



Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes¹

This standard is issued under the fixed designation B 187; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—Tables 2 and X1.1 were editorially corrected in August 2001.

1. Scope

1.1 This specification² establishes the requirements for copper bar, bus bar, rod, and shapes for electrical and nonelectrical applications.

1.1.1 The products for electrical 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,	STP
C11600	—
C14420	—

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

1.1.2 The product for nonelectrical applications shall be made from the following coppers:

Copper UNS No. ³	Reference Designation
C10800	OFLP
C12000	DLP
C12200	DHP

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

1.2 The inch-pound units are standard for this specification.

1.3 This specification is the companion to SI (Metric) Specification B 187M; therefore no SI equivalents are presented herein.

NOTE 1—Material for hot forging will be found in Specification B 224.

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-133 in Section II of that Code.

³ Refer to Practice E 527 for an explanation of the Unified Numbering System.

2. Referenced Documents

2.1 ASTM Standards:

2.1.1 The following documents in the current issue of the Book of Standards form a part of this specification to the extent referenced herein.

B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes⁴

B 187M Specification for Copper Bar, Bus Bar, Rod and Shapes [Metric]⁴

B 193 Test Method for Resistivity of Electrical Conductor Materials⁵

B 216 Specification for Tough-Pitch Fire-Refined Copper—Refinery Shapes⁴

B 224 Classification of Coppers⁴

B 249/B 249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings⁴

B 577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper⁴

B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast⁴

E 53 Methods for Chemical Analysis of Copper⁶

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)⁶

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition⁶

E 478 Test Methods for Chemical Analysis of Copper Alloys⁶

E 527 Practice for Numbering Metals and Alloys (UNS)⁷

3. Terminology

3.1 Definitions:

3.1.1 *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 regular shaped edges up to and including 12 in. in width and 0.090 in. and over in thickness.

⁴ Annual Book of ASTM Standards, Vol 02.01.

⁵ Annual Book of ASTM Standards, Vol 02.03.

⁶ Annual Book of ASTM Standards, Vol 03.05.

⁷ Annual Book of ASTM Standards, Vol 01.01.

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

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

3.1.4 *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.

3.1.5 *unaided eye, n*—without visual enhancement; however, corrective spectacles necessary to obtain normal vision shall be permitted.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *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. Ordering Information

4.1 Orders for product under this specification should contain the following information:

4.1.1 ASTM specification designation and year of issue,

4.1.2 Copper UNS Number (see 6.1 and Table 1),

4.1.3 Temper required (see 7.1 and Table 2),

4.1.4 Dimensions and form,

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

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

4.1.6 Edge contours required, (see 13.7) and

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

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

4.2.1 Heat identification or traceability details required,

4.2.2 Hydrogen embrittlement test,

4.2.3 Bend test,

4.2.4 Certification,

4.2.5 Mill test reports, and

4.2.6 Special packaging requirements.

5. Materials and Manufacture

5.1 *Manufacture:*

5.1.1 *Edges:*

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

5.1.1.2 Bar larger than 1/2 in. in thickness may be furnished with sawed edges and deburred corners upon agreement between the manufacturer or supplier and the purchaser.

6. Chemical Composition

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

6.2 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.

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	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
C10200	99.95 min	...	...	0.0010	...	...
C10300	99.95 ^C min	0.001–0.005	...	...	...	...
C10400 ^D	99.95 min	...	8 ^E	...	...	...
C10500 ^D	99.95 min	...	10 ^E	...	...	...
C10700 ^D	99.95 min	...	25 ^E	...	...	...
C10800	99.95 ^C min	0.005–0.012	...	...	...	...
C10920	99.90 min	...	...	0.02	...	...
C10930	99.90 min	...	13 ^E	0.02	...	...
C10940	99.90 min	...	25 ^E	0.02	...	...
C11000	99.90 min	...	...	...	...	...
C11300 ^F	99.90 min	...	8 ^E	...	...	...
C11400 ^F	99.90 min	...	10 ^E	...	...	...
C11500 ^F	99.90 min	...	16 ^E	...	...	...
C11600 ^F	99.90 min	...	25 ^E	...	...	...
C12000	99.90 min	0.004–0.012	...	...	...	...
C12200	99.9 min	0.015–0.040	...	...	...	...
C14420	99.90 ^G min	...	...	...	0.005–0.05	0.04–0.15

^AThis value is exclusive of silver and shall be determined by the difference of the "impurity total" from 100 %. "Impurity total" is defined as the sum of antimony, arsenic, bismuth, cadmium, iron, lead, manganese, nickel, oxygen, phosphorus, selenium, silver, sulfur, tellurium, tin, and zinc present in the sample.

