Designation: B248M – 12

Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric)[1]

This standard is issued under the fixed designation B248M; 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 general requirements common to several wrought product specifications. Unless otherwise specified in the purchase order or in an individual specification, these general requirements shall apply to copper and copper-alloy plate, sheet, strip, and rolled bar supplied under each of the following product specifications issued by ASTM: B36/B36M, B96/B96M, B103/B103M, B121/B121M, B122/B122M, B152/B152M, B169/B169M, B194, B422, B465, B534, B591, B592, B694, B740, B747, B768, and B888.[2]

1.2 *Units*—This specification is the companion specification to inch-pound Specification B248.

2. Referenced Documents

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

2.2 *ASTM Standards:*[3]

B36/B36M Specification for Brass Plate, Sheet, Strip, And Rolled Bar

B96/B96M Specification for Copper-Silicon Alloy Plate, Sheet, Strip, and Rolled Bar for General Purposes and Pressure Vessels

B103/B103M Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar

B121/B121M Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar

B122/B122M Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar

B152/B152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar

B169/B169M Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar

B193 Test Method for Resistivity of Electrical Conductor Materials

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

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B422 Specification for Copper-Aluminum-Silicon-Cobalt Alloy, Copper-Nickel-Silicon-Magnesium Alloy, Copper-Nickel-Silicon Alloy, Copper-Nickel-Aluminum-Magnesium Alloy, and Copper-Nickel-Tin Alloy Sheet and Strip

B465 Specification for Copper-Iron Alloy Plate, Sheet, Strip, and Rolled Bar

B534 Specification for Copper-Cobalt-Beryllium Alloy and Copper-Nickel-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar

B591 Specification for Copper-Zinc-Tin and Copper-Zinc-Tin-Iron-Nickel Alloys Plate, Sheet, Strip, and Rolled Bar

B592 Specification for Copper-Zinc-Aluminum-Cobalt Alloy, Copper-Zinc-Tin-Iron Alloy Plate, Sheet, Strip, and Rolled Bar

B694 Specification for Copper, Copper-Alloy, Copper-Clad Bronze (CCB), Copper-Clad Stainless Steel (CCS), and Copper-Clad Alloy Steel (CAS) Sheet and Strip for Electrical Cable Shielding

B740 Specification for Copper-Nickel-Tin Spinodal Alloy Strip

B747 Specification for Copper-Zirconium Alloy Sheet and Strip

B768 Specification for Copper-Cobalt-Beryllium Alloy and Copper-Nickel-Beryllium Alloy Strip and Sheet

B846 Terminology for Copper and Copper Alloys

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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[2] The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix can be used to accommodate composition variations of the base alloy.

[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**

B888 Specification for Copper Alloy Strip for Use in Manufacture of Electrical Connectors or Spring Contacts
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
E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials
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]
E106 Test Methods for Chemical Analysis of Copper-Beryllium Alloys (Withdrawn 2011)[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
E478 Test Methods for Chemical Analysis of Copper Alloys
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

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 *coil, n*—a length of the product wound into a series of connected turns. The unqualified term "coil" as applied to "flat product" usually refers to a coil in which the product is spirally wound, with the successive layers on top of one another. (Sometimes called a "roll.")

3.2.2 *lengths, mill, n*—straight lengths, including ends, that can be conveniently manufactured in the mills. Full length pieces are usually 2400, 3000, or 3600 mm and subject to established length tolerances.

3.2.2.1 *lengths, stock, n*—straight lengths that are mill cut and stored in advance of orders. They are usually 2400, 3000, or 3600 mm and subject to established length tolerances.

3.2.3 *rolled bar, n*—a rolled flat product over 5 mm thick and up to and including 300 mm wide, with sheared, sawed, or machined edges, in straight lengths or coils (rolls).

4. Materials and Manufacture

4.1 *Materials:*

4.1.1 The material of manufacture shall be a cast bar, cake, slab of such purity and soundness as to be suitable for processing into the products to the product specification listed in Section 1.

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

4.2 *Manufacture:*

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

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

4.3 *Edges*—The edges shall be slit, shared, sawed, or rolled edges, as specified. Slit edges shall be furnished unless otherwise specified in the contract or purchase order. See 5.6 for edge descriptions and corresponding tables for tolerances.

5. Dimensions, Mass, and Permissible Variations

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

NOTE 1—Blank spaces in the tolerance tables indicate either that the material is not available or that no tolerances have been established.

5.2 *Thickness*—The standard method of specifying thickness shall be in decimal fractions of a millimetre. For material 0.50 mm and under in thickness, it is recommended that the nominal thicknesses be stated not closer than the nearest 0.01 mm. A list of preferred thicknesses is shown in Appendix X1. The thickness tolerances shall be those shown in Tables 1-3 for the product specification indicated:

5.2.1 Table 1—Thickness tolerances applicable to Specifications B36/B36M, B103/B103M, B121/B121M, B152/B152M, B465, B591, B592, B747, and B888.

5.2.2 Table 2—Thickness tolerances applicable to Specifications B96/B96M, B122/B122M, B169/B169M, B194, B422, B534, B740, and B768.

