



## Standard Terminology for Copper and Copper Alloys<sup>1</sup>

This standard is issued under the fixed designation B 846; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE—The term stress relief was editorially corrected in November 2000.

### 1. Scope

1.1 The terms defined in this terminology standard are applicable to copper and copper alloy products specifications, test methods, practices, and other documents within the jurisdiction of Committee B-5 on Copper and Copper Alloys.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes<sup>2</sup>

B 379 Specification for Phosphorized Coppers—Refinery Shapes<sup>2</sup>

### 3. Significance and Use

3.1 This terminology is not intended to apply to any standard, test method, practice, or other document not within the jurisdiction of Committee B-5 on Copper and Copper Alloys.

### 4. Terminology

**anneal (annealing)**—a thermal treatment to change the properties or grain structure of the product.

**arc welding**—a group of welding processes wherein coalescence is produced by heating with an arc or arcs, with or without the application of pressure and with or without the use of filler metal.

**as-welded condition**—a condition created as a result of forming annealed sheet or plate into tubular form and welding without subsequent heat treatment or cold work.

**average diameter (for round tubes only)**—the average of the maximum and minimum outside diameters or the maximum and minimum inside diameters, whichever is applicable, as determined at any one cross section of the tube.

**base metal**—the sheet or plate from which the pipe is formed.

**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 (63 to 28 200 kg).

**blank**—a piece of flat product intended for subsequent fabrication by forming, bending, cupping, drawing, hot pressing, and so forth.

**buckle (centre bulge or oil can)**—alternate bulges and hollows recurring along the length of a strip with the edges remaining relatively flat.

**bus bar**—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.

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

**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).

**casting**—a general term for a metal object produced at or near-finished shape by pouring or otherwise introducing molten metal into a mold and allowing it to solidify.

**casting, centrifugal**—a casting produced in a cylindrical mold rotating on its axis with the major axis of the product coinciding with the axis of rotation. The axis of rotation may be horizontal, vertical, or any angle in between.

**casting, centrifuged**—a casting produced in a mold, a number of which may be mounted around a central sprue. The molds are rotated, in a vertical position, about a central axis concentric with the central sprue.

**casting, continuous**—a casting produced by the continuous pouring and solidification of molten metal through a water-cooled mold which determines the cross-sectional shape. The length of the product is not restricted by mold dimensions.

**casting, permanent mold**—a product produced in a reusable mold constructed of a durable material, usually iron or steel, with the molten metal being introduced by gravity, low-pressure or vacuum.

**casting, sand**—a casting produced in a sand mold.

**casting, semicentrifugal**—a casting produced in a manner similar to the centrifugal casting except that a central core is used to allow the formation of other than a cylindrical inside surface. The axis of rotation is always vertical.

**cathode**—unmelted, electrodeposited, and somewhat rough

<sup>1</sup> This terminology is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.93 on Terminology.

Current edition approved April 10, 1999. Published July 1999. Originally published as B 846 – 93. Last previous edition B 846 – 98.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.01.

flat plate normally used for melting. The customary size is about 3 ft (0.914 m) square, about  $\frac{1}{2}$  to  $\frac{7}{8}$  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.

**chemically refined copper**—copper recovered from an aqueous solution by other than electrolytic means. Usually when this term is used alone it refers to chemically refined tough pitch copper. This designation applies to the following:  
—copper cast in refinery shapes suitable for hot or cold working, or both, and by extension, to fabricators' products made therefrom,  
—ingots or ingot bars suitable for remelting.

**cladding ratio**—ratio by percent thickness of the component layers, for example.

**close nipple**—a nipple with no shoulder or unthreaded portion between two threads; the shortest possible pipe nipple with complete threads.

**cold work**—controlled mechanical operations for changing the form or cross section of a product and for producing a strain-hardened product at temperatures below the recrystallization temperature.

**corner radius on square or rectangular wire**—any configuration on the corner between a chamfer and a full radius. The measurement of a corner radius is the distance from the blend point on one surface to the extension of the other surface.

**dents**—depressions in the copper foil which do not significantly change the thickness of the copper foil.

**deoxidized copper, high-residual phosphorus**—copper deoxidized with phosphorus residual in amounts 0.015 to 0.04 %. 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 1—International Standards Organization specifications permit up to 0.050 % phosphorus.

