rod, bar, shapes, and forgings which shall apply to Specifications B16/B16M, B21/B21M, B98/B98M, B124/B124M, B138/B138M, B139/B139M, B140/B140M, B150/B150M, B151/B151M, B187/B187M, B196/B196M, B283/B283M, B301/B301M, B371/B371M, B411/B411M, B441, B453/B453M, B455, B570, B870, B927/B927M, B929, B967/B967M, and B974/B974M to the extent referenced therein.

1.2 The chemical composition, physical and mechanical properties, and all other requirements not included in this specification are prescribed in the product specification.

1.3 *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.

1.3.1 Within the text the SI values are given in brackets.

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 and health 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:*[3]

B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines

B21/B21M Specification for Naval Brass Rod, Bar, and Shapes

B98/B98M Specification for Copper-Silicon Alloy Rod, Bar and Shapes

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

B138/B138M Specification for Manganese Bronze Rod, Bar, and Shapes

B139/B139M Specification for Phosphor Bronze Rod, Bar, and Shapes

B140/B140M Specification for Copper-Zinc-Lead (Red Brass or Hardware Bronze) Rod, Bar, and Shapes

B150/B150M Specification for Aluminum Bronze Rod, Bar, and Shapes

B151/B151M Specification for Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar

B154 Test Method for Mercurous Nitrate Test for Copper Alloys

B187/B187M Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes

B193 Test Method for Resistivity of Electrical Conductor Materials

B194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar

B196/B196M Specification for Copper-Beryllium Alloy Rod and Bar

B283/B283M Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)

B301/B301M Specification for Free-Cutting Copper Rod, Bar, Wire, and Shapes

B371/B371M Specification for Copper-Zinc-Silicon Alloy Rod

[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 *ASME Boiler and Pressure Vessel Code* applications see related Specifications SB-249 in Section II of that Code.

[3] 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.

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

B411/B411M Specification for Copper-Nickel-Silicon Alloy Rod and Bar
B441 Specification for Copper-Cobalt-Beryllium, Copper-Nickel-Beryllium, and Copper-Nickel-Lead-Beryllium Rod and Bar (UNS Nos. C17500, C17510, and C17465)
B453/B453M Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes
B455 Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes
B570 Specification for Copper-Beryllium Alloy (UNS Nos. C17000 and C17200) Forgings and Extrusions
B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper
B846 Terminology for Copper and Copper Alloys
B858 Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys
B870 Specification for Copper-Beryllium Alloy Forgings and Extrusions Alloys (UNS Nos. C17500 and C17510)
B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies
B927/B927M Specification for Brass Rod, Bar, and Shapes
B929 Specification for Copper-Nickel-Tin Spinodal Alloy Rod and Bar
B967/B967M Specification for Copper-Zinc-Tin-Bismuth Alloy Rod, Bar and Wire
B974/B974M Specification for Free-Cutting Bismuth Brass Rod, Bar and Wire
D4855 Practice for Comparing Test Methods (Withdrawn 2008)[4]
E3 Guide for Preparation of Metallographic Specimens
E8/E8M Test Methods for Tension Testing of Metallic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry
E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[4]
E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[4]
E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)[4]
E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)[4]
E112 Test Methods for Determining Average Grain Size
E118 Test Methods for Chemical Analysis of Copper-Chromium Alloys (Withdrawn 2010)[4]
E121 Test Methods for Chemical Analysis of Copper-Tellurium Alloys (Withdrawn 2010)[4]
E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition
E290 Test Methods for Bend Testing of Material for Ductility
E478 Test Methods for Chemical Analysis of Copper Alloys
E581 Test Methods for Chemical Analysis of Manganese-Copper Alloys

[4] The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lengths, mill, n*—straight lengths, including ends, that can be conveniently manufactured in the mill. Full length pieces are usually 10 or 12 ft [3000 or 3600 mm].

3.2.2 *lengths, stock, n*—straight lengths that are mill cut and stored in advance of orders. They are usually 10 or 12 ft [3000 or 3600 mm] and subject to established length tolerances.

4. Materials and Manufacture

4.1 *Materials:*

4.1.1 The material of manufacture shall be a form of the Copper or Copper Alloy UNS No. designation specified in the ordering information of such purity and soundness as to be suitable for processing into the products described in the product specification.

4.1.2 When specified in the contract or purchase order, that heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify specific casting analysis with a specific quantity of finished product.

4.2 *Manufacture*—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.

4.2.1 The product shall be hot or cold worked to the finished size and subsequently annealed or heat treated when required, and straightened to meet the properties specified.

4.2.2 *Edges*—The edge shall be drawn, extruded, or rolled; refer to Edge Contours in Section 6.

5. Chemical Composition

5.1 The material shall conform to the chemical composition requirements prescribed in the product specification.

5.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance given in the product specification.

5.2 The composition limits established for the Copper or Copper Alloy UNS No. designation specified in the product specification do not preclude the presence of other elements. By agreement between the manufacturer or supplier and the purchaser. Limits may be established and analysis required for unnamed elements.

5.3 When material composition has been determined during the course of manufacture, analysis of the finished product by the manufacturer is not required.

6. Dimensions, Mass and Permissible Variations

6.1 *General*—For the purpose of determining conformance with the dimensional requirements, any measured value outside the specified limiting values for any dimension may be cause for rejection.

6.1.1 The dimensions and tolerances for products referenced to this specification, shall be as noted in the following paragraphs and tables, where the product specification is noted in the table heading.

NOTE 2—Blank spaces in the tolerance tables indicate either that the material generally is not available or that no tolerances are established.

6.2 *Diameter or Distance Between Parallel Surfaces*—The diameter of round sections or the distance between parallel surfaces in the case of other sections, except shapes, shall not vary from that specified by more than the amounts specified in Tables 1-12, incl, for the product, specification indicated:

Table 1 and Table 2—List the tolerances for diameter or distance between parallel surfaces of cold-drawn rod in round, hexagonal and octagonal cross sections. Applicable product specifications and alloys are shown in the table titles.

Table 3—Lists the diameter tolerances for piston finish rod applicable to product specifications shown in the table title.

Table 4 and Table 5—List the tolerances for diameter or distance between parallel surfaces of as-extruded rod and bar applicable to the specifications and alloys shown in the table titles. These tolerances are applicable to round, hexagonal, and octagonal rod as well as square and rectangular bar.

Table 6—Lists the diameter tolerances for hot-rolled round rod applicable to the product specification shown in the table title.

Table 7, Table 8 and Table 9—List the thickness tolerances for rectangular and square bar applicable to the product specifications and alloys shown in the table titles.

Table 10 and Table 11—List the width tolerances for rectangular bar applicable to the product specifications and alloys shown in the table titles.