5.2.3 Table 3—Special thickness tolerances applicable to Copper Alloy UNS No. C72500 when ordered to Specification B122/B122M, and to Specifications B194, B534, B740, and B768 as noted in the table.

5.3 *Width*—The width tolerances shall be those shown in Tables 4-6 depending on the type of edge required (see 5.3.1, 5.3.2, and 5.3.3):

5.3.1 Table 4—Width tolerances for slit metal and slit metal with rolled edges.

5.3.2 Table 5—Width tolerances for square-sheared metal.

5.3.3 Table 6—Width tolerances for sawed metal.

5.4 *Length*—The material shall be furnished in coils or straight lengths of plate, sheet, strip, or rolled bar as specified. The length tolerances for straight lengths shall be those shown in Tables 7-10 depending on the method of cutting required (see 5.4.1 – 5.4.4). When ends are permitted, the length and quantity of the ends shall be in accordance with the schedule in Table 8.

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

TABLE 1 Thickness Tolerances
(Applicable to Specifications B36/B36M, B103/B103M, B121/B121M, B152/B152M, B465, B591, B592, B747 and B888)

Thickness, mm		Thickness Tolerances, Plus and Minus, mm						
		Strip			Sheet			
Over	Through	Up to 200 mm, incl, in Width	Over 200 mm to 300 mm, incl, in Width	Over 300 mm to 600 mm, incl, in Width	Over 600 mm to 700 mm, incl, in Width	Over 700 mm to 900 mm, incl, in Width	Over 900 mm to 1200 mm, incl, in Width	Over 1200 mm to 1600 mm, incl, in Width
	0.10	0.007	0.015	...	...	...	...	...
0.10	0.20	0.01	0.02	0.03	...	...	...	...
0.20	0.30	0.015	0.025	0.035	...	...	...	...
0.30	0.40	0.02	0.03	0.045	0.06	0.08	0.09	0.10
0.40	0.50	0.025	0.035	0.05	0.06	0.08	0.09	0.11
0.50	0.60	0.03	0.04	0.05	0.08	0.09	0.10	0.12
0.60	0.70	0.035	0.05	0.06	0.08	0.09	0.10	0.12
0.70	1.0	0.045	0.05	0.06	0.09	0.10	0.12	0.15
1.0	1.3	0.05	0.06	0.07	0.10	0.12	0.15	0.17
1.3	2.0	0.06	0.07	0.08	0.12	0.15	0.17	0.20
2.0	3.5	0.07	0.08	0.10	0.15	0.17	0.20	0.25
3.5	5.0	0.08	0.10	0.11	.17	0.20	0.25	0.30
		Rolled Bar			Plate			
5.0	8.0	0.10	0.11	0.12	0.22	0.25	0.30	0.35
8.0	13.0	0.11	0.12	0.15	0.30	0.35	0.40	0.45
13.0	20.0	0.13	0.17	0.22	0.40	0.45	0.50	0.60
20.0	30.0	0.17	0.22	0.27	0.45	0.55	0.60	0.75
30.0	40.0	0.55	0.55	0.55	0.55	0.65	0.75	0.90
40.0	60.0	0.65	0.65	0.65	0.65	0.75	0.90	1.1

TABLE 2 Thickness Tolerances
(Applicable to Specifications B96/B96M, B122/B122M, B169/B169M, B194, B422, B534, B740, and B768)

Thickness, mm		Thickness Tolerances, Plus and Minus, mm						
		Strip			Sheet			
Over	Through	Up to 200 mm, incl, in Width	Over 200 mm to 300 mm, incl, in Width	Over 300 mm to 600 mm, incl, in Width	Over 600 mm to 700 mm, incl, in Width	Over 700 mm to 900 mm, incl, in Width	Over 900 mm to 1200 mm, incl, in Width	Over 1200 mm to 1600 mm, incl, in Width
	0.10	0.01	0.02	...	...	...	...	...
0.10	0.20	0.015	0.025	0.035	...	...	...	...
0.20	0.30	0.02	0.03	0.05	...	...	...	...
0.30	0.40	0.025	0.035	0.06	...	...	...	...
0.40	0.50	0.03	0.05	0.06	...	...	...	...
0.50	0.60	0.035	0.06	0.07	...	...	...	...
0.60	0.70	0.05	0.06	0.07	0.10	0.13	0.15	0.18
0.70	1.0	0.06	0.07	0.08	0.13	0.15	0.18	0.20
1.0	1.3	0.07	0.08	0.10	0.15	0.18	0.20	0.25
1.3	2.0	0.08	0.10	0.11	0.18	0.20	0.25	0.30
2.0	3.5	0.10	0.11	0.12	0.20	0.25	0.30	0.35
3.5	5.0	0.11	0.13	0.15	0.25	0.30	0.35	0.40
		Rolled Bar			Plate			
5.0	8.0	0.13	0.15	0.18	0.30	0.35	0.40	0.45
8.0	13.0	0.15	0.18	0.20	0.40	0.45	0.50	0.60
13.0	20.0	0.20	0.25	0.30	0.50	0.55	0.60	0.75
20.0	30.0	0.30	0.40	0.50	0.60	0.65	0.75	0.95
30.0	40.0	0.70	0.70	0.70	0.70	0.80	0.95	1.2
40.0	60.0	0.85	0.85	0.85	0.85	0.95	1.1	1.4

5.4.1 Table 7—Length tolerances for straight lengths.

5.4.2 Table 8—Schedule of minimum length and maximum weight of ends for mill lengths, specific lengths with ends, and stock lengths with ends.

