Designation: B187/B187M – 16

Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes[1]

This standard is issued under the fixed designation B187/B187M; 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 requirements for copper conductor bar, rod, and shapes for electrical (bus) applications and rod, bar, and shapes for general applications.

1.1.1 The products for electrical (bus) applications shall be made from the following coppers:[3]

Copper UNS No.[3]	Reference Designation
C10100	OFE
C10200	OF
C10300	OFXLP
C10400, C10500, C10700	OFS
C10920, C10930, C10940	—
C11000	ETP
C11300, C11400, C11500, C11600	STP
C12000	DLP

1.1.1.1 The product may be furnished from any copper listed unless otherwise specified in the contract or purchase order.

1.2 The product for general applications shall be made from any of the coppers in 1.1.1 or the following coppers:

Copper UNS No.[3]	Reference Designation
C10800	OFLP
C12200	DHP

1.2.1 The product may be furnished from any copper listed above unless otherwise specified in the contract or purchase order. Other coppers may be used upon agreement between supplier and purchaserer.

1.3 *Units*—The values stated in either inch-pound units or in SI units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

NOTE 1—Material for hot forging will be found in Specification B124/B124M.

2. Referenced Documents

2.1 *ASTM Standards:*[4]

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

B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes

B193 Test Method for Resistivity of Electrical Conductor Materials

B216 Specification for Tough-Pitch Fire-Refined Copper—Refinery Shapes

B224 Classification of Coppers

B249/B249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings

B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

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

E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[5]

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

[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 Specification SB-187 in Section II of that Code.

[3] Refer to Practice E527 for an explanation of the Unified Numbering System.

[4] 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.

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

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

Unified Numbering System (UNS)
E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method
E2575 Test Method for Determination of Oxygen in Copper and Copper Alloys

3. Terminology

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

3.2 *Definitions:*

3.2.1 *bus bar, n*—includes material of solid rectangular or square cross section or a solid section with two plane parallel surfaces and round or other simple regularly shaped edges up to and including 12 in. in width and 0.090 in. and over in thickness.

3.2.2 *bus conductor stock, n*—a bar, rod, or shape of high conductivity copper used to make electrical conductors.

3.2.3 *bus rod, n*—includes solid round and regular polygons of six and eight sides.

3.2.4 *bus shapes, n*—a solid section other than regular rod, bar, plate, sheet, strip, or flat wire, that may be oval, half oval, half round, triangular, pentagonal, or of any special cross section furnished in straight lengths. Shapes shall not include tube and pipe or other hollow sections.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *orange peel, n*—the surface roughness resulting from working metal of large grain size. The surface is similar in texture to that of the outside surface of an orange.

4. General Requirements

4.1 The following sections of Specification B249/B249M are a part of this specification:

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

4.2 Identical sections in this specification supplement the referenced section.

5. Ordering Information

5.1 Include the following information in orders for product under this specification:

5.1.1 ASTM specification designation and year of issue,
5.1.2 Copper UNS No. (see 7.1 and Table 1),
5.1.3 Temper required (see 8.1 and Table 2),
5.1.4 Dimensions and form,
5.1.5 When product is ordered for *ASME Boiler and Pressure Vessel Code* applications (see Section 16),

TABLE 1 Chemical Requirements

NOTE 1—If the type of silver-bearing copper is not specified (that is whether tough pitch, phosphorized, or oxygen-free), any one of the three types may be supplied at the option of the manufacturer.