Table 12—Lists the diameter or distance between parallel surfaces tolerances for hot-forged rod and bar applicable to the product specification shown in the title.

6.3 *Length*—Rod, bar, and shapes shall be furnished in stock lengths with ends, unless the order specifies stock lengths, specific lengths, or specific lengths with ends as specified in Table 13, Table 14, and Table 15 for the product specification indicated:

TABLE 1 Tolerances for Diameter or Distance Between Parallel Surfaces of Cold-Drawn Rod

(Applicable to Specifications B16/B16M, B21/B21M, B98/B98M (Copper Alloy UNS No. C65100), B124/B124M (Copper Alloy UNS Nos. C11000, C14500, C14700, C46400, C46750, C48200, C48500, C49250, C49255, C49260, C49265, C49300, C49340, C49345, C49350, and C49360), B140/B140M, B301/B301M, B453/B453M, B927/B927M, B967/B967M, and B974/B974M)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]	
	Round	Hexagonal, Octagonal
Up to 0.150 [3.8], incl	0.0013 [0.035]	0.0025 [0.06]
Over 0.150 to 0.500 [3.8 to 12], incl	0.0015 [0.04]	0.003 [0.08]
Over 0.500 to 1.00 [12 to 25], incl	0.002 [0.05]	0.004 [0.10]
Over 1.00 to 2.00 [25 to 50], incl	0.0025 [0.06]	0.005 [0.13]
Over 2.00 [50]	0.15[B] [0.15][B]	0.30[B] [0.30][B]

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified diameter or distance between parallel surfaces expressed to the nearest 0.001 in. [0.01 mm].

TABLE 2 Tolerances for Diameter or Distance Between Parallel Surfaces of Cold-Drawn Rod

(Applicable to Specifications B98/B98M (Copper Alloy UNS No. C65500 and C66100), B124/B124M (Copper Alloy UNS Nos. C27450, C27453, C28500, C36500, C37000, C37700, C61900, C62300, C63000, C63200, C64200, C64210, C65500, C67500, C67600, C69240, C69300, C70620, C71520, and C77400), B138/B138M, B139/B139M, B150/B150M, B151/B151M, B196/B196M, B371/B371M, B411/B411M, and B441)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]	
	Round	Hexagonal, Octagonal
Up to 0.150 [3.8], incl	0.002 [0.050]	. . .
Over 0.150 to 0.500 [3.8 to 12], incl	0.002 [0.050]	0.004 [0.10]
Over 0.500 to 1.00 [12 to 25], incl	0.003 [0.08]	0.005 [0.13]
Over 1.00 to 2.00 [25 to 50], incl	0.004 [0.10]	0.006 [0.15]
Over 2.00 [50]	0.20[B] [0.20][B]	0.40[B] [0.40][B]

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified diameter or distance between parallel surfaces expressed to the nearest 0.001 in. [0.01 mm].

TABLE 3 Diameter Tolerances for Piston-Finish Rod

(Applicable to Specifications B21/B21M, B138/B138M, B139/B139M, and B150/B150M)

Diameter, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
Over 0.500 to 1.00 [12 to 25], incl	0.0013 [0.35]
Over 1.00 to 2.00 [25 to 50], incl	0.0015 [0.04]
Over 2.00 [50]	0.10[B] [0.10][B]

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified diameter expressed to the nearest 0.0005 in. [0.01 mm].

TABLE 4 Tolerances for Diameter or Distance Between Parallel Surfaces of As-Extruded Rod and Bar

(Applicable to Specifications B21/B21M, B124/B124M (Copper Alloy UNS Nos. C27450, C27453, C28500, C36500, C37000, C37700, C46400, C46750, C48200, C48500, C49250, C49255, C49260, C49265, C49300, C49340, C49345, C49350, C49355, C49360, C61900, C62300, C63000, C63200, C64200, C64210, C67500, C67600, C69240, C69300, C70620, and C71520), B138/B138M (Copper Alloy UNS Nos. C67500 and C67600), B150/B150M, and B967/B967M)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
	Rod (Round, Hexagonal, and Octagonal) Bar (Rectangular and Square)
Up to 1.00 [25], incl	0.010 [0.25]
Over 1.00 to 2.00 [25 to 50], incl	0.015 [0.38]
Over 2.00 to 3.00 [50 to 75], incl	0.025 [0.65]
Over 3.00 to 3.50 [75 to 90], incl	0.035 [0.90]
Over 3.50 to 4.00 [90 to 100], incl	0.060 [1.5]

[A] When tolerances are specified as all plus or all minus, double the values given.

Table 13—Length tolerances for full-length pieces applicable to product specifications shown in the table title.

Table 14 *and* Table 15—Lists the schedule of lengths (specific and stock) with ends applicable to product specifications and alloys shown in the table titles.

6.4 *Straightness:*

6.4.1 Unless otherwise specified, drawn rod, bar, and shapes, other than shafting rod, piston-finish rod shall be furnished in straight lengths. The deviation from straightness

TABLE 5 Tolerances for Diameter or Distance Between Parallel Surfaces of As-Extruded Rod and Bar
(Applicable to Specifications B98/B98M, B124/B124M (Copper UNS Nos. C11000, C14500, C14700 and Copper Alloy UNS Nos. C65500, C77400, C87700, and C87710), B138/B138M (Copper UNS No. C67000), B196/B196M, B441 and B929)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
	Rod (Round, Hexagonal, and Octagonal) Bar (Rectangular and Square)
Up to 1.00 [25], incl	0.020 [0.50]
Over 1.00 to 2.00 [25 to 50], incl	0.030 [0.75]
Over 2.00 to 3.00 [50 to 75], incl	0.050 [1.3]
Over 3.00 to 3.50 [75 to 90], incl	0.070 [1.8]
Over 3.50 to 4.00 [90 to 100], incl	0.120 [3.0]

[A] When tolerances are specified as all plus or all minus, double the values given.

TABLE 6 Diameter Tolerances for Hot-Rolled Round Rod
(Applicable to Specifications B98/B98M, B124/B124M, B138/B138M, B150/B150M, B196/B196M, and B441)

Diameter, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
0.250 [6.35] only	+0.020 [+0.50] −0.010 [−0.25]
Over 0.250 to 0.750 [6.35 to 20], incl	0.015 [0.38]
Over 0.750 to 1.25 [20 to 30], incl	0.020 [0.50]
Over 1.25 to 1.50 [30 to 38], incl	0.030 [0.75]
Over 1.50 to 3.00 [38 to 75], incl	1/16 [1.6]
Over 3.00 [75]	1/8 [3.2]

[A] When tolerances are specified as all plus or all minus, double the values given.

shall not exceed the limitations specified in Table 16 for either general or automatic screw machine use for the product specifications and alloys shown in the table titles. To determine compliance with this tolerance, the lengths shall, in case of disagreement, be checked by the following method:

6.4.1.1 Place the lengths on a level table so that the arc or departure from straightness is horizontal. Measure the depth of arc to the nearest 1/32 in. [1.0 mm], using a steel scale and a straightedge. Local departure from straightness should be measured with a 1-ft [300-mm] straightedge and a feeler gage.