5.4.3 Table 9—Length tolerances for square-sheared metal in all widths 3000 mm and under.

5.4.4 Table 10—Length tolerances for sawed metal.

5.5 *Straightness*—The straightness tolerances which are the maximum edgewise curvature (depth of arc) in any 1800-mm portion of the total length, shall be those shown in Tables 11-13 depending on the type of edge required.

5.5.1 Table 11—Straightness tolerances for metal as slit, or as slit and straightened, or as slit and edge-rolled, or metal with drawn edges.

5.5.2 Table 12—Straightness tolerances for square-sheared metal.

5.5.3 Table 13—Straightness tolerances for sawed metal.

TABLE 3 Special Thickness Tolerances

Thickness, mm	Tolerances Applicable to Copper Alloy UNS No. C72500, Specifications B122/B122M Tolerances, Plus and Minus,[A] mm for Strip 200 mm and Under in Width	Tolerances Applicable to Specifications B194, B534, B740, and B768 Tolerances, Plus and Minus,[A] mm for Strip 100 mm and Under in Width
0.10 and under	0.005	0.005
Over 0.10 to 0.16, incl	0.008	0.008
Over 0.016 to 0.22, incl	0.010	0.013
Over 0.22 to 0.35, incl	0.013	0.015
Over 0.35 to 0.45, incl	0.018	0.018
Over 0.45 to 0.55, incl	0.020	0.020
Over 0.55 to 0.60, incl	0.025	0.025
Over 0.65 to 0.80, incl	0.033	0.025
Over 0.80 to 1.2, incl	0.038	...

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

5.6 *Edges*—When rolled edges are required, they may be produced by either rolling or drawing to one of the following specified edge contours:

5.6.1 *Square Edges (Square Corners)*—Edges shall have commercially-squared corners with a permissible maximum radius as prescribed in Table 14.

5.6.2 *Rounded Corners*—Edges shall have rounded corners as shown in Fig. 1 with a radius as prescribed in Table 15.

5.6.3 *Rounded Edges*—Edges shall be rounded as shown in Fig. 2 with a radius as prescribed in Table 16.

5.6.4 *Full-Rounded Edges*—Edges shall be full-rounded as shown in Fig. 3 with a radius as prescribed in Table 17.

5.7 *Weight Tolerances for Hot-Rolled Material:*

5.7.1 Table 18—Lot weight tolerances for hot-rolled sheet and plate applicable to Specifications B36/B36M, B96/B96M (Copper Alloy UNS No. C65500), B103/B103M, B122/B122M, B152/B152M, and B591.

5.7.2 The weight of each lot of five or more plates or sheets of the same type and the same specified dimensions, when ordered to thickness, shall not vary from the theoretical by more than the amount prescribed in Table 18 for the product specification indicated. The weight of any individual plate or sheet may vary from the nominal by not more than one third in excess of the tolerances prescribed in Table 18 for the product specification indicated. The tolerances for lots of less than five plates or sheets shall be governed by the tolerances for individual plates or sheets.

5.7.3 For the purpose of calculation, the densities of the materials covered by these specifications are listed in Appendix X2.

6. Workmanship, Finish, and Appearance

6.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable. A superficial film of residual light lubricant is normally present and is acceptable unless otherwise specified.

7. Sampling

7.1 *Sampling*—The lot size, portion size, and selection of sample pieces shall be as follows:

7.1.1 *Lot Size*—An inspection lot shall be 5000 kg or less material of the same mill form, alloy, temper and nominal dimensions, subject to inspection at one time, or shall be the product of one cast bar from a single melt charge, whose weight shall not exceed 12 000 kg that has been continuously processed and subject to inspection at one time.

7.1.2 *Portion Size*—A portion shall be two representative samples taken from the product of one cast bar that has been continuously processed to the finished temper and dimensions.

7.1.2.1 *Chemical Analysis*—A sample for chemical analysis shall be taken in accordance with Practice E255 for product in its final form. Unless required otherwise by the purchaser at the time the order is placed, the manufacturer shall have the option of determining conformance to chemical composition by analyzing samples taken at the time the castings are poured or samples taken from the semi-finished product, if heat identity can be maintained throughout all operations. If the manufacturer determines the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product. The minimum weight of the composite sample in accordance with Practice E255 shall be as follows:

ASTM Designation	Weight of Sample, min, g
B36/B36M, B96/B96M, B103/B103M, B121/B121M, B122/B122M, B152/B152M, B169/B169M, B194, B422, B465, B534, B591, B592,B740, B747, B768, and B888	150

7.1.2.2 *Samples for All Other Tests*—Samples for all other tests shall be taken from the sample portion in 7.1.2 and be of a convenient size to accommodate the test and comply with the requirements of the appropriate ASTM standard and test methods.

8. Number of Tests and Retests

8.1 *Chemical Requirements:*

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

8.1.2 When samples are taken from the semi-finished or finished product, at least one sample representative of the product of each cast bar from a single melt charge continuously processed with heat identity maintained shall be analyzed.

