



Standard Classification of Coppers¹

This standard is issued under the fixed designation B 224; 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.

1. Scope*

1.1 This is a classification of the various types of copper currently available in refinery shapes and wrought products in commercial quantities. It is not a specification for the various types of copper.

1.2 In this classification, use is made of the standard copper designations in use by the copper industry.

1.3 Although this classification includes certain UNS designations as described in Practice E 527, these designations are for cross-reference only and are not requirements. Therefore, in case of conflict, this ASTM classification shall govern.

1.4 This classification does not attempt to differentiate between all compositions that could be termed either coppers or copper-base alloys, but in conformance with general usage in the trade, includes those coppers in which the copper is specified as 99.85 % or more, silver being counted as copper.

NOTE 1—Coppers may contain small amounts of certain elements intentionally permitted to impart specific properties, without excessively lowering electrical conductivity. The total copper plus specific permitted elements is usually specified as 99.85 % or more. These intentionally permitted elements normally include, but are not limited to, arsenic, cadmium, chromium, lead, magnesium, silver, sulfur, tellurium, tin, zinc, and zirconium, plus deoxidizers, up to specific levels adopted by the International Standards Organization.

1.5 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*²

¹ This classification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.07 on Refined Copper.

Current edition approved May 1, 2004. Published June 2004. Originally approved in 1948. Last previous edition approved in 1998 as B 224 – 98.

² 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.

B 5 Specification for High Conductivity Tough Pitch Copper Refinery Shapes

B 115 Specification for Electrolytic Copper Cathode

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

B 216 Specification for Tough-Pitch Fire-Refined Copper for Wrought Products and Alloys—Refinery Shapes

B 379 Specification for Phosphorized Coppers—Refinery Shapes

E 527 Practice for Numbering Metals and Alloys (UNS)

F 68 Specification for Oxygen-Free Copper in Wrought Forms for Electron Devices

3. Terminology

3.1 Appendix X1 describes the terms used in designating the various coppers listed.

3.2 Appendix X2 describes the refinery shapes.

3.3 Appendix X3 describes the fabricators' forms.

4. Significance and Use

4.1 This classification lists the types of copper available from refineries or fabricators, or both, defines the common terms used, and gives the characteristics of many of the coppers available. It is useful to the neophyte looking for the appropriate copper for a particular application.

5. Basis of Classification

5.1 Table 1 lists the standard designations, and the refinery shapes and fabricators' products currently produced. The listed coppers are not necessarily available in the complete range of sizes in the form shown, nor from any one supplier in all forms.

5.2 Existing ASTM specifications for refinery copper and for wrought copper products may cover more than one of the coppers listed in Table 1 or may include only part of the range covered by any one of the coppers shown in this classification.

6. Keywords

6.1 classification, coppers

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



TABLE 1 Classification of Coppers

NOTE 1—Table 1 lists the standard designations, refinery shapes, and fabricator's products.

Designations	Type of Copper ^A	UNS Nos. ^B	Form in which Copper is Available ^C							
			From Refiners ^D				From Fabricators ^E			
			Wire Bars	Billets	Cakes	Ingots and Ingot Bars	Flat Products	Pipe and Tube	Rod and Wire	Shapes
CATH	Electrolytic cathode									
			Cathodes only							
			Tough-Pitch Coppers							
ETP	Electrolytic tough-pitch	C11000	X	X	X	X	X	X	X	X
RHC	Remelted, high-conductivity tough pitch	C11010	X	X	X	X	X	X	X	X
ETP	Electrolytic tough-pitch (anneal resist)	C11100	X	X	X		X	X	X	X
FRHC	Fire-refined, high-conductivity tough-pitch	C11020	X	X	X	X	X	X	X	X
STP	Silver-bearing, tough-pitch	C11300, C11400, C11500, C11600	X	X	X	X	X	X	X	X
FRTP	Fire-refined, tough-pitch	C12500		X	X	X	X	X	X	X
FRSTP	Fire-refined tough-pitch with silver	C12900		X	X	X	X			X
			Oxygen-Free Coppers (Without use of Deoxidants)							
OFE	Oxygen-free, electronic	C10100	X	X	X		X	X	X	X
OF	Oxygen-free	C10200	X	X	X		X	X	X	X
OFS	Oxygen-free, silver-bearing	C10400, C10500, C10700	X	X	X		X	X	X	X
OFXLP	Oxygen-free, extra low phosphorus	C10300	X	X	X		X	X	X	X
OFLP	Oxygen-free, low-phosphorus	C10800	X	X	X		X	X	X	X
			Deoxidized Coppers							
DLP	Phosphorized, low-residual phosphorus	C12000		X			X	X	X	X
DLPS ^F	Phosphorized, low-residual phosphorus silver-bearing	C12100		X			X	X	X	X
DHP ^G	Phosphorized, high-residual phosphorus	C12200		X	X		X	X	X	X
DHPS ^F	Phosphorized, high-residual phosphorus silver-bearing	C12300					X	X	X	X
DPTE ^H	Phosphorized, tellurium-bearing	C14520		X					X	
			Other Coppers							
	Sulfur-bearing	C14700		X					X	
	Zirconium-bearing	C15000		X	X		X		X	
PTE	Tellurium-bearing	C14500		X					X	