	Composition % Maximum (Unless shown as a range or minimum)					
Copper UNS No.	Copper (Incl. Silver)	Phos-phorus	Silver	Oxygen	Tellurium	Tin
C10100	99.99[A] min	[B]	[B]	[B]	[B]	[B]
C10200	99.95[C] min	...	...	0.0010	...	...
C10300	99.95[D] min	0.001–0.005	...	...	...	...
C10400[E]	99.95[C] min	...	8[F]	0.0010	...	...
C10500[E]	99.95[C] min	...	10[F]	0.0010	...	...
C10700[E]	99.95[C] min	...	25[F]	0.0010	...	...
C10800	99.95[D] min	0.005–0.012	...	...	...	...
C10920	99.90 min	...	...	0.02	...	...
C10930	99.90 min	...	13[F]	0.02	...	...
C10940	99.90 min	...	25[F]	0.02	...	...
C11000	99.90 min	...	...	[G]	...	...
C11300[H]	99.90 min	...	8[F]	[G]	...	...
C11400[H]	99.90 min	...	10[F]	[G]	...	...
C11500[H]	99.90 min	...	16[F]	[G]	...	...
C11600[H]	99.90 min	...	25[F]	[G]	...	...
C12000	99.90 min	0.004–0.012	...	...	...	...
C12200	99.90 min	0.015–0.040	...	...	...	...

[A] Copper value is determined by the difference between the impurity total and 100 %. The copper value is exclusive of Ag.
[B] Impurity maximums in ppm of C10100 shall be: antimony 4, arsenic 5, bismuth 1, cadmium 1, iron 10, lead 5, manganese 0.5, nickel 10, oxygen 5, phosphorus 3, selenium 3, silver 25, sulfur 15, tellurium 2, tin 2, and zinc 1.
[C] Copper value is determined by the difference between the impurity total and 100 %.
[D] Copper (includes silver) + phosphorus, min.
[E] C10400, C10500, and C10700 are oxygen-free coppers with the addition of a specified amount of silver. The compositions of these alloys are equivalent to C10200 plus the intentional addition of silver.
[F] Values are minimum silver in Troy ounces per Avoidupois ton (1 oz/ton is equivalent to 0.0034 %).
[G] Oxygen and trace elements may vary depending on the process.
[H] C11300, C11400, C11500, and C11600 are electrolytic tough-pitch copper with silver additions. The compositions of these alloys are equivalent to C11000 plus the intentional addition of silver.

TABLE 2 Mechanical (All Alloys) and Electrical Requirements[A] (Conductor Alloys Only)

Temper Designation			Tensile Strength, ksi, [MPa][B]		Yield Strength, ksi, [MPa] Min[C]			Electrical Resistivity,[E] Max, Ω·g/m² at 20°C [68°F]				
Standard	Former	Diameter or Distance Between Parallel Surfaces, in.	Min	Max	Min	Elongation in 4 × Diameter or Thickness of Specimen Min. %[D]	Bend Test Angle of Bend °	C10100	C10200, C10400, C10500, C10700, C10920, C10930, C10940, C11000, C11300, C11400, C11500, C11600	C10300	C12000	Rockwell Hardness F Scale, 60-kg Load, 1/16-in. Ball
O60	Soft anneal	Rod and bar:										
		All sizes	28 [195]	37 [255]	8 [55][C]	25	180	0.15176	0.153 28	0.156 14	0.16661	50 max
H04	Hard	Rod:										
		Up to ⅜ [10] incl.	45 [310]	60 [410]	—	12	120	0.15585	0.157 37	0.15940	0.17031	—
		Over ⅜ [10] to 1 [25] incl.	40 [275]	55 [380]	—	12	120	0.15585	0.15737	0.15940	0.17031	80 min
		Over 1 [25] to 2 [50] incl.	35 [240]	50 [345]	—	15	120	0.15585	0.15737	0.15940	0.17031	75 min
		Over 2 [50] to 3 [75] incl.	33 [230]	48 [330]	—	15	120	0.15425	0.15577	0.15940	0.17031	65 min
		Over 3 [75]	30 [205]	48 [330]	—	15	120	0.15425	0.15577	0.15940	0.17031	—
		Bar:										
H02	Half Hard	Up to ⅜ [10] incl. thickness and up to 4 [110] incl. in width	37.5 [260]	50 [345]	—	10	120	0.15585	0.15737	0.15940	0.17031	80 min
		All other sizes	33 [230]	50 [345]	—	15	120	0.15425	0.15577	0.15940	0.17031	65 min
		Channels, angles and shapes	Not established[F]	[F]	—	15	—	0.15425	0.15577		0.17031	—

[A] See 9.1.
[B] ksi = 1000 psi.
[C] Light-straightening operation is permitted.
[D] In any case, a minimum gage length of 1 in. shall be used.
[E] See Appendix X1.
[F] Special agreement shall be made between the manufacturer or supplier and the purchaser.