8.1.3 When samples are taken from the semi-finished or finished product and heat identity has not been maintained, a single sample representative of each 5000-kg lot, or fraction thereof, shall be analyzed. When the product piece is greater than 5000 kg, one sample to be representative of the product piece shall be analyzed.

8.2 *Mechanical and Electrical Requirements and Grain Size*—Unless otherwise provided in the product specification, test specimens shall be taken from each of the two sample pieces selected in accordance with 7.1.2. The required tests shall be made on each of the specimens. In the case of copper alloy Specifications B194, B534, and B740, one specimen shall be tested without further treatment, and the other specimen shall be tested after precipitation hardening. In the case of the

TABLE 4 Width Tolerances for Slit Metal and Slit Metal with Rolled Edges
(Applicable to all specifications listed in 1.1)

Width, mm	Width Tolerances,[A] Plus and Minus, mm			
	For Thicknesses 0.102 to 0.80 mm, incl	For Thicknesses Over 0.80 to 3.2 mm, incl	For Thicknesses Over 3.2 to 5.0 mm, incl	For Thicknesses Over 5.0 to 12.0 mm, incl
50.8 and under	0.13	0.25	0.30	0.38
Over 50.8 to 200, incl	0.20	0.33	0.38	0.38
Over 200 to 600, incl	0.40	0.40	0.40	0.79
Over 600 to 1270, incl	0.79	0.79	0.79	1.19

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

TABLE 5 Width Tolerances for Square-Sheared Metal
(Applicable to all specifications listed in 1.1)

NOTE 1—All lengths up to 3.05 m, inclusive.

Width, mm	Width Tolerances,[A] Plus and Minus, mm		
	1.59 mm and Under in Thickness	Over 1.5 mm to 3.5 mm, incl, in Thickness	Over 3.5 mm in Thickness
500 and under	0.79	1.2	1.6
Over 500 to 900, incl	1.2	1.2	1.6
Over 900 to 3000, incl	1.6	1.6	1.6

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

TABLE 6 Width Tolerances for Sawed Metal
(Applicable to all specifications listed in 1.1)

Width, mm	Width Tolerances,[A] Plus and Minus, mm		
	For Lengths Up to 3000 mm, incl		For Length Over 3000 mm
	For Thicknesses Up to 38 mm, incl	For Thicknesses Over 38.1 mm	All Thicknesses
Up to 300, incl	0.79	1.6	1.6
Over 300 to 3000, incl	1.6	1.6	1.6

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

TABLE 7 Length Tolerances for Straight Lengths
(Applicable to all specifications listed in 1.1 except B694)

NOTE 1—The following length tolerances 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, mm	Length Tolerances, mm
Specific lengths, mill lengths, multiple lengths, and specific lengths with ends	
3000 and under	6.4
Over 3000 to 6000, incl	13
Stock lengths and stock lengths with ends	25[A]

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

requirements in Table 4, Mill Hardened Tempers, in Specifications B194 and B740, the two specimens need to be tested, because the product is in the precipitation hardened temper as supplied. The reported value shall be the arithmetic average of the readings. In the case of hardness, three readings shall be taken and averaged for each sample.

8.3 *Retests:*

8.3.1 If the chemical analysis of the specimens prepared from samples selected in accordance with 7.1.2 fails to conform to the specified limits, analysis shall be made on a new composite sample prepared from the samples selected in accordance with 7.1.2.

8.3.2 If one of the two tests made to determine any of the mechanical or physical properties fails to meet a specified limit, this test shall be repeated on the remaining sample pieces, selected in accordance with 7.1.2 and the results of these tests shall comply with the specified requirements.

8.3.3 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

8.3.4 If the percent elongation of any tension test specimen is less than that specified and any part of the fracture is outside the middle two thirds of the gage length or in a punched or scribed mark within the reduced section, a retest shall be allowed.

8.3.5 If a bend test specimen fails, due to conditions of bending more severe than required by the specification, a retest shall be permitted, either on a duplicate specimen or on a remaining portion of the failed specimen.

8.3.6 After removal of defective specimens and correction of test methods, only one retest cycle is permitted. If after the retest the material fails to meet the requirements of this specification, it shall be rejected.

9. Specimen Preparation

9.1 *Chemical Analysis*—A composite sample of the semi-finished or finished product shall be prepared in accordance with Practice E255 or as described in 7.1.2.1.

9.2 Specimens shall be prepared in accordance with the method prescribed in 10.3 for all other tests. Full cross section specimens shall be used whenever possible. Samples shall be representative of the condition of the material, and particular specimen preparation techniques shall be stated in the specific product specification.

10. Test Methods

10.1 The test method used for routine chemical analysis for specification compliance and preparation of certifications and test reports, when required, shall be at the discretion of the reporting laboratory.

10.1.1 Commonly accepted technique for routine chemical analysis of copper and copper alloys include, but are not limited to, X-ray fluorescence spectroscopy, atomic absorption spectrophotometry, argon plasma spectroscopy, and emission spectroscopy.