^A See Appendix X1.^B The chemical compositions associated with these numbers are listed in the product specifications and in the Standard Designations for Copper and Copper Alloys that appear in this publication under "Related Material".^C The "X" in the table indicates commercial availability.^D See Appendix X2.^E See Appendix X3.^F This includes oxygen-free copper to which phosphorus and silver have been added in amounts agreed upon.^G This includes oxygen-free copper to which phosphorus has been added.^H This includes oxygen-free tellurium-bearing copper to which phosphorus has been added in amounts agreed upon.

APPENDIXES

(Nonmandatory Information)

X1. TERMS USED TO DESIGNATE THE COPPERS

(Alphabetical listing of these terms does not necessarily indicate relative order of commercial importance.)

X1.1 Terms Relating to Method of Refining

X1.1.1 *electrolytic copper*—copper of any origin, refined by electrolytic deposition including electrowinning. Usually when this term is used alone it refers to electrolytic tough pitch copper. This designation applies to the following:

X1.1.1.1 Cathodes that are the direct product of the refining operation as described in Specification B 115.

X1.1.1.2 Electrodeposited copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.

X1.1.1.3 Electrodeposited copper cast into ingots or ingot bars suitable for remelting.

X1.1.2 *fire-refined copper*—copper of any origin or type finished by furnace refining without having been processed at any stage by electrolytic or chemical refining. Usually when the term fire-refined copper is used alone it refers to fire-refined tough pitch copper as described in Specification B 216. This designation applies to the following:

X1.1.2.1 Copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.

X1.1.2.2 Ingots or ingot bars suitable for remelting.

X1.2 Terms Relating to Characteristics Determined by Method of Casting or Processing

X1.2.1 *deoxidized copper*—copper cast in the form of refinery shapes, produced free of cuprous oxide, as determined by metallographic examination at 75× under polarized light, by the use of metallic or metalloidal deoxidizers. Oxygen may be present as residual deoxidation products. By extension, the term applies to fabricators' products made therefrom.

X1.2.2 *oxygen-free copper*—electrolytic copper produced free of cuprous oxide, as determined by metallographic examination at 75× under polarized light, without the use of metallic or metalloidal deoxidizers. By extension, the term applies to fabricators' products made therefrom.

X1.2.3 *tough pitch copper*—copper of any origin cast in the form of refinery shapes, as described in Specification B 5, containing a controlled amount of oxygen in the form of cuprous oxide. By extension the term is also applicable to fabricators' products made therefrom.

X1.3 Terms Relating to Specific Kinds of Copper and to Products Made Therefrom

X1.3.1 *deoxidized copper, high-residual phosphorus*—copper deoxidized with phosphorus residual in amounts 0.015

to 0.040 %. The copper is not susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper is of relatively low-electrical conductivity due to the amount of phosphorus present.

NOTE X1.1—International Standards Organization specifications permit up to 0.050 % phosphorus.

X1.3.2 *deoxidized copper, low-residual phosphorus*—copper deoxidized with phosphorous residual in amounts 0.004 to 0.012 %. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

X1.3.3 *high-conductivity copper*—copper that in the annealed condition has a minimum electrical conductivity of 100 % IACS as required in Specifications B 5, B 115 and B 170.