5.1.6 Shapes; dimensional tolerances required and agreed upon (see 13.3),

5.1.7 Quantity; number of pounds, pieces, or footage required,

5.1.8 Length: stock or specific (see 13.5), and

5.1.9 When material is purchased for agencies of the U.S. government (see Section 12).

5.2 The following options are available and should be specified in the contract or purchase order when required:

5.2.1 Heat identification or traceability details required,

5.2.2 Hydrogen embrittlement test,

5.2.3 Bend test,

5.2.4 Certification,

5.2.5 Mill test reports,

5.2.6 Special packaging requirements,

5.2.7 Edges other than finished edges (see 6.2.1.2), and

5.2.8 Edge contours other than square edge (see 13.7).

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The materials shall conform to the published compositional requirements of the Copper or Copper Alloy UNS No. designation specified in the ordering information.

6.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

6.2 *Manufacture:*

6.2.1 *Edges:*

6.2.1.1 Bar shall be furnished with finished edges (see 13.7) unless otherwise specified at the time of order placement.

6.2.1.2 Bar may be furnished with sawed edges and deburred corners upon agreement between the manufacturer or supplier and the purchaser (see 5.2.7).

7. Chemical Composition

7.1 The specified copper shall conform to the chemical requirements prescribed in Table 1.

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

8. Temper

8.1 Tempers available under this specification and as described in Classification B601 are as follows:

Temper Designation	
Standard	Former
O60	soft anneal
H02	half hard
H04	hard

9. Physical Property Requirements

9.1 *Electrical Resistivity*—Bar, rod, and shapes of alloys Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10920, C10930, C10940, C11000, C11300, C11400, C11500, C11600, and C12000 shall conform to the electrical resistivity limits prescribed in Table 2 for specified copper, temper, form, and size when determined in accordance with Test Method B193.

9.2 *Electrical Resistivity*—Unless otherwise specified in the contract or ordering information, the manufacturer has the option of using Test Method E1004 to determine conformance to the electrical resistivity limits prescribed in Table 2 for Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10920, C10930, C10940, C11000, C11300, C11400, C11500, C11600, and C12000. In case of dispute, Test Method B193 shall be used.

10. Mechanical Property Requirements

10.1 *Tensile Requirements:*

10.1.1 The bars and rod shall conform to the tensile, yield, and elongation requirements of Table 2.

10.1.1.1 For shapes, the tensile requirements (if any) shall be by agreement between the manufacturer and the purchaser.

10.2 *Rockwell Hardness*—Rockwell hardness tests offer a quick and convenient method of checking copper of any temper for general conformity to the requirements of tensile strength. The approximate Rockwell hardness values for the specified tempers are given in Table 2 for general information and assistance in testing.

11. Performance Requirements

11.1 *Bending Requirements:*

11.1.1 When specified in the contract or purchase order, for bar, bus bar, flat wire, and rod, test specimens shall withstand being bent cold (right way bend) through an angle as specified in Table 2 for the specified temper and size without fracture on the outside of the bent portion and with no evidence of slivers, cracks, orange peel, or similar surface defects being visible to the unaided eye.

11.1.2 The bend shall be made on a radius equal to the minimum cross-sectional dimension of the specimen, and this dimension shall be radial to the bend.

11.1.3 The axis of the bend shall be at an angle of 90° to the direction of rolling, drawing, or extrusion (right way bend).

11.1.4 Edgewise and wrong way bend test requirements for bar or bus bar shall be by agreement between the manufacturer or supplier and the purchaser.

11.2 *Microscopical Examination:*

11.2.1 Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10800, and C12000 shall be substantially free of cuprous oxide as determined by Procedure A, Microscopical Examination, of Test Methods B577.