**deoxidized copper, low-residual phosphorus**—copper deoxidized with phosphorus 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.

**dewetting**—a condition that results when molten solder has coated a surface and then receded leaving irregular-shaped mounds of solder separated by areas covered with a thin film but base metal is not exposed.

**dish (cross or transverse bow)**—the departure from flatness across the full width of the strip in the form of a single arc, excluding burrs.

**disk**—a round, commercially flat solid blank made from a flat rolled product.

**distribution tube (Type D)**—a seamless or welded copper tube known as copper distribution tube (Type D).

**double layer flat**—a coil in which the product is spirally wound into two connected disk-like layers such that one layer is on top of the other. (Sometimes called “double layer pancake coil” or “double layer spirally wound coil.”)

**drawn stress relieved (DSR)**—a thermal treatment of a cold-drawn tubular product to improve ductility without significantly affecting its tensile strength or microstructure.

**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:  
—cathodes that are the direct product of the refining operation.  
—electrodeposited copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.  
—electrodeposited copper cast into ingots or ingot bars suitable for remelting.

**embrittlement**—the reduction of the normal ductility in a metal due to a physical or chemical change. As it relates to these test methods, embrittlement is the loss of ductility caused by the reaction of cuprous oxide in the copper product when exposed at elevated temperatures to a reducing atmosphere.

**ends**—straight pieces, shorter than the nominal length, left over after cutting the product into mill lengths, stock lengths, or specific lengths. They are subject to minimum length and maximum weight requirements.

**extrusion**—a uniform metal shape, long in relation to its cross-sectional dimensions, produced by forcing a suitably preheated billet or preform through an orifice (die) of the desired cross section. Extrusions generally are furnished in straight lengths.

**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. This designation applies to the following:  
—copper cast in refinery shapes suitable for hot or cold working or both, and by extension, to fabricators' products made therefrom.  
—ingots or ingot bars suitable for remelting.

**flash**—as in welding, the metal that protrudes at the weld of the tube, internally, externally, or both, as a result of the pressure applied when a forge-type seam is produced; the two types of flash are internal flash and external flash.

**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.”

**flat wire**—a product up to and including 0.188 in. (4.78 mm) in thickness and up to and including  $\frac{1}{4}$  in. (31.8 mm) in width.

**foil**—a term often applied to thin sheet or strip usually 0.005 in. (0.13 mm) or less in thickness.

**herringbone**—a series of long continuous waves running at various angles to the rolling direction.

**high-conductivity copper**—copper that in the annealed condition has a minimum electrical conductivity of 100 % IACS.

**hot working**—controlled mechanical operations for shaping a

product at temperatures above the recrystallization temperature.

**inclusions**—foreign particles which may or may not be enclosed in the copper foil.

**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.

**lengths**—straight pieces of the product.

**lengths, standard**—uniform lengths recommended in a Simplified Practice Recommendation or established as a Commercial Standard.

**longitudinal corrugation**—a condition similar to dish except that the sense of curvature changes sign at least once across the width of the strip.

**multiple**—straight lengths of integral multiples of a base length, with suitable allowance for cutting, if and when specified.

**nodules**—small irregularly shaped imperfections in the electrolytic copper foil which do not cause the foil to fail the thickness tolerance.

**order strengthening**—a thermal treatment of a cold-worked product at a temperature below its recrystallization temperature causing ordering to occur to obtain an increase in yield strength.

**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.

**oxygen-free copper, low phosphorus**—oxygen-free copper containing 0.005 to 0.12 % 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.

—deoxidized, phosphorus-arsenical copper

—arsenical, tough-pitch copper

—silver-bearing copper

—sulfur-bearing copper

—deoxidized phosphorus-tellurium copper

—zirconium-bearing copper

—tellurium-bearing copper

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

**oxygen-free electronic copper**—high-purity, high-conductivity oxygen-free copper normally intended for electronic applications. The copper has high resistance to hydrogen embrittlement, as determined in Specification B 170. The copper in the annealed condition has a minimum electrical conductivity of 101 % IACS.

**pinholes**—small holes occurring as imperfections which penetrate entirely through the copper foil.

**pipe nipple**—a short length of pipe with male threads at both ends.

**pipe, seamless**—seamless tube conforming to the particular

dimensions commercially known as “standard pipe sizes.”