TABLE 8 Schedule of Minimum Length and Maximum Weight of Ends for Mill Lengths, Specific Lengths with Ends, and Stock Lengths with Ends
(Applicable to all specifications listed in 1.1 except B694)

Nominal Length, mm	1.3 mm and Under in Thickness		Over 1.3 to 3.2 mm, incl, in Thickness		Over 3.2 to 6.5 mm, incl, in Thickness	
	Minimum Length of Shortest Piece, mm	Maximum Permissible Weight of Ends, % of Lot Weight	Minimum Length of Shortest Piece, mm	Maximum Permissible Weight of Ends, % of Lot Weight	Minimum Length of Shortest Piece, mm	Maximum Permissible Weight of Ends, % of Lot Weight
1800 to 2400, incl	1200	20	1200	25	900	30
2400 to 3000, incl	1800	25	1500	30	1200	35
3000 to 4300, incl	2000	30	1800	35	1500	40

TABLE 9 Length Tolerances for Square-Sheared Metal in All Widths 3000 mm and Under
(Applicable to all specifications listed in 1.1 except B694)

Length, mm	Length Tolerance,[A] Plus and Minus, mm		
	For Thicknesses Up to 1.6 mm, incl	For Thicknesses Over 1.6 to 3.2 mm, incl	For Thicknesses Over 3.2mm
508 and under	0.8	1.2	1.6
Over 508 to 914, incl	1.2	1.2	1.6
Over 914 to 3048, incl	1.6	1.6	1.6

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

TABLE 10 Length Tolerances for Sawed Metal
(Applicable to all specifications listed in 1.1 except B694)

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

Width, mm	Length Tolerance, mm
Up to 3000, incl	64

TABLE 11 Straightness Tolerances for Slit Metal or Slit Metal Either Straightened or Edge-Rolled
(Applicable to all specifications listed in 1.1)

Maximum Edgewise Curvature (Depth of Arc) in any 1800-mm Portion of the Total Length			
Width, mm	Straightness Tolerance, mm		
	As Slit Only		As Slit and Either Straightened or Edge Rolled
	Shipped in Rolls	Shipped Flat	Shipped Flat, in Rolls, or on Bucks
Over 6 to 10, incl	51	38	13
Over 10 to 12, incl	38	25	13
Over 12 to 25, incl	25	19	13
Over 25 to 50, incl	16	16	9.5
Over 50 to 100, incl	13	13	9.5
Over 100	9.5	9.5	9.5

10.2 In case of disagreement concerning chemical composition, an applicable test method for chemical analysis may be found in Test Methods E53, E54, E62, E75, E106, E118, E121, or E478.

10.2.1 The specific test method(s) to be used shall be stated in the particular product specification.

10.2.2 In case of disagreement concerning sulfur content, the test method described in the Annex shall be used.

TABLE 12 Straightness Tolerances for Square-Sheared Metal
(Applicable to all specifications listed in 1.1)
(Not applicable to metal over 3000 mm in length)

Maximum Edgewise Curvature (Depth of Arc) in any 1800-mm Portion of the Total Length		
Thickness, mm	Straightness Tolerances, mm	
	Up to 250 mm, incl, in Width	Over 250 mm in Width
3.2 and under	1.6	0.79
Over 3.2 to 5.0, incl	3.2	1.2
Over 5.0	3.2	1.6

TABLE 13 Straightness Tolerances for Sawed Metal
(Applicable to all specifications listed in 1.1)
(Not applicable to metal over 3600 mm in length)

Maximum Edgewise Curvature (Depth of Arc) in Any 2000-mm Portion of the Total Length	
Width, mm	Straightness Tolerances, mm
80 and under	1.6
Over 80	1.2

TABLE 14 Tolerances for Radius of Commercially Square Corners of Rolled or Drawn Edges with Square Corners
(Applicable to all specifications listed in 1.1 except B694)

Thickness, mm	Permissible Radius of Corners, max, mm
0.8 to 1.6, incl	0.25
Over 1.6 to 4.8, incl	0.40
Over 4.8 to 25, incl	0.8

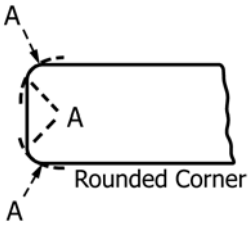
10.3 The following test methods shall be used for determining the mechanical and physical properties required in the specifications listed in Section 1:

Tension	E8/E8M
Grain size	E112
Rockwell hardness	E18
Electrical resistivity	B193

10.3.1 The testing procedure used for a particular property is dependent upon alloy, temper, and configuration of the product. The manufacturer shall have the option of selecting the most representative procedure unless a specific procedure is specified at the time the contract is placed.

11. Significance of Numerical Limits

11.1 For the purposes of determining compliance with the specified limits for requirements of the properties listed in the following table and for dimensional tolerances, an observed



NOTE 1—The arc of the rounded corner shall not necessarily be tangent at points " A," but the product shall be commercially free from sharp, rough, or projecting edges.