11.2.2 In lieu of the Microscopic examination for copper C10100, C10200, C10300, C10400, C10500, C10700, C10800 the manufacturer has the option to determine the actual oxygen content of the copper in the final size. If the oxygen level is equal to or less than 10 ppm, then it is considered free of cuprous oxide. For Copper C12000 when phosphorus content is within the specification (0.004 and 0.012 %) it should be considered substantially free of cuprous oxide. In case of dispute, testing shall be in accordance with Test Method E2575.

11.2.3 In case of dispute, testing shall be in accordance with Procedure C, Closed Bend Test, of Test Methods B577.

11.3 *Embrittlement Test:*

11.3.1 When specified in the contract or purchase order, Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10800, and C12000 shall pass the embrittlement test described in Procedure B, Microscopical Examination of Thermally Treated Specimens, in Test Methods B577.

11.3.2 In case of dispute, testing shall be in accordance with Procedure C, Closed Bend Test, of Test Methods B577.

12. Orders for U.S. Government Agencies

12.1 Orders for agencies of the U.S. government shall conform to the special government requirements stipulated in the Supplemental Requirements section.

13. Dimensions, Mass, and Permissible Variations

13.1 The dimensions and tolerances for material manufactured under this specification shall be as specified in the following tables:

13.2 *Diameter or Distance Between Parallel Surfaces:*

13.2.1 *Rod: Round, Hexagonal, Octagonal*—See Table 3.

13.2.2 *Bar: Rectangular and Square:*

13.2.2.1 *Thickness Tolerances for Rectangular and Square Bar*—See Table 4 for rolled or drawn edges and Table 5 for sawed edges with deburred corners.

13.2.2.2 *Width Tolerances for Rectangular and Square Bar*—See Table 6 for rolled or drawn edges and Table 7 for sawed edges with deburred corners.

13.3 *Shapes*—The dimensional tolerances of shapes shall be as agreed upon by the manufacturer or supplier and the purchaser and shall be specified in the order.

13.4 *Coils*—The coil size shall be as agreed upon between the manufacturer or supplier and the purchaser and shall be specified in the order.

13.5 *Length:*

13.5.1 *Specified Length*—When exact lengths are ordered, the lengths shall be not less than the ordered length and shall not exceed it by more than the amount specified in Table 8.

13.5.2 *Stock Lengths*—For material ordered in stock lengths, full-length pieces shall be not less than the designated length and shall not exceed it by more than 1 in. Short lengths may be included as prescribed in Table 9.

13.6 *Straightness*—Unless otherwise specified in the contract or purchase order, the material shall be supplied in straight

TABLE 3 Diameter Tolerances for Cold-Drawn Rod (H04 and O60 Tempers)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]	
	Round	Hexagonal or Octagonal
Up to 0.150 [3.8] incl.	0.0013 [0.035]	0.0025 [0.06]
Over 0.150 [3.8] to 0.500 [12] incl	0.0015 [0.04]	0.003 [0.08]
Over 0.500 [12] to 1.00 [25] incl.	0.002 [0.05]	0.004 [0.10]
Over 1.00 [25] to 2.00 [50] incl.	0.0025 [0.06]	0.005 [0.13]
Over 2.00 [50]	0.15[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. [0.025 mm].

TABLE 4 Thickness Tolerances for Drawn or Rolled Rectangular and Square Bar Plus and Minus,[A] in. [mm]

Thickness	Width, in. [mm]			
	2 [50] and Under	Over 2 [50] to 4 [100] incl.	Over 4 [100] to 8 [200] incl.	Over 8 [200] to 12 [300] incl.
Up to 0.500 [13], incl.	0.003 [0.08]	0.004 [0.10]	0.0045 [0.11]	0.0055 [0.14]
Over 0.500 [13] to 1.000 [25], incl.	0.004 [0.10]	0.0045 [0.11]	0.005 [0.13]	0.006 [0.15]
Over 1.000 [25] to 2.000 [50], incl.	0.0045 [0.11]	0.005 [0.13]	0.006 [0.15]	...

