



Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar¹

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

1. Scope*

1.1 This specification² establishes the requirements for copper sheet, strip, plate, and rolled bar produced from the following coppers.

Copper UNS No. ^A	Previous Designation	Type of Copper
C10100 ^B	OFE	Oxygen-free electronic
C10200 ^B	OF	Oxygen-free without residual deoxidants
G10300	...	Oxygen-free extra low phosphorus
C10300	OFXLP	Oxygen-free extra low phosphorus
C10400, C10500, C10700	OFS	Oxygen-free, silver bearing
G10800	...	Oxygen-free low phosphorus
C10800	OFLP	Oxygen-free low phosphorus
C10910	...	Low oxygen
G11000 ^{B,C}	ETP, TP ^C	Electrolytic tough pitch ^C , Tough pitch ^C
C11000 ^{B, C}	ETP, TP ^C	Electrolytic tough pitch, ^C Tough pitch ^C
C11300, C11400, C11600 ^B	STP	Silver bearing tough pitch
C12000	DLP	Phosphorized, low residual phosphorus
C12200 ^B	DHP	Phosphorized, high residual phosphorus
G12300	DPS	Phosphorized, silver bearing
C12300	DHPS	Phosphorized, silver bearing
C14200	DPA	Phosphorus deoxidized, arsenical
C14420	...	Tin bearing tellurium copper
C14530	...	Tin tellurium bearing copper

^A Except Copper UNS Nos. C10910 (low oxygen), C14200 (phosphorus deoxidized, arsenical), C14420 (tin bearing tellurium), and C14530 (tin tellurium bearing) these types of copper are classified in Classification **B224**.

^B SAE Specification CA101 conforms to Copper UNS No. C10100; SAE Specification CA102 conforms to the requirements for Copper UNS No. C10200; SAE Specification CA110 conforms to the requirements for Copper UNS No. C11000; SAE Specifications CA113, CA114, and CA116 conform to the requirements for Copper UNS Nos. C11300, C11400, and C11600; SAE Specification CA120 conforms to Copper UNS No. C12000; and SAE Specification CA122 conforms to the requirements for Copper UNS No. C12200.

^C Unless specified in the contract or purchase order the supplier is permitted to provide ETP copper or TP copper.

NOTE 1—Each of the coppers listed has unique properties that can make it suitable for specific applications. The purchaser should consult with the supplier to determine which copper would be best suited for the intended application.

NOTE 2—This specification is not intended to establish requirements for material rolled to ounce-weight thicknesses. Such material is defined in Specification **B370**.

Plates for locomotive fireboxes are defined in Specification **B11**.

Flat copper products with finished (rolled or drawn) edges (flat wire and strip) are defined in Specification **B272**.

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 For *ASME Boiler and Pressure Vessel Code* applications see related Specification SB-152 in Section **II** of that Code.

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



1.1.1 When a specific copper is not identified in the contract or purchase order, the supplier may furnish product from any of the listed coppers.

1.2 Units—The values stated in either ~~SI~~inch-pound units or ~~inch-pound~~SI units are to be regarded separately as standard. The values stated in each system ~~may~~are not ~~be~~necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other. ~~Combining other and~~ values from the two systems ~~may result in non-conformance~~ with the standard shall not be combined.

~~1.3 The following safety hazards caveat only pertains to the test method portion, Section 13 of this specification: This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.~~

1.3 The following safety hazard caveat pertains only to the test method(s) described in this specification:

1.3.1 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.4 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*³

~~B11 Specification for Copper Plates for Locomotive Fireboxes (Withdrawn 1980)~~⁴

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

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

B248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric)

B272 Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)

B370 Specification for Copper Sheet and Strip for Building Construction

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

E3 Guide for Preparation of Metallographic Specimens

~~E8E8/E8M Test Methods for Tension Testing of Metallic Materials [Metric] E0008 E0008M~~

~~E8M Test Methods for Tension Testing of Metallic Materials [Metric] (Withdrawn 2008)~~⁴

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)⁴

E112 Test Methods for Determining Average Grain Size

E478 Test Methods for Chemical Analysis of Copper Alloys

~~E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)~~

2.2 *ASME Standard:*

~~ASME Boiler and Pressure Vessel Code~~⁵

3. General Requirements

3.1 The following sections of Specification ~~B248~~ or ~~B248M~~ constitute a part of this ~~specification~~ specification:

3.1.1 ~~Terminology~~Terminology

3.1.2 ~~Materials and Manufacture~~Manufacture

3.1.3 ~~Sampling~~Sampling

3.1.4 ~~Number of Tests and Retests~~Retests

3.1.5 ~~Specimen Preparation~~Preparation

3.1.6 ~~Test Methods~~Methods

3.1.7 ~~Packaging and Package Marking~~Marking

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~~standard's Document Summary page on the ASTM website.