6.4.2 Shafting rod, when so specified, shall comply with the tolerances of Table 17 for the product specifications shown in the table title. To determine compliance with this paragraph, shafting shall, in case of disagreement, be checked by the following method:

6.4.2.1 Place the shaft upon two freely rotating supports, one fourth of the shaft length extending beyond each support. Measure the departure from straightness at each end and at the center by means of a dial gage mounted on a suitable movable block and set successively at the three points to be measured while rotating the shaft slowly and carefully to avoid vibration. The total range of the dial reading at a given point, divided by two, gives the departure from straightness at that point.

6.5 *Edge Contours:*

6.5.1 *Finish*—All rectangular and square bar shall have finished edges.

6.5.2 *Angles*—All regular polygonal sections shall have substantially exact angles. For hexagonal and octagonal rods cold-drawn to size, corner radii shall not exceed 1/16 in. [1.5 mm] for sizes up to 2 in. [50 mm], incl., and 3/32 in. [2.5 mm] for sizes over 2 in. [50 mm].

6.5.2.1 When specified, hexagons and octagons shall be furnished with corners rounded to a radius of 11 % of the distance between parallel faces. The distance from corner to corner (see Note 3) shall be the basis for acceptance or rejection. the appropriate tolerances are listed in Table 18.

NOTE 3—The distance from corner to corner is determined by calculating the distance across parallel faces times 1.121 for hexagons and 1.064 for octagons.

6.5.3 *Rectangular and Square Bar*—Unless otherwise specified, square corners shall be furnished on rectangular and square bar. When so ordered, the edge contours described in 6.5.4 – 6.5.7 inclusive shall be furnished.

6.5.4 *Square Corners*—Unless otherwise specified, bar shall be finished with commercially square corners with a maximum permissible radius of 1/32 in. [1.0 mm] for bars over 3/16 to 1 in. [5 to 25 mm], inclusive, in thickness, and 1/16 in. [1.5 mm] for bars over 1 in. [25 mm] in thickness.

6.5.5 *Rounded Corners*—When specified, bar shall be finished with corners rounded as shown in Fig. 1 to a quarter circle with a radius of 1/16 in. [1.5 mm] for bars over 3/16 to 1 in. [25 mm], inclusive, in thickness, and 1/8 in. [5 mm] for bars over 1 in. [25 mm] in thickness. The tolerance on the radius shall be ±25 %.

6.5.6 *Rounded Edge*—When specified bar shall be finished with edges rounded as shown in Fig. 2, the radius of curvature being 1¼ times the thickness of the bar for bars over 3/16 in. [5 mm] in thickness. The tolerance on the radius shall be one fourth the thickness of the bar.

6.5.7 *Full Rounded Edge*—When specified, bar shall be finished with substantially uniform round edges, the radius of curvature being approximately one half the thickness of the product, as shown in Fig. 3, but in no case to exceed one half the thickness of the product by more than 25 %.

7. Workmanship, Finish, and Appearance

7.1 *Workmanship*—The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable. The product shall be well cleaned and free from dirt.

7.2 *Finish*—A superficial film of residual light lubricant normally is present and is permissible unless otherwise specified.

7.3 *Appearance:*

7.3.1 The surface finish and appearance shall be the normal quality for product ordered.

7.3.2 When intended application information is provided in the ordering information of the contract or purchase order, the surface shall be that normally produced for the application.

7.3.3 Superficial films of discoloration, or lubricants, or tarnish inhibitors are permissible unless otherwise specified.

8. Sampling

8.1 The lot size, portion size, and selection of sample pieces shall be as follows:

TABLE 7 Thickness Tolerances for Rectangular and Square Bar
(Applicable to Specifications B124/B124M, (Copper Alloy UNS Nos. C11000, C14500, and C14700), B301/B301M, and B974/B974M)

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus,[A] in. [mm] for Widths Given in Inches					
	½ [12] and Under	Over ½ to 1¼ [12 to 30] Incl	Over 1¼ to 2 [30 to 50] Incl	Over 2 to 4 [50 to 100] Incl	Over 4 to 8 [100 to 200] Incl	Over 8 to 12 [200 to 300] Incl
Over 0.188 to 0.500 [4.8 to 12], incl	0.003 [0.08]	0.003 [0.08]	0.0035 [0.09]	0.004 [0.10]	0.0045 [0.11]	0.0055 [0.13]
Over 0.500 to 1.00 [12 to 25], incl	...	0.004 [0.10]	0.004 [0.10]	0.0045 [0.11]	0.005 [0.13]	0.006 [0.15]
Over 1.00 to 2.00 [25 to 50], incl	...	0.0045 [0.11]	0.0045 [0.11]	0.005 [0.13]	0.006 [0.15]	...
Over 2.00 to 4.00 [50 to 100], incl	...	...	...	0.30[B]	...	...

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified thickness expressed to the nearest 0.001 in. [0.01 mm].

TABLE 8 Thickness Tolerances for Rectangular and Square Bar
(Applicable to Specifications B16/B16M, B21/B21M, B98/B98M, (Copper Alloy UNS No. 65100), B124/B124M(Copper Alloy UNS Nos. C46400, C46750, C48200, and C48500), B140/B140M, B453/B453M, B927/B927M, and B967/B967M)

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus,[A] in. for Widths Given in Inches					
	½ and Under	Over ½ to 1¼ Incl	Over 1¼ to 2 Incl	Over 2 to 4 Incl	Over 4 to 8 Incl	Over 8 to 12 Incl
Over 0.188 to 0.500 [4.8 to 12], incl	0.0035 [0.09]	0.004 [0.10]	0.0045 [0.11]	0.0045 [0.11]	0.006 [0.13]	0.008 [0.20]
Over 0.500 to 1.00 [12 to 25], incl	...	0.0045 [0.11]	0.005 [0.13]	0.005 [0.13]	0.007 [0.18]	0.009 [0.23]
Over 1.00 to 2.00 [25 to 50], incl	...	0.005 [0.13]	0.005 [0.13]	0.006 [0.15]	0.008 [0.20]	...
Over 2.00 to 4.00 [50 to 100], incl	...	...	...	0.30[B]	...	...

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified thickness expressed to the nearest 0.001 in. [0.01 mm].