X1.3.4 *oxygen-free electronic copper*—high-purity, high-conductivity oxygen-free copper normally intended for electronic and ultra-high vacuum (Specification F 68) applications. The copper has high resistance to hydrogen embrittlement, as determined in Specification B 170 or F 68, or both. The copper in the annealed condition has a minimum electrical conductivity of 101 % IACS.

X1.3.5 *oxygen-free copper, extra low phosphorus*—oxygen-free copper containing 0.001 to 0.005 % phosphorus. The copper is not readily susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 98.16 % IACS.

X1.3.6 *oxygen-free copper, low phosphorus*—oxygen-free copper containing 0.005 to 0.012 % phosphorus. The copper is not susceptible to hydrogen embrittlement, as determined in Specification B 379. The copper in the annealed condition has a minimum conductivity of 90 % IACS.

X1.3.7 *silver-bearing copper*.

X1.3.8 *sulfur-bearing copper*.

X1.3.9 *deoxidized, phosphorus-tellurium copper*.

X1.3.10 *zirconium-bearing copper*.

X1.3.11 *tellurium-bearing copper*.

NOTE X1.2—Coppers listed in X1.3.7-X1.3.11 contain the designated element or elements in amounts as agreed upon between the manufacturer or supplier and the purchaser.

X2. DEFINITIONS OF REFINERY SHAPES

X2.1 *billet*—refinery shape used for piercing or extrusion into tubular products or for extrusion into rods, bars, and shapes. Circular in cross section, usually 3 to 16 in. (76 to 406 mm) in diameter, normally ranging in weight from 100 to 4200 lb (45 to 1905 kg).

X2.2 *cake*—refinery shape used for rolling into plate, sheet, strip, or shape. Rectangular in cross section and of various sizes, normally ranging in weight from 140 to 62 000 lb (63 to 28 200 kg).

X2.3 *cathode*—unmelted, electrodeposited, and somewhat rough flat plate normally used for melting. The customary size is about 3 ft (0.914 m) square, about ½ to ⅞ in. (12.7 to 22.2 mm) thick, weighing up to about 300 lb (136 kg), and may

have hanging loops attached. Cathodes may also be cut to smaller dimensions.

X2.4 *ingot and ingot bar*—refinery shapes used for remelting (not fabrication). Ingots normally range in weight from 20 to 35 lb (9 to 16 kg) and ingot bars from 50 to 70 lb (23 to 32 kg). Both are usually notched to facilitate breaking into smaller pieces.

X2.5 *wire bar*—refinery shape used for rolling into rod or flat product for subsequent processing into wire, strip, or shape. Approximately 3½ to 5 in. (89 to 127 mm) square in cross section, usually 54 in. (1372 mm) in length and ranging in weight from 200 to 420 lb (91 to 191 kg). Usually tapered at both ends.

X3. DEFINITIONS OF FABRICATORS' COPPER PRODUCTS

X3.1 *flat product*—a rectangular or square, solid section of relatively great length in proportion to thickness. Included in the designation “flat product” depending on the width and thickness, are plate, sheet, strip, and bar. Also included is the product known as “flat wire.”

X3.2 *pipe*—tube conforming to the particular dimensions commercially known as “Standard Pipe Sizes.”

X3.3 *rod*—a solid section, round, hexagonal, or octagonal in straight lengths. Round rod for further processing into wire (known as “hot-rolled rod,” “wire-rod,” “redraw wire,” or

“drawing stock”) is furnished coiled.

X3.4 *shape*—a solid section, other than flat product, rod or wire, furnished in straight lengths. Shapes are usually made by extrusion but may also be fabricated by drawing.

X3.5 *tube*—a unidirectionally elongated hollow product of uniform round or other cross section having a continuous periphery.

X3.6 *wire*—a solid section, including rectangular flat wire but excluding other flat products, furnished in coils or on spools, reels, or bucks.

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 224 – 98) that may impact the use of this standard. (Approved May 1, 2004.)

- (1) Removed UNS Alloy Nos. C11030 (CRTP) and C12700, C12800, and C13000 (FRSTP) from the document.
- (2) Removed terms describing “chemically refined copper” from the document.

- (3) Removed Referenced Documents B 30 and B 584 from the document.
- (4) Table X1.1 renamed as Table 1, former Appendix X1 removed and subsequent Appendixes renumbered.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).