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

TABLE 5 Thickness Tolerances for Sawed Edge, Deburred Corner Rectangular and Square Bar, Plus and Minus,[A] in. [mm] for Widths Given in Inches [mm]

Thickness	2 [50] and Under incl.	Over 2 [50] to 4 [100] incl.	Over 4 [100] to 8 [200] incl.	Over 8 [200] to 12 [300] incl.
Up to 0.250 [6], incl.	0.0025 [0.06]	0.003 [0.08]	0.0035 [0.09]	0.005 [0.13]
Over 0.250 [6] to 0.375 [10] incl.	0.003 [0.08]	0.004 [0.10]	0.0045 [0.11]	0.005 [0.13]
Over 0.375 [10] to 0.500 [13] incl.	0.0035 [0.09]	0.0045 [0.11]	0.005 [0.13]	0.006 [0.15]
Over 0.500 [13] to 0.750 [19] incl.	0.0055 [0.14]	0.0055 [0.14]	0.0055 [0.14]	0.007 [0.18]
Over 0.750 [19] to 1.000 [25] incl.	0.007 [0.18]	0.007 [0.18]	0.007 [0.18]	0.009 [0.23]
Over 1.000 [25] to 1.500 [38] incl.	0.015 [0.38]	0.020 [0.50]	0.022 [0.55]	0.025 [0.60]
Over 1.500 [38] to 2.000 [50] incl.	0.020 [0.50]	0.024 [0.60]	0.026 [0.65]	0.030 [0.75]

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

TABLE 6 Width Tolerances for Drawn or Rolled Rectangular and Square Bar

Width, in. [mm]	Tolerances, Plus and Minus,[A] in. [mm]
2 [50] and under	0.008 [0.2]
Over 2 [50] to 4 [100], incl.	0.012 [0.3]
Over 4 [100] to 12 [310] incl.	0.30[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].

TABLE 7 Width Tolerances for Sawed Edge with Deburred Corner Rectangular and Square Bar, Plus and Minus, in. [mm][A]

Thickness	Width, in. [mm]	
	12 [300] and under incl.	Over 12 [300]
Up to 1.500 [40], incl	1/32 [0.8]	1/16 [1.6]
Over 1.500 [40]	1/16 [1.6]	1/16 [1.6]

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

TABLE 8 Length Tolerances for Rod, Bar, and Shapes (Full-Length Pieces Specific and Stock Lengths with or without Ends)

Length Classification	Tolerances, All Plus, in. [mm] (Applicable Only to Full-Length Pieces)
Specific lengths	
Up to 6 ft. [1800 mm]	1/8 [3]
Over 6 to 15 ft. [1800 to 4500 mm]	1/4 [6]
Over 15 ft. [4500 mm]	1/2 [13]
Specific lengths with ends	1 [25]
Stock lengths with or without ends	1 [25]

lengths. The deviation from absolute straightness of any longitudinal surface or edge shall not exceed the limitations prescribed in Table 10.

13.6.1 To determine compliance with this section, rod and bar shall, in case of disagreement, be checked by the following method:

13.6.1.1 Place the rod or bar on a level table so that the arc or departure from straightness is horizontal. Measure the maximum depth of arc to the nearest 1/32 in. [0.8 mm] using a steel scale and a straight edge.

13.7 *Edge Contours:*

13.7.1 *Angles*—All polygonal sections shall have substantially exact angles and sharp corners.

TABLE 9 Schedule of Lengths (Specific and Stock) with Ends

Diameter or Distance Between Parallel Surfaces for Round Hexagonal, 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
½ [13] and under	0.250 [160] and under	6 to 14 [1800 to 4300] incl.	75	20
Over ½ to 1 [13 to 25] incl.	Over 0.250 to 1 [160 to 650] incl.	6 to 14 [1800 to 4300] incl.	70	30
Over 1 to 1½ [25 to 40] incl.	Over 1 to 2.25 [650 to 1450] incl.	6 to 12 [1800 to 3600] incl.	60	40
Over 1½ to 2 [40 to 50] incl.	Over 2.25 to 4 [1450 to 2600] incl.	6 to 12 [1800 to 3600] incl.	50	45
Over 2 to 3 [50 to 75] incl.	Over 4 to 9 [2600 to 5000] incl.	6 to 10 [1800 to 3000] incl.	40	50

[A] Width times thickness, disregarding any rounded corner or edges.
[B] Expressed to the nearest ½ ft [100 mm].