TABLE 9 Thickness Tolerances for Rectangular and Square Bar
(Applicable to Specifications B98/B98M (Copper Alloy UNS Nos. C65500 and C66100), B124/B124M (Copper Alloy UNS Nos. C27450, C27453, C28500, C36500, C37000, C37700, C61900, C62300, C63000, C63200, C64200, C64210, C65500, C67500, C67600, C69240, C69300, C70620, C75120, C77400, C87700, and C87710), B138/B138M, B139/B139M, B150/B150M, B151/B151M, B196/B196M, B411/B411M, B441, and B929)

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus,[A] in. [mm] for Widths Given in Inches					
	½ [12] and Under	Over ½ to 1¼ [12 to 30] Incl	Over 1¼ to 2 [30 to 50] Incl	Over 2 to 4 [50 to 100] Incl	Over 4 to 8 [100 to 200] Incl	Over 8 to 12 [200 to 300] Incl
Over 0.188 to 0.500 [4.8 to 12], incl	0.005 [0.13]	0.005 [0.13]	0.006 [0.15]	0.007 [0.18]	0.009 [0.23]	0.012 [0.30]
Over 0.500 to 1.00 [12 to 25], incl	...	0.006 [0.15]	0.007 [0.18]	0.008 [0.20]	0.010 [0.25]	0.013 [0.33]
Over 1.00 to 2.00 [25 to 50], incl	...	0.006 [0.15]	0.007 [0.18]	0.009 [0.23]	0.011 [0.28]	...
Over 2.00 to 4.00 [50 to 100], incl	...	...	...	0.50[B]	...	...

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified thickness expressed to the nearest 0.001 in. [0.1 mm].

TABLE 10 Width Tolerances for Rectangular Bar
(Applicable to Specifications B16/B16M, B21/B21M, B98/B98M (Copper Alloy UNS No. C65100), B124/B124M (Copper Alloy UNS Nos. C11000, C14500, C14700, C46400, C46750, C48200, and C48500), B140/B140M, B301/B301M, B453/B453M, B927/B927M, B967/B967M and B974/B974M)

Width, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
Over 0.188 to 0.500 [4.8 to 12], incl	0.0035 [0.09]
Over 0.500 to 1.25 [12 to 30], incl	0.005 [0.13]
Over 1.25 to 2.00 [30 to 50], incl	0.008 [0.20]
Over 2.00 to 4.00 [50 to 100], incl	0.012 [0.30][B]
Over 4.00 to 12.00 [100 to 300], incl	0.30[B] [0.30]

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified width expressed to the nearest 0.001 in. [0.01 mm].

TABLE 11 Width Tolerances for Rectangular Bar
(Applicable to Specifications B98/B98M (Copper Alloy UNS Nos. C65500 and C66100), B124/B124M (Copper Alloy UNS Nos. C27450, C27453, C28500, C36500, C37000, C37700, C61900, C62300, C63000, C63200, C64200, C64210, C65500, C67500, C67600, C69240, C69300, C70620, C75120, C77400, C87700, and C87710), B138/B138M, B139/B139M, B150/B150M, B151/B151M, B196/B196M, B411/B411M, B441, and B929)

Width, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
Over 0.188 to 0.500 [4.8 to 12], incl	0.005 [0.13]
Over 0.500 to 1.25 [12 to 30], incl	0.007 [0.18]
Over 1.25 to 2.00 [30 to 50], incl	0.010 [0.25]
Over 2.00 to 4.00 [50 to 100], incl	0.015 [0.38]
Over 4.00 to 12.00 [100 to 300], incl	0.50[B] [0.50][B]

[A] When tolerances are specified as all plus or all minus, double the values given.
[B] Percent of specified width expressed to the nearest 0.001 in. [0.01 mm].

8.1.1 *Lot Size*—An inspection lot shall be 10 000 lb [5000 kg], or less, of the same mill form, alloy, temper, and nominal dimensions, subject to inspection at one time. Alternatively, a lot shall be the product of one cast bar from a single melt charge, or one continuous casting run whose weight does not exceed 40 000 lb [20 000 kg] that has been continuously processed and subject to inspection at one time.

8.1.2 *Portion Size*—The portion shall be four or more pieces selected as to be representative of each lot. Should the lot consist of less than five pieces, representative samples shall be taken from each piece.

TABLE 12 Diameter Tolerances for Hot-Forged Rod and Bar
(Applicable to Specification B138/B138M)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, All Plus, in. [mm]	
	As-Forged	Rough-Turned
Over 3.50 [90]	0.125 [3.2]	0.050 [1.3]

TABLE 13 Length Tolerances for Rod, Bar, and Shapes (Full-Length Pieces Specific and Stock Lengths With or Without Ends)
(Applicable to Specifications B16/B16M, B21/B21M, B98/B98M, B138/B138M, B139/B139M, B140/B140M, B150/B150M, B151/B151M, B196/B196M, B301/B301M, B371/B371M, B411/B411M, B441, B453/B453M, B927/B927M, B929, B967/B967M, and B974/B974M)

NOTE 1—The length tolerances in this table are all plus; if all minus tolerances are desired, use the same values; if tolerances are desired plus and minus, halve the values given.

Length Classification	Tolerances, All Plus, in. [mm] (Applicable Only to Full-Length Pieces)
Specific lengths	⅜ [10]
Specific lengths with ends	1 [25]
Stock lengths with or without ends	1[A] [25][A]

[A] As stock lengths are cut and placed in stock in advance of orders, departure from this tolerance is not practicable.

8.2 *Chemical Analysis:*

8.2.1 The sample for chemical analysis shall be taken in accordance with Practice E255 for product in its final form from the pieces selected in 8.1.2 and combined into one composite sample. The minimum weight of the composite sample shall be 150 g.

8.2.2 Instead of sampling as directed in 8.2.1, the manufacturer shall have the option of sampling at the time castings are poured or from the semifinished product. When samples are taken during the course of manufacture, sampling of the finished product by the manufacturer is not required. The number of samples taken for the determination of composition shall be as follows:

8.2.2.1 When samples are taken at the time the castings are poured, at least one sample shall be taken for each group of castings poured from the same source of molten metal.

8.2.2.2 When samples are taken from semifinished product, a sample shall be taken to represent each 10 000 lb [5000 kg], or fraction thereof, except that not more than one sample shall be required per piece.

8.2.2.3 Only one sample need be taken from the semifinished product of one cast bar from a single melt charge continuously processed.

8.3 *Samples for All Other Tests*—Samples for all other tests shall be taken from the sample portions selected in 8.1.2 and be of a convenient size to accommodate the test and comply with the requirements of the appropriate product specification and test method.

9. Number of Tests and Retests

9.1 *Tests:*

9.1.1 *Chemical Analysis*—Chemical composition shall be determined as the per element mean of results from at least two replicate analyses of the sample(s) and the results of each replication shall meet the requirements of the product specification.

