Designation: ~~B601 – 09~~ B601 – 12

Standard Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast[1]

This standard is issued under the fixed designation B601; 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.

1. Scope*

1.1 This classification establishes temper designations for copper and copper alloys—wrought and cast. The temper designations are classified by the process or processes used in manufacturing the product involved and its resulting properties. It is not a specification of copper and copper alloys.

1.2 The property requirements for the tempers are given in the applicable product specification.

2. Referenced Documents

2.1 *ASTM Standards*:[2]

B846 Terminology for Copper and Copper Alloys

3. Terminology

3.1 For terminology related to copper and copper alloys, refer to Terminology B846.

4. Significance and Use

4.1 *Significance*—This classification establishes an alphanumeric code of the tempers of copper and copper alloy products.

4.2 *Use*—An alphanumeric code establishes a system by which product tempers in specifications and published data are designated.

4.2.1 The letters in the code identify the type of process used to produce the product temper. For example, “H” indicates a temper resulting from cold working.

NOTE 1—These letters are frequently the same as those used in temper systems of other metal products.

NOTE 2—Undefined letters, used in prior temper systems and included in this system for reference, are defined in Appendix X1.

5. Classification of Tempers

5.1 *Annealed Tempers, O*—Tempers produced by annealing to meet mechanical property requirements.

5.2 *Annealed Tempers, with Grain Size Prescribed, OS*—Tempers produced by annealing to meet standard or special grain size requirements.

5.3 *As-Manufactured Tempers, M*—Tempers produced in the product by the primary manufacturing operations of casting, or casting and hot working, and controlled by the methods employed in the operations.

5.4 *Cold-Worked Tempers, H*—Tempers produced by controlled amounts of cold work, by manufacturing process, or by use.

5.5 *Cold-Worked (Drawn), and Stress-Relieved Tempers, HR*—Tempers produced by controlled amounts of cold work followed by stress relief.

5.5.1 *Order-Strengthening Tempers, HT*—Tempers produced by controlled amounts of cold work followed by a thermal treatment to produce order strengthening.

5.5.2 *End Annealed Temper, HE*—Temper produced by cold work followed by anneal of the ends of the product.

5.6 *Heat-Treated Tempers, T*—Tempers that are based on solution heat treatments followed by rapid cooling, with or without subsequent cold working or thermal treatments.

5.6.1 *Quench-Hardened Tempers, TQ*—Tempers produced by quench-hardening treatments.

5.6.2 *Solution Heat-Treated Temper, TB*—Tempers produced by solution heat-treating precipitation hardenable or spinodal hardenable alloys.

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

5.6.3 *Solution Heat-Treated and Cold-Worked Tempers, TD*—Tempers produced by controlled amounts of cold work of solution heat-treated precipitation hardenable or spinodal hardenable alloys.

5.6.4 *Precipitation Heat-Treated Temper, TF*—Tempers produced by Solution Heat-Treatment and precipitation heat treatment of precipitation-hardenable alloys.

5.6.5 *Spinodal Heat Treated Temper, TX*—Tempers produced by Solution Heat-Treatment and spinodal heat treatment of spinodal hardenable alloys.

5.6.6 *Cold-Worked and Precipitation Heat-Treated Tempers, TH*—Tempers produced in alloys that have been solution heat treated, cold worked, and precipitation heat treated.

5.6.7 *Cold-Worked and Spinodal Heat-Treated Tempers, TS*—Tempers produced in alloys that have been solution heat treated, cold worked, and spinodal heat treated.

5.6.8 *Mill-Hardened Tempers, TM*—Tempers of heat-treated materials as supplied by the mill resulting from combinations of cold work and precipitation heat treatment or spinodal heat treatment.

5.6.9 *Precipitation Heat-Treated or Spinodal Heat-Treated and Cold-Worked Tempers, TL*—Tempers produced by cold working the precipitation heat-treated or spinodal heat-treated alloys.

5.6.10 *Precipitation Heat-Treated or Spinodal Heat-Treated, Cold-Worked, and Thermal Stress-Relieved Tempers, TR*—Tempers produced in the cold-worked precipitation heat-treated or spinodal heat-treated alloys by thermal stress relief.

5.7 *Tempers of Welded Tubes, W*—(Welded tubes are produced from strip of various tempers and essentially have the temper of the strip except in the heat-affected zone.)

5.7.1 *Tube, As-Welded Tempers, WM*—Tempers that result from forming and welding when producing tube.

5.7.2 *Tube, Welded and Annealed Temper, WO*—Temper that results from forming, welding, and annealing when producing tube.

5.7.3 *Tube, Welded and Cold-Worked Tempers, WH*—Tempers that result from forming, welding, and cold working when producing tube.

5.7.4 *Tube, Welded, Cold-Worked and Stress-Relieved Tempers, WR*—Tempers that result from forming, welding, cold working, and stress relieving when producing tube.