**pipe, threadless**—a seamless copper tube of standard pipe outside diameters conforming to particular dimensions commercially known as threadless pipe (TP).

**pits**—small holes having jagged edges, occurring as imperfections which do not penetrate entirely through the copper foil.

**plate**—*as in inch-pound specifications*, a wrought flat product over 0.188-in. thick and over 12-in. wide, in straight lengths or coils (rolls).

**plate**—*as in SI specifications*, a wrought flat product over 5-mm thick and over 300-mm wide, in straight lengths or coils (rolls).

**portion size**—the number of lengths of pipe to be used for a specific test.

**precipitation heat treatment**—a thermal treatment of a solution heat-treated product to produce property changes such as hardening, strengthening, and conductivity increase by precipitation of constituents from the supersaturated solid solution. This treatment has also been called “age hardened” and “precipitation hardened.”

**quench hardening**—a treatment for copper-aluminum alloy products consisting of heating above the betaizing temperature followed by quenching to produce a hard martensitic structure.

**random**—run of mill lengths without any indicated preferred length.

**reel or spool**—a cylindrical device that has a rim at each end and an axial hole for a shaft or spindle, and on which the product is wound to facilitate handling and shipping.

**residual stress**—stresses that remain within a body as the result of plastic deformation or casting.

**rod, for staybolts**—a round solid section furnished in straight lengths.

**rod, piston finish**—a round rod having a special surface produced by turning or grinding to close tolerances for diameter and straightness.

**rod, shafting**—a round rod specially manufactured to the close straightness tolerances required for use in shafting.

**roll**—a length of the product 25 ft (7.62 m) to 50 ft (15.24 m) inclusive, spirally wound into a series of connected turns, with successive turns on top of one another.

**sample**—the final form of a material submitted for chemical analysis (drillings, millings, and so forth) or a prepared test specimen to be used for mechanical testing.

**scarfing**—the removing of flash or bead by a cutting operation.

**sheet**—*as in inch-pound specifications*, a rolled flat product up to and including 0.188-in. thick and over 24-in. wide, in straight lengths or coils (rolls).

**sheet**—*as in SI specifications*, a rolled flat product up to and including 5-mm thick and over 600-mm wide, in straight lengths or coils (rolls).

**short plumbing (hospital) threads**—a special modified form of the tapered pipe thread basically achieved by elimination of the imperfect threads. This thread is normally used only on chromium-plated nipples to ensure that a minimum of thread shall remain exposed after the nipple is threaded into a fitting.

**single layer flat**—a coil in which the product is spirally wound

into a single disk-like layer. (Sometimes called “pancake coil” or “single layer spirally wound coil.”)

**solderability**—the capability of a metal to be wetted by solder.

**solution heat treatment**—a thermal treatment of a product to put alloying elements into solution in the base metal by heating into the temperature range of solid solubility, followed by cooling at a sufficient rate to retain them in a supersaturated solid solution.

**specific**—straight lengths that are uniform in length, as specified, and subject to established length tolerances.

**specific with ends**—specific lengths, including ends.

**spinodal heat treatment**—a thermal treatment of a solution-heat-treated product to produce property changes such as hardening, strengthening, and conductivity increase by spinodal decomposition of a solid solution. This treatment has also been called “age hardened,” “spinodal hardened,” or “spinodally decomposed.”

**stagger wound**—a coil in which the turns are positioned into layers approximately parallel to the axis of the coil, but not necessarily with the fixed regularity of a level or traverse wound coil.

**standard**—uniform lengths recommended in a simplified practice recommendation or established as a commercial standard.

**stock with ends**—stock lengths, including ends.

**strain hardening**—the increase in strength and hardness and decrease in ductility due to permanent deformation of the structure by cold working.

**stress corrosion crack**—spontaneous failure of metals by cracking under combined action of corrosion and stress, residual or applied.

**stress relief**—a treatment of a product to reduce residual stresses.

*by mechanical treatment*—without causing a significant change in size.

*by thermal treatment*—without causing recrystallization.

**strip**—*as in inch-pound specifications*, a rolled flat product, other than flat wire, up to and including 0.188-in. thick, in straight lengths, coils (rolls), or traverse wound on reels or spools having either slit, sheared or slit and rolled edges in widths up to 24-in. inclusive, or having finished drawn or rolled edges, in widths over 1¼-in. to 12-in. inclusive.