9.1.2 *Tensile Strength, Grain Size, Electrical Resistivity*—The test results for each individual test specimen shall be reported as the average of results obtained from specimens prepared from each of two pieces selected in 8.1.2 and each specimen must meet the requirements of the product specification. In the case of copper-beryllium alloy, two specimens shall be taken for each required test. One specimen from each piece shall be tested without further treatment, and the other specimen shall be tested after precipitation heat treatment.

9.1.2.1 *Rockwell Hardness*—The value of the hardness number of each specimen shall be established as the arithmetical average of at least three readings and each specimen must meet the requirements of the product specification.

9.1.2.2 *Bend, Cuprous Oxide (Hydrogen Embrittlement Susceptibility), and Mercurous Nitrate Tests*—All specimens tested must meet the product requirements to qualify for specification conformance.

9.1.3 *Other Requirements*—At least two specimens shall be subjected to test for each of the other requirements and each specimen shall conform to the test requirements.

9.2 *Retests:*

9.2.1 When requested by the manufacturer or supplier, a retest shall be permitted when test results obtained by the purchaser fail to conform with the product specification requirement(s).

9.2.2 Retesting shall be as directed in the product specification for the initial test except for the number of test specimens which shall be twice that normally required for the test. Test results for all specimens shall conform to the product specification requirement(s) in retest and failure to comply shall be cause for lot rejection.

10. Specimen Preparation

10.1 *Chemical Analysis*—Sample preparation shall be in accordance with Practice E255.

10.1.1 Analytical specimen preparation shall be the responsibility of the reporting laboratory.

10.2 *Tensile Test*—The test specimen shall conform to the requirements prescribed for the particular product in the Test Specimen Section of Test Methods E8/E8M (see Round Specimens; Specimens for Wire, Rod, and Bar; Specimens for Rectangular Bar; or Specimens for Shapes Structure or Other). Unless specified, tensile testing may be performed on unmachined samples by using the maximum gage length extensometers that will fit between the gripping devices. The testing facility must be able to demonstrate that there is no statistically significant difference between the unmachined test results and the standard test method defined in Test Methods E8/E8M. Statistical significance testing must follow Practice D4855.

10.3 *Grain Size*—The test specimen shall be prepared in accordance with Guide E3.

TABLE 14 Schedule of Lengths (Specific and Stock) with Ends for Rod, Bar, and Shapes
(Applicable to Specifications B16/B16M, B21/B21M, B138/B138M (Copper Alloy UNS No. C67500 and C67600), B140/B140M, B301/B301M, B453/B453M, B927/B927M, and B974/B974M)

Diameter or Distance Between Parallel Surfaces for Round, Hexagonal, and Octagonal Rod, and Square Bar, in. [mm]	Rectangular Bar, Area,[A] in.^{2} [mm^2]	Nominal Length, ft [mm]	Shortest Permissible Length,[B] % of Nominal Length	Maximum Permissible Weight of Ends, % of Lot Weight
0.500 [12] and under	0.250 [160] and under	6 to 14 [2000 to 4250], incl	75	20
Over 0.500 to 1.00 [12 to 25], incl	over 0.250 to 1.00 [160 to 650], incl	6 to 14 [2000 to 4250], incl	70	30
Over 1.00 to 1.50 [25 to 38], incl	over 1.00 to 2.25 [650 to 1500], incl	6 to 12 [2000 to 3750], incl	60	40
Over 1.50 to 2.00 [38 to 50], incl	over 2.25 to 4.00 [1500 to 2500], incl	6 to 12 [2000 to 3750], incl	50	45
Over 2.00 to 3.00 [50 to 75], incl	over 4.00 to 9.00 [2500 to 5850], incl	6 to 10 [2000 to 3000], incl	40	50

[A] Width times thickness, disregarding any rounded corners or edges.
[B] Expressed to the nearest ½ ft [150 mm].

TABLE 15 Schedule of Lengths (Specific and Stock) with Ends for Rod, Bar, and Shapes
(Applicable to Specifications B98/B98M, B138/B138M (Copper Alloy UNS No. C67000), B139/B139M, B150/B150M, B151/B151M, B196/B196M, B371/B371M, B411/B411M, B441, B929, and B967/B967M)

Diameter or Distance Between Parallel Surfaces for Round, Hexagonal, and Octagonal Rod, and Square Bar, in. [mm]	Rectangular Bar, Area,[A] in.^{2} [mm^2]	Nominal Length, ft [mm]	Shortest Permissible Length,[B] % of Nominal Length	Maximum Permissible Weight of Ends, % of Lot Weight
0.500 [12] and under	0.250 [160] and under	6 to 12 [2000 to 4000], incl	65	30
Over 0.500 to 1.00 [12 to 25], incl	over 0.250 to 1.00 [160 to 650], incl	6 to 12 [2000 to 4000], incl	60	40
Over 1.00 to 1.50 [25 to 38], incl	over 1.00 to 2.25 [650 to 1500], incl	6 to 10 [2000 to 3000], incl	50	50
Over 1.50 to 2.00 [38 to 50], incl	over 2.25 to 4.00 [1500 to 2500], incl	6 to 10 [2000 to 3000], incl	40	60

[A] Width times thickness, disregarding any rounded corners or edges.
[B] Expressed to the nearest ½ ft [150 mm].

TABLE 16 Straightness Tolerances for Rod, Bar, and Shapes

Form and Size, in. [mm]	Length, ft [mm]	Maximum Curvature (Depth of Arc), in. [mm]
For General Use		
(Applicable to Specifications B16/B16M, B21/B21M, B98/B98M, B138/B138M, B139/B139M, B140/B140M, B150/B150M, B151/B151M, B196/B196M, B301/B301M, B371/B371M, B411/B411M, B441, B453/B453M, B927/B927M, B929, B967/B967M, and B974/B974M)		
Rod: drawn	up to 2 [600]	1/32 [0.80]
	incl 2 to 5 [600 to 1500]	1/32 in any 2-ft portion [0.80 in any 600-mm portion][A]
	incl 5 to 10 [1500 to 3000]	1/8 in any 5-ft portion [3.0 in any 1500-mm portion][A]
	10 [3000] and over	½ in any 10-ft portion [12 in any 3000-mm portion][A]
Bar and shapes (rolled or drawn)	6 [2000] and over	½ in any 6-ft portion [12 in any 2000-mm portion][A,B]
Drawn Rod—For Automatic Screw Machine Use		
(Applicable to Specifications B16/B16M,B140/B140M,B301/B301M, B453/B453M, and B974/B974M)		
Round only:		
Under ¼ [6.35]	10 [3000] and over	½ in any 10-ft portion [12 in any 3000-mm portion][A]
¼ [6.35] and over	10 [3000] and over	¼ in any 10-ft portion [6.35 in any 3000-mm portion][A]
Local departure from straightness, ¼ [6.35] and over only	...	1/64 in any 1-ft portion of the total length [0.40 in any 300-mm portion of the total length]
Hexagonal and octagonal:		
Under ¼ [6.35]	10 [3000] and over	½ in any 10-ft portion [12.7 in any 3000-mm portion][A]
¼ [6.35] and over	10 [3000] and over	3/8 in any 10-ft portion [9.5 in any 3000-mm portion][A]

[A] Of total length.
[B] Applicable to any longitudinal surface or edge.