TABLE 10 Straightness Tolerances Applicable to Any Longitudinal Surface or Edge

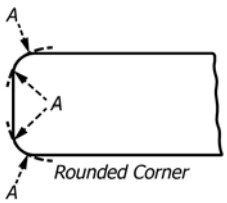
	Maximum Curvature (Depth of Arc), in. [mm]	Portion of Total Length in Which Depth of Arc Is Measured, in. [mm]
Rod	½ [13]	120 [3000]
Shapes	½ [13]	72 [1800]
Bar (except half hard rectangular bar listed in following line)	¼ [6]	60 [1500]
Half hard rectangular bar ⅛ to ⅝ in. [3 to 15 mm] incl., in thickness, having widths ranging from 2 to 6 in. [50 to 150], incl.	⅛ [3]	96 [2400]

TABLE 11 Radius for Square Corners

Specified Thickness, in. [mm]	Maximum Radius Permissible for Square Corners, in. [mm]
Up to 3⁄16 [5] incl.	1⁄64 [0.4]
Over 3⁄16 to 1 [5 to 25] incl.	1⁄32 [0.8]
Over 1 [25]	1⁄16 [1.6]

13.7.2 *Square Corners*—Unless otherwise specified in the contract or purchase order, bar shall be finished with commercially square corners with the maximum permissible radius shown in Table 11.

13.7.3 *Rounded Corners*—When specified in the contract or purchase order, bar may be finished with corners rounded as shown in Fig. 1 to a quarter circle with a radius as shown in Table 12. The tolerance on the radius shall be ±25 %.



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

13.7.4 *Rounded Edge*—When specified in the contract or purchase order, bar may be finished with edges rounded as shown in Fig. 2, with a radius of curvature as shown in Table 13.

13.7.5 *Full Rounded Edge*—When specified in the contract or purchase order, bar may 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 %.

13.7.6 *Shapes*—Products with edge or corner contours other than described in 13.7.1 – 13.7.5 are classified as shapes.

NOTE 2—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.

14. Specimen Preparation

14.1 *Microscopical Examination*—Specimen preparation shall be in accordance with Procedure A of Test Methods B577.

15. Test Methods

15.1 Refer to Specification B249/B249M for the appropriate mechanical test method.

15.2 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement.

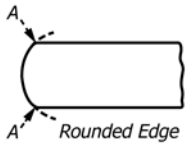
Element	ASTM Test Method
Copper	E53
Phosphorus	E62
Selenium	Refer to Annex, Specification B216
Silver	E478
Tellurium	Refer to Annex, Specification B216

15.2.1 For Copper No. C10100, refer to the Annex of Specification B170 for test methods.

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

TABLE 12 Radius for Rounded Corners

Specified Thickness, in. [mm]	Nominal Radius of Corners, in. [mm]	
	For Widths Up to and Including 2× Thickness	For Widths More Than 2× Thickness
Up to ⅛ [2], incl.	1/64 [0.4]	full rounded edges as given in 13.7.5
Over ⅛ to 3/16 [2 to 6], incl.	1/32 [0.8]	1/32 [0.8]
Over 3/16 to 1 [6 to 25], incl.	1/16 [1.6]	1/16 [1.6]
Over 1 [25]	⅛ [3]	⅛ [3]



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.

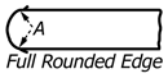
FIG. 2 Rounded Edge

16. Certification

16.1 When product is ordered to meet the requirements of the *ASME Boiler and Pressure Vessel Code*, the certification requirements of Specification B249/B249M are mandatory.