5.7.5 *Tube, Welded, and Fully Finished Tempers, O, OS, H*—Tempers that result from both annealing a welded and cold-worked tube, or cold working, a welded cold-worked and annealed tube. With these treatments, the weld area has been transformed into a wrought structure, and the usual temper designations apply.

6. Temper Designation Codes and Names

6.1 *Annealed Tempers, O:*

6.1.1 *Annealed to Meet Mechanical Properties, O:*

Temper Codes	Temper Names
O10	Cast and Annealed (Homogenized)
O11	As Cast and Precipitation Heat Treated
O20	Hot Forged and Annealed
O25	Hot Rolled and Annealed
O26	Hot Rolled and Temper Annealed
O30	Hot Extruded and Annealed
O31	Hot Extruded and Precipitation Heat Treated
O32	Hot Extruded and Temper Annealed
O40	Hot Pierced and Annealed
O50	Light Anneal
O60	Soft Anneal
O61	Annealed
O65	Drawing Anneal
O68	Deep Drawing Anneal
O70	Dead Soft Anneal
O80	Annealed to Temper—⅛ Hard
O81	Annealed to Temper—¼ Hard
O82	Annealed to Temper—½ Hard

[1] This classification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.91 on Editorial and Publications.

Current edition approved ~~Oct. 1, 2009~~Oct. 1, 2012. Published ~~November 2009~~November 2012. Originally approved in 1974. Last previous edition approved in ~~2007~~2009 as ~~B601 – 07.~~B601 – 09. DOI: ~~10.1520/B0601-09.~~10.1520/B0601-12.

[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.

6.1.2 *Annealed Tempers, with Grain Size Prescribed—OS*

Temper Codes	Temper Designations Nominal Avg Grain Size, mm
OS005	0.005
OS010	0.010
OS015	0.015
OS025	0.025
OS035	0.035
OS045	0.045
OS050	0.050
OS060	0.060
OS065	0.065
OS070	0.070
OS100	0.100
OS120	0.120
OS150	0.150
OS200	0.200

6.2 *Cold-Worked Tempers, H:*

6.2.1 *Cold-Worked Tempers to Meet Standard Requirements Based on Cold Rolling or Cold Drawing, H:*

Temper Codes	Temper Names
H00	⅛ Hard
H01	¼ Hard
H02	½ Hard
H03	¾ Hard
H04	Hard
H06	Extra Hard
H08	Spring
H10	Extra Spring
H12	Special Spring
H13	Ultra Spring
H14	Super Spring

6.2.2 *Cold-Worked Tempers to Meet Standard Requirements Based on Temper Names Applicable to Particular Products, H:*

Temper Codes	Temper Names
H50	Hot Extruded and Drawn
H52	Hot Pierced and Drawn
H55	Light Drawn, Light Cold-Worked
H58	Drawn General Purpose
H60	Cold Heading, Forming
H63	Rivet
H64	Screw
H66	Bolt
H70	Bending
H80	Hard Drawn
H85	Medium Hard-Drawn Electrical Wire
H86	Hard-Drawn Electrical Wire
H90	As-finned

6.3 *Cold-Worked Tempers with Added Treatments:*

6.3.1 *Cold Worked and Stress Relieved, HR:*

Temper Codes	Temper Names
HR01	¼ Hard and Stress Relieved
HR02	½ Hard and Stress Relieved
HR04	Hard and Stress Relieved
HR06	Extra Hard and Stress Relieved
HR08	Spring and Stress Relieved
HR10	Extra Spring and Stress Relieved
HR12	Special Spring and Stress Relieved
HR20	As-finned and Stress Relieved
HR50	Drawn and Stress Relieved

6.3.2 *Cold Rolled and Order Strengthened, HT:*

Temper Codes	Temper Names
HT04	Hard Temper and Treated
HT08	Spring Temper and Treated

6.3.3 *Hard Drawn End Annealed, HE:*

Temper Codes	Temper Name
HE80	Hard Drawn and End Annealed

6.4 *As-Manufactured Tempers, M:*

Temper Codes	Temper Names
M01	As Sand Cast
M02	As Centrifugal Cast
M03	As Plaster Cast
M04	As Pressure Die Cast
M05	As Permanent Mold Cast
M06	As Investment Cast
M07	As Continuous Cast
M10	As Hot Forged—Air Cooled
M11	As Hot Forged—Quenched
M20	As Hot Rolled
M25	As Hot Rolled and Rerolled
M30	As Hot Extruded
M40	As Hot Pierced
M45	As Hot Pierced and Rerolled

6.5 *Heat-Treated Tempers, T:*
6.5.1 *Quench Hardened, TQ:*

Temper Codes	Temper Names
TQ00	Quench Hardened
TQ30	Quench Hardened and Tempered
TQ50	Quenched Hardened and Temper Annealed
TQ55	Quench Hardened and Temper Annealed, Cold Drawn and Stress Relieved
TQ75	Interrupted Quench