^BImpurity maximums in ppm of C10100 shall be: antimony 4, 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.

^CCopper (includes silver) + phosphorus, min.

^DC10400, 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.

^EValues are minimum silver in Troy ounces per Avoirdupois ton (1 oz/ton is equivalent to 0.0034 %).

^FC11300, 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.

^GCopper (includes silver) + tellurium + tin.



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

Temper Designation		Diameter or Distance Between Parallel Surfaces, in.	Tensile Strength, ksi ^B		Elongation in 4 × Diameter or Thickness of Specimen Min. % ^C	Bend Test Angle of Bend °	Electrical Resistivity, ^D Max, Ω·g/m ² at 20°C (68°F)				Rockwell Hardness F Scale, 60-kg Load, 1/16-in. Ball
Standard	Former		Min	Max			C10100	C10200, C10400, C10500, C10700, C10920, C10930, C10940, C11000, C11300, C11400, C11500, C11600	C14420	C10300	
O60	Soft anneal	Rod and bar:									
		All sizes	28	37	25	180	0.151 76	0.153 28	0.161 35	0.156 14	50 max
H04	Hard	Rod:									
		Up to 3/8 incl.	45	55	12	120	0.155 85	0.157 37	0.163 07	0.159 40	—
		Over 3/8 to 1 incl.	40	50	12	120	0.155 85	0.157 37	0.163 07	0.159 40	80 min
		Over 1 to 2 incl.	35	45	15	120	0.155 85	0.157 37	0.163 07	0.159 40	75 min
		Over 2 to 3 incl.	33	43	15	120	0.154 25	0.155 77	0.163 07	0.159 40	65 min
		Bar:									
		Up to 3/8 incl. thickness and up to 4 incl. in width	37.5	50	10	120	0.155 85	0.157 37	0.163 07	0.159 40	80 min
		All other sizes	33	45	15	120	0.154 25	0.155 77	0.163 07	0.159 40	65 min
		Channels, angles and shapes	^E	—	15	—	0.154 25	0.155 77	—	159 40	—

^ASee 7.1.

^Bksi = 1000 psi.

^CIn any case, a minimum gage length of 1 in. shall be used.

^DSee Appendix X1.

^ESpecial agreement shall be made between the manufacturer or supplier and the purchaser.

7. Temper

7.1 Tempers available under this specification and as described in Practice B 601 are as follows:

Temper Designation	
Standard	Former
O60	soft anneal
H04	hard

8. Physical Properties

8.1 Electrical Resistivity:

8.1.1 When specified in the order, the electrical resistivity of Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10920, C10930, C10940, C11000, C11300, C11400, C11500, C11600, and C14420 shall not exceed the limits prescribed in Table 2 for specified copper, temper, form, and size when determined in accordance with Test Method B 193.

9. Mechanical Properties

9.1 Tensile Requirements:

9.1.1 The tension test shall be the standard test for all tempers and acceptance or rejection for mechanical properties shall depend only on the tensile strength, which shall conform to the requirements in Table 2.

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

9.2 Rockwell Hardness:

9.2.1 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.

9.3 Bending Requirements:

9.3.1 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.

9.3.2 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.

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

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

10. Microscopical Examination

10.1 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 B 577.

10.1.1 In case of dispute, testing shall be in accordance with Procedure C, Closed Bend Test, of Test Methods B 577.

11. Embrittlement Test

11.1 When specified in the contract or purchase order, Copper UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700, C10800, and C12000 shall pass embrittlement test described in Procedure B, Microscopical Examination of Thermally Treated Specimens, in Test Methods B 577.

11.1.1 In case of dispute, testing shall be in accordance with Procedure C, Closed Bend Test, of Test Methods B 577.

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 and Table 5.

13.2.2.2 *Width Tolerances for Rectangular and Square Bar*—See Table 6 and Table 7.

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 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. 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.

13.7.2 *Square Corners*—Unless otherwise specified in the contract or purchase order, bar shall be finished with commer-

TABLE 4 Thickness Tolerances for Extruded Rectangular and Square Bar Plus and Minus,^A in.

Thickness	Width, in.			
	2 and Under	Over 2 to 4 incl.	Over 4 to 8 incl.	Over 8 to 12 incl.
Up to 0.500, incl.	0.003	0.004	0.0045	0.0055
Over 0.500 to 1.000, incl.	0.004	0.0045	0.005	0.006
Over 1.000 to 2.000, incl.	0.0045	0.005	0.006	...

^AWhen tolerances are specified as all plus or all minus, double the values given.