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

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, ~~Three~~Two Park Ave., New York, NY 10016-5990, http://www.asme.org.



- 3.1.8 Workmanship, Finish, and ~~Appearance~~:Appearance
- 3.1.9 Significance of Numerical ~~Limits~~:Limits
- 3.1.10 Rejection and ~~Rehearing~~:Rehearing

3.2 In addition, when a section with a title identical to that referenced in 3.1, above, appears in this specification, it contains additional requirements which supplement those appearing in Specification B248 or B248M.

4. Terminology

4.1 ~~Definitions~~—Terms used in this specification are in accordance with ~~Terminology~~For definitions of terms related to copper and copper alloys, B846 and Specifications refer to Terminology B248B846 and B248M.

4.2 ~~Definitions of Terms Specific to This Standard:~~

4.2.1 ~~capable of~~—the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements the material shall be subject to rejection.

5. Ordering Information

5.1 ~~Orders for products under this specification shall include the following:~~Include the following specified choices when placing orders for product under this specification, as applicable:

- 5.1.1 ~~ASTM specification designation and year of issue~~:issue;
 - 5.1.2 ~~Quantity;~~
 - 5.1.2 ~~Copper [Alloy] UNS No. (Section (or 4). When other internationally recognized copper [alloy]). With Alloys C10400, C10500, C10700, C11300, C11400, C11600, or C12300, the amount of silver in ounces per ton~~:ton;
 - 5.1.3 ~~Temper (Section 7);~~
 - 5.1.4 ~~Dimensions: thickness, width, and weight~~edges (Section 12);
 - 5.1.5 ~~How furnished (straight furnished: straight lengths or coils)~~:coils;
 - 5.1.6 ~~Quantity – total weight or total length or number of pieces of each size;~~
 - 5.1.7 ~~Length (Section 12);~~ and
 - 5.1.8 ~~Weight of coils: coil weights or coil size limitations, if required~~:required.
 - 5.1.9 ~~When the product is purchased for agencies of the U.S. Government,~~
- 5.2 ~~The following requirements shall be specified if applicable; options are available but may not be included unless specified at the time of placing of the order when required:~~
- 5.2.1 ~~Embrittlement test for the alloys listed in 11.2.~~
 - 5.2.2 ~~Certification, if required~~—Certification (Section 15);
 - 5.2.3 ~~Mill test report, if required~~—Test Report (Section 16);
 - 5.2.4 ~~Resistivity test for alloys listed in Table 5 (see Section 9);~~
 - 5.2.4 ~~Embrittlement test for the alloys listed in 11.2,~~
 - 5.2.5 ~~Type of edge, if other than slit, and~~
 - 5.2.5 ~~Supplemental requirements~~—If product is purchased for agencies of the U.S. government as given in Government (see the Supplemental Requirements section of Specifications B248 and B248M-).

6. Chemical Composition

6.1 The materials shall conform to the chemical requirements ~~prescribed in Table 1;~~ for the copper [alloy] UNS No. specified in the ordering information.

6.2 These composition limits do not preclude the presence of other elements. ~~Limits for unnamed elements~~—By agreement between the manufacturer and purchaser, limits may be established and analysis required by agreement between manufacturer and the purchaser. ~~for unnamed elements.~~

7. Temper

7.1 ~~As Hot-Rolled (M20)~~—The standard temper of copper sheet and plate produced by hot rolling as designated in ~~Tables 2 and 3~~ with the prefix “M”. ~~Former designation and standard designation are detailed in Classification B601~~ are shown:

7.1.1 Plate not specified for ASME Boiler Pressure Vessel Code applications are generally available in the M20 temper.

7.2 ~~Rolled (H)~~—The standard tempers of cold-rolled copper sheet, strip, plate, and rolled bar are as designated in ~~Tables 2 and 3~~ with the prefix “H”. ~~Former designation and standard designation are detailed in Classification B601~~ are shown:

7.1 ~~Annealed (O)~~—The standard temper of annealed copper sheet, strip, and plate are as designated tempers for product described in this specification are given in Tables 2-2 and 34 with the prefix “O”. ~~Former designation and standard designation are detailed in Classification B601~~ are shown:

7.1.1 The temper of copper sheet and plate hot-rolled and annealed shall be that produced by hot rolling and subsequent annealing is designated in ~~Tables 2 and 3~~ as O25.As Hot Rolled Temper M20:

TABLE 1 Chemical Requirements

Element	Composition, %																	
	Copper UNS No.																	
	C10100 ^A	C10200	C10300	C10400 ^B	C10500 ^B	C10700 ^B	C10800	C10910	C11000	C11300 ^C	C11400 ^C	C11600 ^C	C12000	C12200	C12300 ^D	C14200	C14420	C14530
Copper (incl silver), min	99.99 ^E	99.95	99.95 ^E	99.95	99.95	99.95	99.95 ^E	99.95	99.90	99.90	99.90	99.90	99.90	99.9	99.90	99.4	99.90 ^G	99.90 ^H
Copper, min	99.99 ^E	99.95 ^E incl silver	99.95 ^F incl silver	99.95 ^E incl silver	99.95 ^E incl silver	99.95 ^E incl silver	99.95 ^F incl silver	99.95 incl silver	99.90 incl silver	99.90 incl silver	99.90 incl silver	99.90 incl silver	99.90 incl silver	99.9 incl silver	99.90 incl silver	99.4 incl silver	99.90 ^G incl silver	99.90 ^H incl silver
Phosphorus	A	...	0.001– 0.005	...	...	...	0.005– 0.012	...	...	...	...	...	0.004– 0.012	0.015– 0.040	0.015– 0.040	0.015– 0.040	...	0.001– 0.010
Arsenic	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Arsenic	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Oxygen, max	0.0005	0.0010	...	0.0010	0.0010	0.0010	...	0.005	...	...	...	...	...	...	...	...	...	...
Oxygen, max	0.0005	0.0010	...	0.0010	0.001	0.001	...	0.005	...	...	...	...	...	...	...	...	...	...
Silver	A	...	...	8 ^I	10 ^I	25 ^I	...	...	...	8 ^I	10 ^I	25 ^I	...	...	4 ^I	...	...	...
Selenium + tellurium, max	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.023
Tellurium	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.005– 0.05	0.003– 0.023 ^J
Tin	A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.04– 0.15	0.003– 0.023

^A 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.

^B 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.

^C C11300, C11400, 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.

^D Copper UNS No. C12300 is produced by the addition of silver to phosphorus-deoxidized copper.

^E Copper shall be determined by difference between impurity total and 100 %.

^F Includes phosphorus.

^G Includes tellurium + tin.

^H Includes tin + tellurium + selenium.

^I Values are minimum silver Troy oz/Avoirdupois ton (1 oz/ton is equivalent to 0.0034 %).

^J Tellurium or selenium, or both.



TABLE 2 Tensile Strength (Inch-Pound Units) Requirements and Approximate Hardness Values for the Tempers Given (Inch-Pound Units)

Temper Designation		Tensile Strength, ksi ^A		Approximate Rockwell Hardness ^B	
Standard Code	Former Name	Min	Max	F Scale	Superficial 30T
Cold-rolled tempers:					
H00	Eighth hard	32	40	54–82	up to 49
H01	Quarter hard	34	42	60–84	18–51
H02	Half hard	37	46	77–89	43–57
H03	Three-quarter-hard	41	50	82–91	47–59
H04	Hard	43	52	86–93	54–62
H06	Extra hard	47	56	88–95	56–64
H08	Spring	50	58	91–97	60–66
H10	Extra spring	52	...	92 and over	61 and over
Hot-rolled tempers:					
M20 ^C	Hot-rolled	30 ^E	38	up to 75	up to 41
O25 ^D	Hot-rolled and annealed	30 ^E	38	up to 65	up to 31

^A ksi = 1000 psi.

^B Rockwell values apply as follows: The F scale applies to metal 0.020 in. and over in thickness. The Superficial 30-T scale applies to metal 0.012 in. and over in thickness.

^C See Section 7.1.17.1.1.1.

^D See Section 7.3.1.17.1.3.1.

^E When material is specified to meet the requirements of ASME Boiler and Pressure Vessel Code, the minimum yield strength at 0.5 % extension under load or at 0.2 % offset shall be 10 ksi.