TABLE 17 Straightness Tolerances for Shafting
(Applicable to Specifications B21/B21M, B138/B138M, B139/B139M, and B150/B150M)

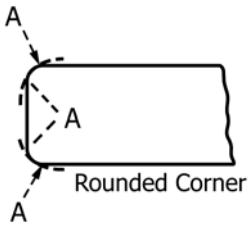
Length of Shaft, ft [mm]	Maximum Permissible Departure from Straightness of Either Center or End Portions, in. [mm]	Minimum Diameter Applicable for Length Indicated, in. [mm]
Up to 6 [2000], incl	0.005 [0.13]	½ [12]
7 [1750]	0.007 [0.18]	½ [12]
8 [2400]	0.009 [0.23]	½ [12]
9 [2750]	0.012 [0.30]	½ [12]
10 [3050]	0.014 [0.36]	½ [12]
11 [3350]	0.017 [0.43]	½ [12]
12 [3650]	0.020 [0.50]	½ [12]
14 [4250]	0.028 [0.63]	5/8 [16]
16 [4875]	0.036 [0.91]	¾ [20]
18 [5500]	0.045 [1.14]	1 [25]
20 [6100]	0.055 [1.4]	1¼ [30]
22 [6700]	0.068 [1.73]	1½ [40]
24 [7300]	0.078 [2.00]	1¾ [44]
26 [7900]	0.094 [2.38]	2 [50]

TABLE 18 Tolerances for Rounded Corner Hexagons and Octagons

Distance Between Parallel Faces, in. [mm]	Tolerances on Distance Across Corners (Plus and Minus), in. [mm]
Up to 11/16 [17.3], incl	0.008 [0.20]
Over 11/16 to 2 [17.3 to 50], incl	0.010 [0.25]
Over 2 [50]	0.5 %

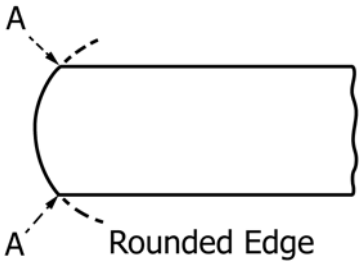
10.4 *Rockwell Hardness*—The test specimen shall be of a size and shape to permit testing by the available test equipment and shall be taken to permit testing in a plane parallel or perpendicular to the direction of deformation given to the product.

10.4.1 The surface of the test specimen shall be sufficiently smooth and even to permit the accurate determination of hardness.



NOTE 1—The arc shall not necessarily be tangent at Points *A* but the product shall be commercially free from sharp, rough, or projecting edges.

FIG. 1 Rounded Corners



NOTE 1—The arc shall be substantially symmetrical with the axis of the product. The corners, *A*, will usually be sharp but shall not have rough or projecting edges.

FIG. 2 Rounded Edge

NOTE 1—The arc shall not necessarily be tangent at Points *A* but shall be substantially symmetrical with the axis of the product, and the product shall be commercially free from sharp, rough, or projecting edges.

FIG. 3 Full Rounded Edge

10.4.2 The specimen shall be free of scale and foreign matter and care shall be taken to avoid any change in condition, that is, heating or cold work.

10.5 *Electrical Resistivity*—Test specimens are to be full size where practical and shall be the full cross section of the material it represents.

10.5.1 When the test specimen is cut from material in bulk, care shall be taken that the properties are not appreciably altered in the preparation. Plastic deformation may work harden a material and tend to raise the resistivity, while heating tends to anneal the material with a consequent reduction in resistivity.

10.5.2 When necessary, products are to be rolled or cold-drawn to a wire approximately 0.080 in. (12 gage AWG) (2.0 mm) and at least 160 in. [4000 mm] in length. The specimen shall be annealed at approximately 935 ± 10 °F [500 ± 20 °C] for 30 min in an inert atmosphere and cooled to ambient temperature in the inert atmosphere.

10.5.3 For heat-treatable material, diameter and heat treatment shall be agreed upon between the manufacturer and the purchaser.

10.6 *Residual Stress Test*—When specified in the ordering information, test specimens shall conform to the requirements of Test Methods B154 or B858, as applicable.

10.6.1 Residual stress test specimens shall be of the full size of the product and tested without bending, springing, polishing, or any other preparation, except as allowed by the test method.

10.7 *Determination of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper*—Test specimen shall conform to the appropriate requirements of the Test Specimen Section of Test Methods B577.

10.8 *Bend Test:*

10.8.1 The test specimen shall be prepared in accordance with Test Methods E290.

10.8.2 When impractical to test full-size specimens but practical to test full-thickness specimens from material not exceeding 1½ in. [40 mm] in nominal thickness, the specimens shall be of the thickness of the material and the ratio of width to thickness shall be 2:1, provided the width is not less than ¾ in. [20 mm].

10.8.3 When material exceeds ½ in. [10 mm] in thickness diameter, or distance across flats, the specimen may be machined when full-section or full-thickness specimen are not used. The diameter or thickness of the specimen shall be at least ½ in. [10 mm] and the ratio of width to thickness of rectangular specimens shall be 2:1. In rectangular specimens of reduced thickness, the outside or tension surface shall be an as fabricated surface.

10.9 *Replacement Specimens*—Should any test specimen show defective machining or develop flaws, it may be discarded and another specimen substituted.

11. Test Methods

11.1 The test method(s) used for quality control or production control, or both, for the determination of conformance with product property requirements are discretionary.

11.1.1 The test method(s) used to obtain data for the preparation of certification or test report, or both, shall be made available to the purchaser on request.

11.2 *Chemical Composition:*

11.2.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer, or supplier and the purchaser. An applicable test method may be found in the following documents: Test Methods E53, E54, E62, E75, E76, E118, E121, E478, and E581.

11.2.1.1 The specific method to be used for each specified element may be prescribed in the product specification.

11.2.1.2 The test methods for the determination of composition for copper-beryllium alloys shall be as described in Annex A1 of Specification B194.

11.2.2 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.