TABLE 13 Radius for Rounded Edge

Specified Thickness, in. [mm]	Nominal Radius of Rounded Edge, in. [mm]	Tolerance on Radius, Plus and Minus, in. [mm]
Up to 3/16 [5], incl.	1¼ × thickness	½ × thickness
Over 3/16 [5]	1¼ × thickness	¼ × thickness



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

17. Keywords

17.1 bar; bus bar; copper; electrical conductors; embrittlement test; rod; shapes; UNS No. C10100; UNS No. C10200; UNS No. C10300; UNS No. C10400; UNS No. C10500; UNS No. C10700; UNS No. C10920; UNS No. C10930; UNS No. C10940; UNS No. C11000; UNS No. C11300; UNS No. C11400; UNS No. C11500; UNS No. C11600; UNS No. C10800; UNS No. C12000; UNS No. C12200

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 *Federal Standards:*[6]

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 Standards:*[6]

MIL-STD-105 Sampling Procedures and Table for Inspection by Attributes

MIL-STD-129 Marking for Shipment and Storage

S1.1.3 *Military Specification:*[6]

NOTE 3—MIL-C-3993, Packaging of Copper and Copper-Base Alloy Mill Products, has been withdrawn and replaced by Practice B900.

S2. Quality Assurance

S2.1 *Responsibility for Inspection*—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 B 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:*

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

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.

APPENDIX

(Nonmandatory Information)

X1. RESISTIVITY

TABLE X1.1 Resistivity Relationships

Conductivity at 68°F, %	101.0	100.0	99.37	98.40	98.35	98.16	97.40	96.16	92.20
Ω·g/m^2	0.151 76	0.153 28	0.15425	0.155 77	0.15585	0.156 14	0.157 37	0.159 40	0.16661
Ω·lb/mile^2	866.53	875.20	880.75	889.42	889.88	891.60	898.55	910.15	951.31
Ω·cmil/ft	10.268	10.371	10.437	10.539	10.54	10.565	10.648	10.785	11.273
Ω·mm^2/m	0.017 070	0.017 241	0.017350	0.017 521	0.017530	0.017 564	0.017 701	0.017 930	.018740
μΩ·in.	0.672 07	0.678 79	0.68309	0.689 81	0.69018	0.691 51	0.696 90	0.705 90	0.73782
μΩ·cm	1.7070	1.7241	1.7350	1.7521	1.7530	1.7564	1.7701	1.7930	1.8740

X1.1 "Resistivity" is used in place of "conductivity." The value of 0.153 28 Ω·g/m^2 at 20°C [68°F] is the international standard for the resistivity of annealed copper equal to 100 % conductivity. This term means that a wire 1 m in length and weighing 1 g would have a resistance of 0.153 28 Ω. This is equivalent to a resistivity value of 875.20 Ω·lb/mile^2, which signifies the resistance of a wire 1 mile in length weighing 1 lb. It is also equivalent, for example, to 1.7241 μΩ/cm of length of a bar 1 cm^2 in cross section. A complete discussion of this subject is contained in *NBS Handbook 100* of the National Institute of Standards Technology.[7] Relationships that may be useful in connection with the values of resistivity prescribed in this specification are as shown in Table X1.1, each column containing equivalent expressions at 20°C [68°F]:

[7] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B187/B187M – 15) that may impact the use of this standard. (Approved April 1, 2016).

(1) Revised 15.2.

Committee B05 has identified the location of selected changes to this standard since the last issue (B187/B187M – 11) that may impact the use of this standard. (Approved May 1, 2015).

(1) Corrected Temper Designation in Table 10.

Committee B05 has identified the location of selected changes to this standard since the last issue (B187 – 06) that may impact the use of this standard. (Approved April 1, 2011).

(1) All references to MIL C 3993 for Packaging of Copper and Copper-Base Alloy Mill Products have been replaced by Practice B900.
(2) The option has been given in Section 9.2 to use Test Method E1004 in addition to Test Method B193.
(3) Section 11.2.2 has been added to allow the analysis of oxygen content directly as an alternative to Test Method A.
(4) Resistivity limits have been established for C12000 in Table 2.
(5) In Table 2 no mechanical values have been changed. However, for Bar the temper H02 has replaced H04 since H02 more accurately describes those required values and conforms to similar values found in B152.
(6) Added references to Practice B900 and Test Method E2575 to Section 2.
(7) Added new resistivity relationship values to non-mandatory information in Appendix.