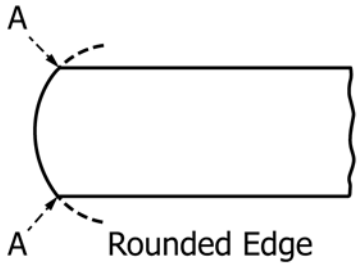
FIG. 1 Rounded Corners

TABLE 15 Tolerances for Radius on Corners of Rolled or Drawn Edges with Rounded Corners

(Applicable to all specifications listed in 1.1 except B694)

Thickness, mm	Radius of Corners, mm	
	Min	Max
Up to 3.2, incl[A]	...	...
Over 3.2 to 4.8, incl	0.40	1.2
Over 4.8 to 25, incl	0.80	2.4
Over 25 to 50, incl	1.6	4.8

[A] Not available.



NOTE 1—The arc of the rounded edge 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

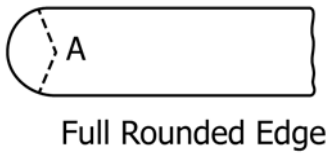
value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29:

TABLE 16 Tolerances for Radius of Rolled or Drawn Rounded Edges

(Applicable to all specifications listed in 1.1 except B694)

Thickness, mm	Radius of Edges[A]	
	Min	Max
Up to 4.78, incl	¼ *t*	1¾ *t*
Over 4.78	1 *t*	1½ *t*

[A] The *t* refers to the measured thickness of the test specimen.



NOTE 1—The arc of the rounded edge 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

TABLE 17 Tolerances for Radius of Rolled or Drawn Full-Rounded Edges

(Applicable in all specifications listed in 1.1)

Thickness, mm	Radius of Edges[A]	
	Min	Max
All thicknesses	½ *t*	¾ *t*

[A] The *t* refers to the thickness of the test specimen.

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

12. Inspection

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

12.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer, or supplier, and the

TABLE 18 Lot Weight Tolerances for Hot-Rolled Sheet and Plate
(Applicable to Specifications B36/B36M, B96/B96M (Copper Alloy UNS Nos. C65500), B103/B103M, B122/B122M, B152/B152M, and B591)

Thickness, mm	Weight Tolerances, Plus and Minus, Percentage of Theoretical Weight				
	1200 mm and Under in Width	Over 1200 to 1500 mm, incl, in Width	Over 1500 to 1800 mm, incl, in Width	Over 1800 to 2200 mm, incl, in Width	Over 2200 to 2800 mm, incl, in Width
3.18 and under	8	9.5	11	12.5	14
Over 3.18 to 4.78, incl	6.5	8	9.5	11	12.5
Over 4.78 to 6.35, incl	6	7.5	8.5	9	10
Over 6.35 to 7.92, incl	5.5	7	8	8.5	9
Over 7.92 to 9.53, incl	5	6	7	7.5	8
Over 9.53 to 11.1, incl	4.5	5	6	7	7.5
Over 11.1 to 12.7, incl	4	4.5	5.5	6	6.5
Over 12.7 to 15.9, incl	3.5	4.5	5	5.5	6
Over 15.9 to 19.1, incl	3	4	4.5	5	5.5
Over 19.1 to 25.4, incl	2.75	3.5	4	4.5	5
Over 25.4 to 38.1, incl	2.5	3	3.5	4	4.5
Over 38.1 to 50.8, incl	2.25	2.75	3.25	3.75	4.25

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 specification, shall be included in the agreement. All testing and the inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

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

13. Rejection and Rehearing

13.1 *Rejection:*

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

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

13.1.3 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 rehearing.

13.2 *Rehearing:*

13.2.1 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 of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

14. Certification

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

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

15. Test Report

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

16. Product Identification

16.1 For *ASME Boiler and Pressure Vessel Code* applications, the name or trademark of the manufacturer and the manufacturer's lot identification number shall be legibly stamped or stenciled on each finishing plate and sheet in two places not less than 300 mm from the edge. If the plate and sheet are too small to locate the markings as such, the marking may be placed near the center of the plate and sheet. In the case of butt straps, the markings may be placed 300 mm from the end. The plate number and type shall be legibly stamped on each plate and on each test specimen.

17. Packaging and Package Marking

17.1 *Packaging:*

17.1.1 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.

17.2 *Package Marking:*

17.2.1 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, shape, gross and net weight, and name of supplier.

17.2.2 When specified in the contract or purchase order, the product specification number shall be shown.

18. Keywords

18.1 general requirements, plate; general requirements, rolled bar; general requirements, sheet; general requirements, strip; general requirements, wrought copper and copper alloys

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 Standards:*

B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies[3]

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

S1.1.3 *Military Standards:*[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 and tests set forth when such inspections and tests are deemed necessary to assure 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 Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

ANNEX

(Mandatory Information)

A1. TEST METHOD FOR SULFUR BY COMBUSTION AND INFRARED DETECTOR

A1.1. Scope

A1.1.1 This test method covers the determination of sulfur in electrolytic cathode copper.

A1.1.2 *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.*

A1.2. Summary of Test Method

A1.2.1 The sulfur is converted to sulfur dioxide (SO_2) by combustion in a stream of oxygen and the SO_2 is measured by infrared absorption.

A1.2.2 This test method is written for use with commercial analyzers equipped to carry out the above operations automatically.

A1.3. Interferences

A1.3.1 The elements ordinarily present do not interfere.

A1.4. Apparatus

A1.4.1 *Combustion and Analyzing Instrumentation,* capable of making the required measurements.