11.3 *Other Tests:*

11.3.1 The product in final form shall conform with physical, mechanical, and other requirements specified in the

product specification when subjected to test in accordance with the appropriate test method in the following table:

Test	Test Methods
Grain size	E112
Electrical resistivity	B193
Tensile	E8/E8M
Rockwell hardness	E18
Hydrogen embrittlement	B577
Semi-guided bend	E290

11.3.2 *Grain Size*—The intercept method shall be used to determine grain size in case of dispute.

11.3.3 *Electrical Resistivity*—The limit of measurement uncertainty for Test Method B193 shall be ±0.30 % as a routine method and ±0.15 % as an umpire method.

11.3.4 *Tensile:*

11.3.4.1 The method to be used for determining yield strength shall be specified in the product specification.

11.3.4.2 Elongation shall be determined in accordance with the first two paragraphs of the subsection entitled "Elongation" of the Procedure section of Test Methods E8/E8M.

11.3.4.3 Whenever test results are obtained from both full-size and machined specimens and they differ, the test results from the full-size specimens shall prevail.

11.3.4.4 Test results are not seriously affected by variations in speed of testing. A considerable range of testing speed is permitted; however, the rate of stressing to the yield strength should not exceed 100 ksi/min. Above the yield strength the movement per minute of the testing machine head under load should not exceed 0.5 in./in. or gage length (or distance between grips for full-section specimens).

11.3.5 *Rockwell Hardness*—Special attention should be given the Standardizing Machine section of Test Methods E18.

11.3.6 *Hydrogen Embrittlement*—In case of dispute, Procedure C, Closed Bend Test, of Test Methods B577 shall be used.

11.4 The product shall meet the performance requirements of the product specification when subjected to the following test as required:

11.4.1 *Residual Stress Tests:*

11.4.1.1 Unless otherwise agreed upon by 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.

11.4.1.2 *Mercurous Nitrate Test*—The material shall be subjected to test in accordance with Test Method B154.

11.4.1.3 *Ammonia Vapor Test*—The material shall be subjected to test in accordance with Test Method B858. If the pH value is not specified in the product specification, it shall be established per agreement between the supplier and purchaser.

11.4.2 *Semiguided Bend Test*—The mandrel radius and bend angle shall be specified in the product specification. When the test specimen has been machined, the retained original surface shall constitute the outer periphery of the bend that shall be made on a radius equal to that dimension of the machined radial to the bend.

12. Significance of Numerical Limits

12.1 For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following table and for dimensional tolerances, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29.

Property	Rounded Unit for Observed or Calculated Value
Chemical composition	
Hardness	nearest unit in the last right-hand
Electrical resistivity	significant digit used in expressing the
Electrical conductivity	limiting value
Tensile strength	nearest ksi [5 MPa]
Yield strength	
Elongation:	nearest 1 %
Grain size:	
Under 0.060 mm	nearest multiple of 0.005 mm
0.060 mm and over	nearest 0.01 mm

13. Inspection

13.1 The manufacturer, or supplier, shall inspect and make tests necessary to verify the furnished product conforms to the specification requirements.

13.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer, or supplier, and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector representing the purchaser, that the product is being furnished in accordance with the product specification, shall be included in the agreement. All testing and inspection shall be conducted so as not to interfere unnecessarily with the operations of the works.

13.3 When mutually agreed upon, the manufacturer, or supplier, and the purchaser may conduct the final inspection simultaneously.

14. Rejection and Rehearing

14.1 *Rejection:*

14.1.1 Product that fails to conform to the product specification requirements when tested by the purchaser or purchaser's agent, shall be subject to rejection.

14.1.2 Rejection shall be reported to the manufacturer, or supplier, promptly. In addition, a written notification of rejection shall follow.

14.1.3 In case of dissatisfaction with the results of the test upon which rejection is based, the manufacturer or supplier shall have the option to make claim for a rehearing.

14.2 *Rehearing:*

14.2.1 As a result of product rejection, the manufacturer or supplier shall have the option to make claim for a retest to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification, or, alternately, upon agreement by both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

15. Certification

15.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and inspected as directed in the product specification and the requirements have been met.

15.2 When specified in the purchase order or contract, that product is purchased for ASME Boiler and Pressure Vessel applications, certification to the product specification is mandatory.

16. Mill Test Report

16.1 When specified in the purchase order or contract, a report of test results shall be furnished.

17. Product Marking

17.1 Product identification marking shall be as required by the product specification.

18. Packaging and Package Marking

18.1 *Packaging:*

18.1.1 The product shall be separated by size, composition, and temper, and prepared for shipment by common carrier, in such a manner to afford protection from the normal hazards of transportation.

18.1.2 When specified in the purchase order or contract, that product is purchased for agencies of the U.S. Government, the requirements of Practice B900 may apply.

18.2 *Package Marking*—Each shipping unit shall be legibly marked with the purchase order number, Copper or Copper Alloy UNS No., designation, temper, size, shape, gross and net weight, and name of supplier or manufacturer. The specification number shall be shown when specified.

19. Keywords

19.1 bar, general requirements; bar, rod, shapes, general requirements; rod, general requirements; shape, general requirements

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order, for agencies of the U.S. Government.

S1. Referenced Documents

S1.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

S1.1.1 *ASTM Standard:*

B900 Specification for Packaging of Copper and Copper Alloy Mill Products for US Government

S1.1.2 *Federal Standards:*[5]

Fed. Std. No. 102 Preservation, Packaging, and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. No. 185 Identification Marking of Copper and Copper-Base Alloy Mill Products

S1.1.2 *Military Standard:*[5]

MIL-STD-129 Marking for Shipment and Storage

S2. Quality Assurance

S2.1 *Responsibility for Inspection:*

S2.1.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified. Except as otherwise specified in the contract or purchase order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements unless disapproved by the purchaser at the time the order is placed. The purchaser shall have the right to perform any of the inspections or tests set forth when such inspections and tests are deemed necessary to ensure that the material conforms to prescribed requirements.

S3. Identification Marking

S3.1 All material shall be properly marked for identification in accordance with Fed. Std. No. 185 except that the ASTM specification number and the alloy number shall be used.

S4. Preparation for Delivery

S4.1 *Preservation, Packaging, Packing:*

S4.1.1 *Military Agencies*—The material shall be separated by size, composition, grade or class, and shall be preserved and packaged, Level A or C, packed Level A, B, or C, as specified in the contract or purchase order, in accordance with the requirements of Practice B900.

S4.1.2 *Civil Agencies*—The requirements of Fed. Std. No. 102 shall be referenced for definitions of the various levels of packaging protection.

S4.2 *Marking:*

S4.2.1 *Military Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with MIL-STD-129.

S4.2.2 *Civil Agencies*—In addition to any special marking required by the contract or purchase order, marking for shipment shall be in accordance with Fed. Std. No. 123.