TABLE 5 Thickness Tolerances for Nonextruded Rectangular and Square Bar Thickness Tolerances, Plus and Minus,^A in. for Widths Given in Inches

Thickness	2 and Under incl.	Over 2 to 4 incl.	Over 4 to 8 incl.	Over 8 to 12 incl.
Up to 0.250, incl.	0.0025	0.003	0.0035	0.005
Over 0.250 to 0.375 incl.	0.003	0.004	0.0045	0.005
Over 0.375 to 0.500 incl.	0.0035	0.0045	0.005	0.006
Over 0.500 to 0.750 incl.	0.004	0.005	0.0055	0.007
Over 0.750 to 1.000 incl.	0.005	0.006	0.007	0.009
Over 1.000 to 1.500 incl.	0.015	0.020	0.022	0.025
Over 1.500 to 2.000 incl.	0.020	0.024	0.026	0.030

^AWhen tolerances are specified as all plus or all minus, double the values given.

TABLE 6 Width Tolerances for Extruded Rectangular and Square Bar

Width, in.	Tolerances, Plus and Minus, ^A in.
1.250 and under	0.005
Over 1.250 to 2, incl.	0.008
Over 2 to 4, incl.	0.012
Over 4 to 12 incl.	0.30 ^B

^AWhen tolerances are specified as all plus or all minus, double the values given.

^BPercent of specified width expressed to the nearest 0.001 in.

TABLE 7 Width Tolerances for Nonextruded Rectangular and Square Bar, Plus and Minus, in.^A

Thickness	Width, in.		
	4 and Under	4 to 8, incl.	Over 8 to 12, incl.
Up to 0.500, incl.	0.008	0.20 ^B	0.20 ^B or ^C
Over 0.500	1/32	1/32	1/32

^AWhen tolerances are specified as all plus or all minus, double the values given.

^BPercent of the specified width expressed to the nearest 0.001 in.

^CIf sawed, the tolerance is 1/32.

TABLE 3 Diameter Tolerances for Cold-Drawn H04 Temper Rod

Diameter or Distance Between Parallel Surfaces, in.	Tolerances, Plus and Minus, ^A in.	
	Round	Hexagonal or Octagonal
Up to 0.150 incl.	0.0013	0.0025
Over 0.150 to 0.500 incl.	0.0015	0.003
Over 0.500 to 1.00 incl.	0.002	0.004
Over 1.00 to 2.00 incl.	0.0025	0.005
Over 2.00	0.15 ^B	0.30 ^B

^AWhen tolerances are specified as all plus or all minus, double the values given.

^BPercent of specified diameter or distance between parallel surfaces expressed to the nearest 0.001 in.

cially 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 %.

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.

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. (Applicable Only to Full-Length Pieces)
Specific lengths	
Up to 6 ft.	1/8
Over 6 to 15 ft.	1/4
Over 15 ft.	1/2
Specific lengths with ends	1
Stock lengths with or without ends	1

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.	Rectangular Bar Area, ^A in ²	Nominal Length, ft	Shortest Permissible Length ^B % of Nominal Length	Maximum Permissible Weight of Ends, % of Lot Weight
1/2 and under	0.250 and under	6 to 14 incl.	75	20
Over 1/2 to 1 incl.	over 0.250 to 1 incl.	6 to 14 incl.	70	30
Over 1 to 1 1/2 incl.	over 1 to 2.25 incl.	6 to 12 incl.	60	40
Over 1 1/2 to 2 incl.	over 2.25 to 4 incl.	6 to 12 incl.	50	45
Over 2 to 3 incl.	over 4 to 9 incl.	6 to 10 incl.	40	50

^AWidth times thickness, disregarding any rounded corner or edges.
^BExpressed to the nearest 1/2 ft.

TABLE 10 Straightness Tolerances Applicable to Any Longitudinal Surface or Edge

	Maximum Curvature (Depth of Arc), in.	Portion of Total Length in Which Depth of Arc Is Measured, in.
Rod	1/2	120
Shapes	1/2	72
Bar (except hard rectangular bar listed in following line)	1/4	60
Hard rectangular bar 1/8 to 5/16 in., in thickness, having widths ranging from 2 to 6 in., incl.	1/8	96

TABLE 11 Radius for Square Corners

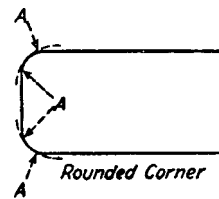
Specified Thickness, in.	Maximum Radius Permissible for Square Corners, in.
Up to 3/16 incl.	1/64
Over 3/16 to 1 incl.	1/32
Over 1	1/16

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. General Requirements

14.1 The following sections of Specification B 249/B 249M are a part of this specification:

- 14.1.1 Terminology,
- 14.1.2 Material and Manufacturer,

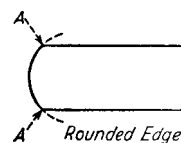


NOTE 1—The arc shall not necessarily be tangent at points, A, but the product shall be commercially free from sharp, rough, or projecting edges.