TABLE 3 Tensile Strength (SI Units) Requirements and Approximate Hardness Values for the Tempers Given (SI Units)

Temper Designation		Tensile Strength, MPa		Approximate Rockwell Hardness ^A	
Standard Code	Former Name	Min	Max	F Scale	Superficial 30T
Cold-rolled tempers:					
H00	Eighth hard	220	275	54–82	up to 49
H04	Quarter hard	235	295	60–84	18–51
H01	Quarter hard	235	290	60–84	18–51
H02	Half hard	255	315	77–89	43–57
H03	Three-quarter-hard	285	345	82–91	47–59
H04	Hard	295	360	86–93	54–62
H06	Extra hard	325	385	88–95	56–64
H08	Spring	345	400	91–97	60–66
H10	Extra spring	360	...	92 and over	61 and over
Hot-rolled tempers:					
M20 ^B	Hot-rolled	205 ^D	260	up to 75	up to 41
O25 ^C	Hot-rolled and annealed	205 ^D	260	up to 65	up to 31

^A Rockwell values apply as follows: The F scale applies to metal 0.50 mm and over in thickness. The Superficial 30-T scale applies to metal 0.30 mm and over in thickness.

^B See Section 7.1.17.1.1.1.

^C See Section 7.3.1.17.1.3.1.

^D When material is specified to meet the requirements of ASME Boiler Pressure Vessel Code, the minimum yield strength at 0.5 % extension under load or at 0.2 % offset shall be 70 MPa.

TABLE 4 Grain Size Requirements and Approximate Rockwell Hardness Values for Cold-Rolled Annealed Tempers Product

Temper Designation		Grain Size, mm		Approximate Rockwell Hardness ^A	
Standard Code	Former Name	Min	Max	F Scale	
				Min	Max
O60	Soft anneal	^B			65
O68	Deep-drawing anneal	^B	0.050	30	75

^A Rockwell hardness values apply as follows: The F scale applies to metal 0.020 in. or 0.50 mm and over in thickness.

^B Although no minimum grain size is required, this material must be fully recrystallized.

7.1.1.1 Plates—Plate not specified for ASME Boiler and Pressure Vessel Code applications shall be furnished generally available in the O25M20 temper.



**TABLE 5 Electrical Mass Resistivity Requirements for Copper
UNS Nos. C10100, C10200, C10300, C10400, C10500, C10700,
C10910, C11000, C11300, C11400, and C11600**

Alloy	Temper	Electrical Resistivity max, $\Omega\cdot\text{g}/\text{m}\cdot\text{g}/\text{m}^2$
C10100	Annealed	0.15176
C10100	Cold Rolled	0.15614
C10200, C10300, C10400, C10500, C10700, C10910, C11000, C11300, C11400, C11600	Annealed	0.15328
C10200, C10300, C10400, C10500, C10700, C10910, C11000, C11300, C11400, C11600	Cold Rolled	0.15775

7.1.2 Cold Rolled Tempers H00 to H10.

7.1.3 The standard tempers of copper sheet, strip, and plate cold-rolled annealed are designated in Table 4 as follows: O60, soft anneal and O68, deep drawing anneal. Annealed Tempers O25, O60, or O68:

NOTE 3—Any product produced in a temper other than those listed in Table 2, Table 3 or Table 4 will be produced and sold by contract and cannot be said to be produced under this specification.

7.1.3.1 Plates specified for ASME Boiler and Pressure Vessel Code applications shall be furnished in the O25 temper.

NOTE 3—Any product produced in a temper other than those listed in Table 2, Table 3, or Table 4 will be produced and sold by contract and cannot be said to be produced under this specification.

NOTE 4—Soft-anneal temper is suitable for most industrial users of copper such as forming, spinning, and simple drawing operations in which close control of temper is not essential. Deep drawing anneal temper is especially suited for very severe drawing and forming operations in which maximum ductility and close control of temper is required.

NOTE 4—Soft-anneal temper is suitable for most industrial users of copper such as forming, spinning, and simple drawing operations in which close control of temper is not essential. Deep drawing anneal temper is especially suited for very severe drawing and forming operations in which maximum ductility and close control of temper is required.

8. Grain Size for Cold Rolled Annealed Tempers

8.1 Grain Size shall be standard requirement for all products of the cold-rolled-annealed (O60 and O68) tempers.

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<https://standards.iteh.ai/catalog/standards/sist/32055159-6f29-483c-b053-250fbc1e380e/astm-b152-b152m-19>