



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

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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)	Phosphorus	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.