**strip**—*as in SI specifications*, a rolled flat product other than flat wire up to and including 5-mm thick in straight lengths, coils (rolls), or traverse wound on reels or spools having either slit or sheared edges in widths up to 600-mm inclusive, or having finished drawn or rolled edges, in widths over 30-mm to 300-mm inclusive.

**temper**—the metallurgical structure and properties of a product resulting from thermal or mechanical processing treatments.

**temper annealing**—a thermal treatment above the eutectoid temperature for copper-aluminum alloy products to minimize the presence of the stable eutectoid structure.

**tempering**—a thermal treatment of a quench-hardened product to improve ductility.

**thermal treatment**—a controlled heating; time at maximum temperature-cooling cycle as needed to satisfy the property

and grain structure requirements of the temper.

**threadless pipe (TP)**—seamless tube conforming to the particular dimensions commercially known as “threadless pipe (TP).”

**tough pitch copper**—copper of any origin cast in the form of refinery shapes, containing a controlled amount of oxygen in the form of cuprous oxide. By extension the term is also applicable to fabricators’ products made therefrom.

**treatment**—a process that is applied to one or both sides of the copper foil to enhance the adhesion of the foil to the base substrate that shall not degrade the foil or the base substrate.

**tube, air conditioning**—a seamless copper tube conforming to a standard series of sizes, and to specified internal cleanliness requirements normally furnished in straight lengths, with the ends capped or sealed.

**tube, automotive and general service**—a seamless copper tube of small diameter conforming to a standard series of sizes commercially known as automotive and general service tube.

**tube, capillary**—a tube of small inside diameter with an inside surface of highest quality and conforming to close-diameter tolerances. It is subject to special tests to ensure precision and uniformity of bore and is specially cleaned and packed.

*tube, condenser*—see **tube, heat exchanger**.

**tube, copper service**—a bendable copper water tube for underground water service.

**tube, copper water**—a seamless copper tube conforming to the particular dimensions commercially known as copper water tube and designated as Types K, L, and M.

**tube, ferrule**—a tube from which metal rings or collars (ferrules) are made for use in installing condenser tubes.

**tube, heat exchanger**—a tube manufactured to special requirements as to dimensional tolerances, finish, and temper for use in condensers and other heat exchangers.

**tube, heat exchanger with integral enhanced surface**—an external or internal surface, or both, modified by a cold forming operation, to produce an enhanced surface for improved heat transfer. The enhancement may take the form of longitudinal or helical fins or ridges, or both, or modifications thereto.

**tube, heat exchanger with integral fins**—a tube having a series of metallic ribs on the outside or inside surface either parallel to the longitudinal axis or circumferentially extended from the tube to increase the effective surface area for heat transfer applications. The fins may be mechanically applied, drawn, or integrally extended from the tube wall.

**tube, refrigeration service**—a seamless copper tube conforming to a standard series of sizes, and to special internal cleanliness and dehydration requirements, normally furnished to soft temper coils and with ends capped or sealed.

**tube, seamless**—a tube produced with a continuous periphery in all stages of the operations.

**tube, seamless water**—a tube conforming to the particular dimensions of tube commercially known as copper water tube and designated as Types K, L, and M in inch-pound units and Types A, B, and C in SI units.

**tube, waveguide**—a tube used as a transmission line to electronic equipment.

**tube, welded**—tube made by processing strip into a tubular shape and welding the edges to make a longitudinal seam.

**tube, welded water**—a tube conforming to the particular dimensions of tube commercially known as copper water tube and designated as Types WK, WL, and WM in inch-pound units, and Types WA, WB, and WC in SI units.

**unaided eye**—visual inspection, without the use of special equipment or enhancement excepting the use of corrective lenses.

**wavy edges (waves—edge wave)**—a continuous pattern of waves or wrinkles along the edges of the strip, with a relatively flat center portion.

**welded pipe**—product made from sheet, strip, or plate with a seam made by welding.

**welded tube**—product made from sheet, strip, or plate with a seam made by welding.

**weld reinforcement**—the portion of the welded joint which extends beyond the inner and outer surface of the base metal of the welded pipe.

**wetting**—the formation of a relatively uniform, smooth, unbroken, and adherent film of solder to a base material.

**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. (1.56 m) in length, and ranging in weight from 200 to 420 lb (91 to 191 kg). Usually tapered on both ends.

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