A1.5. Reagents and Materials

A1.5.1 *Reagents:*

A1.5.1.1 *Accelerator*—Use the accelerator recommended by the instrument manufacturer which, for copper, should be sulfur and tin free.

A1.5.1.2 *Oxygen*—Ultra high purity, 99.95 % min. Other grades of oxygen may be used if sulfur free, or the oxygen may be purified as described in Practices E50.

A1.5.2 *Materials:*

A1.5.2.1 *Crucibles*—Use crucibles recommended by the manufacturer, or equivalent.

A1.5.2.2 *Crucible Tongs*—Use tongs capable of handling recommended crucibles.

A1.6. Hazards

A1.6.1 For precautions to be observed in the use of certain reagents in this test method, refer to Practice E50.

A1.6.2 Use care when handling hot crucibles and operating the furnace to avoid burns and electrical shock.

A1.7. Preparation of Apparatus

A1.7.1 Assemble and test the apparatus according to the manufacturer's instructions.

A1.8 Sample Preparation

A1.8.1 The sample should be uniform in size but not finer than 40 mesh.

A1.9. Calibration

A1.9.1 *Calibration Reference Materials*—Select a minimum of two reference materials with sulfur content near the mid-point and high limit.

A1.9.2 *Instrument Calibration*—Calibrate according to the manufacturer's instructions.

A1.10. Procedure

A1.10.1 Stabilize the furnace and analyzer according to the manufacturer's instruction.

A1.10.2 Transfer the weight of sample recommended by the manufacturer into a crucible and add the same amount of accelerator used in the calibration. Proceed as directed by the manufacturer's instructions.

A1.11. Calculation

A1.11.1 Since most commercially available instruments calculate percent concentrations directly, including corrections for blank and sample weight, calculations by the analyst are not required.

A1.11.2 If the analyzer does not compensate for blank and sample weight values, use the following equation:

$$\text{Sulfur, \%} = \frac{(A - B) \times C}{D} \qquad \text{(A1.1)}$$

where:

A = Digital Voltmeter (DVM) reading for specimen,
B = DVM reading for blank,
C = weight compensator setting, and
D = specimen weight, g.

A1.12. Precision and Bias

A1.12.1 *Precision*—The precision of this test method is dependent upon sample preparation care and preciseness of calibration.

A1.12.2 *Bias*—The accuracy of this test method is dependent to a large extent upon the accuracy of the methods used to determine the sulfur concentration in the calibration standards as well as their homogeneity.

APPENDIXES

(Nonmandatory Information)

X1. PREFERRED THICKNESSES FOR UNCOATED WROUGHT COPPER AND COPPER ALLOY PLATE, SHEET, STRIP, AND ROLLED BAR, UP TO 6.5 mm INCL

X1.1 It is recommended that wherever possible material purchased to these specifications be ordered in thicknesses listed as follows:

mm	mm	mm	mm	mm	mm	mm	mm
0.10	0.22	0.36	0.65	1.0	1.8	2.8	5.0
0.12	0.25	0.40	0.70	1.1	2.0	3.2	6.5
0.16	0.28	0.45	0.80	1.3	2.2	3.6	...
0.18	0.30	0.50	0.90	1.4	2.5	4.0	...
0.20	...	0.55	...	1.6	...	4.5	...

X2. STANDARD DENSITIES

X2.1 For purposes of calculating weights, cross sections, and so forth, the densities of the copper alloys covered by the specifications listed in the Scope Section shall be taken as follows:

ASTM Designation	Material	Copper Alloy UNS No.	Density, g/cm^3
B36/B36M	copper-zinc alloy	C21000	8.86
		C22000	8.80
		C22600	8.77
		C23000	8.75
		C24000	8.66
		C26000	8.53
		C26800	8.47
		C27200	8.44
		C28000	8.39
B96/B96M	copper-silicon alloy	C65100	8.75
		C65400	8.75
		C65500	8.53
B103/B103M	copper-tin alloy	C51000	8.86
		C51100	8.86
		C51180	8.86
		C51900	8.83
		C52100	8.80
		C52180	8.80
		C52400	8.77
		C53400	8.91
		C54400	8.86
B121/B121M	copper-zinc-lead alloy	C33500	8.47
		C34000	8.47
		C34200	8.50
		C35000	8.44
		C35300	8.47
		C35600	8.50
B122/B122M	copper-nickel alloy	C70600	8.94
		C70620	8.94
		C71000	8.94
		C71500	8.94
		C71520	8.94
	copper-nickel-chromium alloy	C72200	8.94
	copper-nickel-tin alloy	C72500	8.89
	copper-nickel-zinc alloy	C73500	8.83
		C74000	8.69
		C74500	8.66
		C75200	8.75
		C76200	8.58
		C77000	8.69
B152/B152M	copper	C10100, C10200, C10300, C10400, C10500, C10700, C10800, C10910, C12000, C12200,	8.94
	copper	C12300, C11000, C11300, C11400, C11600, C14200, C14530	8.91
	copper	C14420	8.89
B169/B169M	copper-aluminum-iron-tin alloy	C61300	7.59
		C61400	7.59
B194	copper-beryllium alloy	C17000	8.22
		C17200	8.22
B422	copper-nickel-silicon-tin alloy	C19002	8.91
	copper-nickel-silicon alloy	C19010	8.91
	copper-nickel-silicon-magnesium alloy	C19015	8.91
	copper-nickel-silicon-tin alloy	C19020	8.91
	copper-nickel-tin alloy	C19025	8.91
	copper-aluminum-silicon-cobalt alloy	C63800	8.28
	copper-nickel-aluminum-magnesium alloy	C64725	8.87
	copper-nickel-silicon-magnesium alloy	C70250	8.82
	copper-nickel-silicon alloy	C70260	8.87
	copper-nickel-silicon-tin alloy	C70265	8.87
	copper-nickel-silicon-silver-zirconium alloy	C70310	8.85
B465	copper-iron alloy	C19200	8.87