[5] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

APPENDIX

(Nonmandatory Information)

X1. STANDARD DENSITIES

X1.1 For purposes of calculating weights, cross sections, and so forth, the densities of the coppers and copper alloys covered by the specifications listed in Section 1 shall be taken as follows:

TABLE X1.1 Densities of Coppers and Copper Alloys

ASTM Designation	Material	Copper or Copper Alloy UNS No.	Density, lb/in.^{3} [g/cm^3]
B16/B16M	free-cutting brass	C36000	0.307 [8.50]
B21/B21M	naval brass	C46200	0.305 [8.44]
		C46400	0.304 [8.41]
		C48200	0.305 [8.42]
		C48500	0.305 [8.41]
B98/B98M	copper-silicon alloy	C65100	0.316 [8.75]
		C65500	0.308 [8.53]
		C65800	0.308 [8.53]
		C66100	0.308 [8.53]
B124/B124M	copper	C11000	0.323 [8.94]
	copper-tellurium	C14500	0.323 [8.94]
	copper-sulfur	C14700	0.323 [8.94]
	plumbing brass	C27450	0.304 [8.41]
	copper-zinc alloy	C27453	0.305 [8.44]
	copper-zinc brass	C28500	0.303 [8.40]
	forging brass	C37700	0.305 [8.44]
	naval brass	C46400	0.304 [8.41]
	tin brass	C46750	0.306 [8.48]
	medium leaded naval brass	C48200	0.305 [8.44]
	leaded naval brass	C48500	0.305 [8.44]
	bismuth brass	C49250	0.301 [8.41]
		C49255	0.304 [8.41]
		C49260	0.303 [8.40]
	low leaded bismuth brass	C49265	0.303 [8.40]
	bismuth brass	C49300	0.304 [8.42]
		C49340	0.305 [8.45]
	low leaded bismuth brass	C49345	0.305 [8.45]
	bismuth brass	C49350	0.311 [8.45]
		C49355	0.300 [8.30]
		C49360	0.304 [8.41]
	aluminum-bronze	C61900	0.271 [7.5]
	aluminum-bronze, 9 %	C62300	0.277 [7.66]
	aluminum-nickel bronze	C63000	0.274 [7.58]
	aluminum-silicon bronze	C64200	0.278 [7.69]
	aluminum-silicon bronze, 6.7 %	C64210	0.278 [7.69]
	high-silicon bronze (A)	C65500	0.308 [8.53]
	manganese bronze (A)	C67500	0.302 [8.36]
	copper-zinc-silicon-manganese	C69240	0.301 [8.33]
	nickel silver, 45-10	C77400	0.306 [8.47]
B138/B138M	manganese bronze	C67000	0.286 [7.92]
		C67500	0.302 [8.36]
B139/B139M	phosphor bronze	C51000	0.320 [8.86]
		C52100	0.318 [8.80]
		C52400	0.317 [8.77]
		C53400	0.322 [8.91]
		C54400	0.320 [8.86]
B140/B140M	leaded red brass	C31400	0.319 [8.83]
		C31600	0.320 [8.86]
		C32000	0.317 [8.77]
B150/B150M	aluminum bronze	C61300	0.285 [7.89]
	aluminum bronze	C61400	0.285 [7.89]
	aluminum bronze	C61900	0.270 [7.5]
	aluminum bronze, 9%	C62300	0.276 [7.66]
	aluminum bronze	C62400	0.269 [7.45]
	aluminum-nickel bronze	C63000	0.274 [7.58]
	aluminum-nickel bronze	C63200	0.276 [7.64]
	aluminum-silicon bronze	C64200	0.278 [7.69]
	aluminum-silicon bronze, 6.7 %	C64210	0.278 [7.69]
B151/B151M	copper-nickel-zinc alloy (nickel silver) and copper-nickel alloy	C70600	0.323 [8.94]
		C71500	0.323 [8.94]
		C72000	0.323 [8.94]
		C74500	0.313 [8.86]
		C75200	0.317 [8.77]
		C75700	0.314 [8.69]

TABLE X1.1 *Continued*

ASTM Designation	Material	Copper or Copper Alloy UNS No.	Density, lb/in.^{3} [g/cm^3]
		C76400	0.315 [8.72]
		C77000	0.314 [8.69]
		C79200	0.314 [8.69]
		C79400	0.317 [8.77]
B187/B187M	copper:	. . .	0.323 [8.94]
	deoxidized and oxygen-free	. . .	0.321 [8.89]
	other classifications		
B196/B196M	copper-beryllium alloy	C17000	0.297 [8.22]
		C17200	0.297 [8.22]
		C17300	0.297 [8.22]
B301/B301M	free-cutting copper	C14500	0.323 [8.94]
		C14700	0.323 [8.94]
		C14710	0.323 [8.94]
		C14720	0.323 [8.94]
		C18700	0.323 [8.94]
B371/B371M	copper-zinc-silicon alloy	C69400	0.296 [8.94]
		C69700	0.300 [8.19]
B411/B411M	copper-nickel-silicon alloy	C64700	0.322 [8.91]
B441	copper-cobalt-beryllium	C17500	0.316 [8.75]
	copper-nickel-beryllium	C17510	0.316 [8.75]
B453/B453M	copper-zinc-lead (leaded brass)	C33500	0.306 [8.47]
		C34000	0.306 [8.47]
		C34500	0.306 [8.47]
		C35000	0.305 [8.44]
		C35300	0.306 [8.47]
		C35330	0.306 [8.47]
		C35600	0.307 [8.50]
B455	copper-zinc-lead (leaded brass)	C38000	0.305 [8.44]
		C38500	0.306 [8.47]
B929	copper-nickel-tin spinodal alloy	C72900	0.323 [8.94]
B967/B967M	bismuth brass	C49250	0.301 [8.41]
		C49255	0.304 [8.41]
		C49260	0.303 [8.40]
	low leaded bismuth brass	C49265	0.303 [8.40]
	bismuth brass	C49300	0.304 [8.42]
		C49340	0.305 [8.45]
	low leaded bismuth brass	C49345	0.305 [8.45]
	bismuth brass	C49350	0.305 [8.45]
		C49355	0.300 [8.30]
		C49360	0.304 [8.41]

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B249/B249M – 16) that may impact the use of this standard. (Approved April 1, 2017.)

(1) Added UNS Alloy Nos. C27453 and C28500 to Table 2, Table 4, Table 9, Table 11, and Table X1.1.

Committee B05 has identified the location of selected changes to this standard since the last issue (B249/B249M – 15a) that may impact the use of this standard. (Approved Oct. 1, 2016.)

(1) Added UNS Alloy Nos. C49265 and C49345 to Table 1, Table 4, and Table X1.1.