FIG. 1 Rounded Corners

TABLE 12 Radius for Rounded Corners

Specified Thickness, in.	Nominal Radius of Corners, in.	
	For Widths Up to and Including 2× Thickness	For Widths More Than 2× Thickness
Up to 1/8, incl.	1/64	full rounded edges as given in 13.7.5
Over 1/8 to 3/16, incl.	1/32	1/32
Over 3/16 to 1, incl.	1/16	1/16
Over 1	1/8	1/8

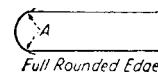


NOTE 1—The arc shall be substantially symmetrical with the axis of the product. The corners, A, will usually be sharp, but shall not have rough or projecting edges.

FIG. 2 Rounded Edge

TABLE 13 Radius for Rounded Edge

Specified Thickness, in.	Nominal Radius of Rounded Edge, in.	Tolerance on Radius, Plus and Minus, in.
Up to 3/16, incl.	1 1/4 × thickness	1/2 × thickness
Over 3/16	1 1/4 × thickness	1/4 × 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

- 14.1.3 Workmanship, Finish and Appearance,
 - 14.1.4 Number of Tests and Retests,
 - 14.1.5 Test Methods,
 - 14.1.6 Specimen Preparation,
 - 14.1.7 Significance of Numerical Limits,
 - 14.1.8 Inspection,
 - 14.1.9 Rejection and Rehearing,
 - 14.1.10 Certification,
 - 14.1.11 Test Reports, and
 - 14.1.12 Packaging and Package Marking.
- 14.2 Identical sections in this specification supplement the referenced section.



15. Specimen Preparation

15.1 *Microscopical Examination*—Specimen preparation shall be in accordance with Procedure A of Test Methods B 577.

16. Test Methods

16.1 Refer to Specification B 249/B 249M for the appropriate mechanical test method.

16.2 Chemical composition shall, in case of disagreement be determined as follows:

Element	ASTM Test Method
Copper	E 53
Phosphorus	E 62

Selenium
Silver
Tellurium

Refer to Annex, Specification B 216
E 478
Refer to Annex, Specification B 216

16.2.1 For Copper No. C10100, refer to the Annex of Specification B 170 for test methods.

16.2.2 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.

17. Keywords

17.1 bar; bus bar; copper; electrical conductors; embrittlement test; rod; shapes

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*:⁸

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*:⁸

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

MIL-STD-129 Marking for Shipment and Storage

S1.1.3 *Military Specification*:⁸

MIL-C-3993 Packaging of Copper and Copper-Base Alloy Mill Products

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 MIL-C-3993.

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.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



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APPENDIX

(Nonmandatory Information)

X1. RESISTIVITY

TABLE X1.1 Resistivity Relationships

Conductivity at 68°F,%	101.0	100.0	98.40	98.16	97.40	96.16	90.0	88.0
Ω·g/m ²	0.151 76	0.153 28	0.155 77	0.156 14	0.157 37	0.159 40	0.170 31	0.174 18
Ω·lb/mile ²	886.53	875.20	889.42	891.60	898.55	910.15	972.44	994.55
Ω·cmil/ft	10.268	10.371	10.539	10.565	10.648	10.785	11.523	11.785
Ω·mm ² /m	0.017 070	0.017 241	0.017 521	0.017 564	0.017 701	0.017 930	0.019 156	0.019 592
μΩ·in.	0.672 07	0.678 79	0.689 81	0.691 51	0.696 90	0.705 90	0.754 21	0.771 35
μΩ·cm	1.7070	1.7241	1.7521	1.7564	1.7701	1.7930	1.9157	1.9592

X1.1 “Resistivity” is used in place of “conductivity.” The value of 0.153 28 Ω·g/m² 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/mile², 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 cm² in cross section. A complete discussion of this

subject is contained in *NBS Handbook 100* of the National Institute of Standards Technology.⁹ 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):

⁹ Available from National Institute of Standards and Technology, (NIST), Gaithersburg, MD 20899.

SUMMARY OF CHANGES

Committee B05, Copper and Copper Alloys, has identified the location of selected changes to this standard since the last issue (B 187 – 97) that may impact the use of this standard.

(I) Corrections were made in Table 1 to conform to standard chemical requirements.

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