ASTM Designation	Material	Copper Alloy UNS No.	Density, g/cm^3
		C19210	8.94
		C19400	8.91
		C19500	8.92
		C19700	8.84
		C19720	8.84
B534	copper-cobalt-beryllium alloy	C17500	8.75
	copper-nickel-beryllium alloy	C17510	8.77
B591	copper-zinc-tin alloys	C40500	8.83
	copper-zinc-tin-nickel alloys	C40810	8.86
		C40850	8.86
		C40860	8.86
	copper-zinc-tin alloys	C41100	8.80
		C41300	8.80
		C41500	8.80
		C42200	8.80
		C42500	8.75
	copper-zinc-tin-nickel alloys	C42520	8.80
	copper-zinc-tin alloys	C43000	8.75
		C43400	8.75
B592	copper-zinc-aluminum-cobalt alloy	C66300	8.77
		C68800	8.20
B694	copper	C11000	8.94
	copper-iron alloy	C19400	8.91
	copper-zinc alloy	C22000	8.80
		C23000	8.80
	copper-zinc-iron-cobalt alloy	C66400	8.80
	copper-zinc-iron alloy	C66410	8.80
	copper-zinc-iron-tin alloy	C66430	8.77
	copper-nickel alloy	C71000	8.94
B740	copper-nickel-tin alloys	C72700	8.89
		C72900	8.94
		C72650	8.86
B747	copper-zirconium alloy	C15100	8.94
B768	copper-cobalt-beryllium alloy	C17410	8.80
	copper-nickel-beryllium alloy	C17450	8.94
		C17460	8.80
B888	copper-tin-tellurium alloy	C14530	8.94
	copper-zirconium alloy	C15100	8.94
	copper-silver bearing alloy	C15500	8.91
	copper-beryllium alloy	C17000	8.41
		C17200	8.36
	copper-cobalt-beryllium alloy	C17410	8.80
	copper-nickel-beryllium alloy	C17450	8.80
		C17460	8.80
	copper-cobalt-beryllium alloy	C17500	8.84
	copper-nickel-beryllium alloy	C17510	8.84
	copper-nickel-tin alloy	C19002	8.91
	copper-nickel-silicon alloy	C19010	8.91
	copper-nickel-silicon-magnesium alloy	C19015	8.91
	copper-nickel-silicon alloy	C19025	8.91
	copper-iron alloy	C19210	8.91
		C19400	8.91
		C19500	8.91
		C19700	8.84
	copper-zinc alloy	C23000	8.75
		C26000	8.53
	copper-zinc-tin-nickel alloy	C40810	8.87
		C40850	8.87
		C40860	8.87
	copper-zinc-tin alloy	C42200	8.80
		C42500	8.77
	copper-zinc-tin-iron-nickel alloy	C42520	8.80
		C42600	8.80
	copper-tin-iron-nickel alloy	C50580	8.89
		C50780	8.87
	copper-tin alloy	C51000	8.87
	copper-tin-iron-nickel alloy	C51080	8.87
	copper-tin alloy	C51100	8.87
	copper-tin-iron-nickel alloy	C51180	8.89
		C51980	8.84
	copper-tin alloy	C52100	8.80
	copper-tin-iron-nickel alloy	C52180	8.80
		C52480	8.77
	copper-aluminum-silicon-cobalt alloy	C63800	8.28
	copper-nickel-zinc-tin-silicon alloy	C64725	8.87
	copper-silicon-tin alloy	C65400	8.55

ASTM Designation	Material	Copper Alloy UNS No.	Density, g/cm^3
	copper-zinc-aluminum-cobalt alloy	C68800	8.20
	copper-nickel-silicon-magnesium alloy	C70250	8.80
	copper-nickel-silicon alloy	C70260	8.87
	copper-nickel-silicon-tin alloy	C70265	8.87
	copper-nickel-silicon-silver-zirconium alloy	C70310	8.84
	copper-nickel-zinc alloy	C75200	8.75
		C76200	8.58

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B248M - 07) that may impact the use of this standard. (Approved April 1, 2012.)

(1) Specification B888 was added to the Scope and all other pertinent sections.
(2) In section 7.1.2.1, Specification B103/B103M was moved from needing a 225 g sample to a 150 g sample to agree with the product document.
(3) Moved Specification B740 in the heading of the left column in Table 3 to the heading in the right column. According to the producer, this is where this specification belongs.
(4) Added specifications and alloys to the table in Appendixes X2, Standard Densities.