**Designation: ~~B601 – 12~~ B601 – 16**

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

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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 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.



[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.

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[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.

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

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.

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:*~~*Annealed Tempers, O:*

6.1.1 *Annealed to Meet Mechanical Properties, O:* ~~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 |

6.1.2 *Annealed Tempers, with Grain Size Prescribed—OS:* ~~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:*~~*Cold-Worked Tempers, H:*

6.2.1 *Cold-Worked Tempers to Meet Standard Requirements Based on Cold Rolling or Cold Drawing, H:* ~~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:* ~~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~~ |
| H85 | Medium Hard-Drawn Electrical Wire |
| H86 | Hard-Drawn Electrical Wire |
| H90 | As-finned |

6.3 ~~*Cold-Worked Tempers with Added Treatments:*~~*Cold-Worked Tempers with Added Treatments:*

6.3.1 *Cold Worked and Stress Relieved, HR:* ~~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~~ |
| HR50 | Drawn and Stress Relieved |

6.3.2 *Cold Rolled and Order Strengthened, HT:* ~~Cold Rolled and Order Strengthened, HT:~~

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

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6.3.3 *Hard Drawn End Annealed, HE:* ~~Hard Drawn End Annealed, HE:~~

| ~~Temper Codes~~<br>Temper Code | ~~Temper Name~~<br>Temper Name |
|---|---|
| HE80 | Hard Drawn and End Annealed |



6.4 *As-Manufactured Tempers, M:* ~~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:*~~*Heat-Treated Tempers, T:*

6.5.1 *Quench Hardened, TQ:* ~~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~~ |
| TQ55 | Quench Hardened and Temper Annealed, Cold Drawn and Stress Relieved |
| TQ75 | Interrupted Quench |

6.5.2 *Solution Heat Treated, TB:* ~~Solution Heat Treated, TB:~~

| ~~Temper Codes~~ Temper Code | ~~Temper Name~~ Temper Name |
|---|---|
| ~~TB00~~ | ~~Solution Heat Treated (A)~~ |
| TB00 | Solution Heat Treated (A) |

6.5.3 *Solution Heat Treated and Cold Worked, TD:* ~~Solution Heat Treated and Cold Worked, TD:~~

| Temper Codes | Temper Names |
|---|---|
| TD00 | Solution Heat Treated and Cold Worked: ⅛ Hard |
| TD01 | Solution Heat Treated and Cold Worked: ¼ Hard (¼ H) |
| TD02 | Solution Heat Treated and Cold Worked: ½ Hard (½ H) |
| TD03 | Solution Heat Treated and Cold Worked: ¾ Hard (¾ H) |
| TD04 | Solution Heat Treated and Cold Worked: Hard (H) |



6.5.4 *Solution Heat Treated and Precipitation Heat Treated, TF:* ~~Solution Heat Treated and Precipitation Heat Treated, TF:~~

| ~~Temper Codes~~ Temper Codes | ~~Temper Name~~ Temper Names |
|---|---|
| TF00 | Precipitation Hardened (AT) |
| TF01 | Precipitation Heat-Treated Plate—Low Hardness (ATLH) |
| TF02 | Precipitation Heat-Treated Plate—High Hardness (ATHH) |

6.5.5 *Solution Heat Treated and Spinodal Heat Treated, TX:* ~~Solution Heat Treated and Spinodal Heat Treated, TX:~~

| ~~Temper Codes~~ Temper Codes | ~~Temper Name~~ Temper Names |
|---|---|
| ~~TX00~~ | ~~Spinodal Hardened (AT)~~ |
| TX00 | Spinodal Hardened–Low Strength (ATLS) |
| TX01 | Spinodal Hardened–High Strength (ATHS) |

6.5.6 *Solution Heat Treated, Cold Worked, and Precipitation Heat Treated, TH:* ~~Solution Heat Treated, Cold Worked, and Precipitation Heat Treated, TH:~~

| Temper Codes | Temper Names |
|---|---|
| TH01 | ¼ Hard and Precipitation Heat Treated (¼ HT) |
| TH02 | ½ Hard and Precipitation Heat Treated (½ HT) |
| TH03 | ¾ Hard and Precipitation Heat Treated (¾ HT) |
| TH04 | Hard and Precipitation Heat Treated (HT) |

6.5.7 *Cold-Worked Tempers and Spinodal Heat Treated to Meet Standard Requirements Based on Cold Rolling or Cold Drawing, TS:* ~~Cold-Worked Tempers and Spinodal Heat Treated to Meet Standard Requirements Based on Cold Rolling or Cold Drawing, TS:~~

| Temper Codes | Temper Names |
|---|---|
| TS00 | ⅛ Hard and Spinodal Hardened (⅛ TS) |
| TS01 | ¼ Hard and Spinodal Hardened (¼ TS) |
| TS02 | ½ Hard and Spinodal Hardened (½ TS) |
| TS03 | ¾ Hard and Spinodal Hardened (¾ TS) |
| TS04 | Hard and Spinodal Hardened |
| TS06 | Extra Hard and Spinodal Hardened |
| TS08 | Spring and Spinodal Hardened |
| TS10 | Extra Spring and Spinodal Hardened |
| TS12 | Special Spring and Spinodal Hardened |
| TS13 | Ultra Spring and Spinodal Hardened |
| TS14 | Super Spring and Spinodal Hardened |



6.5.8 *Mill Hardened, TM:* ~~Mill Hardened, TM:~~

| Temper Codes | Manufacturing Designations |
|---|---|
| ~~TM00~~ | ~~AM~~ |
| TM00 | AM |
| TM01 | ¼ HM |
| TM02 | ½ HM |
| TM03 | ¾ HM |
| ~~TM04~~ | ~~HM~~ |
| TM04 | HM |
| ~~TM05~~ | ~~SHM~~ |
| TM05 | SHM |
| ~~TM06~~ | ~~XHM~~ |
| TM06 | XHM |
| ~~TM08~~ | ~~XHMS~~ |
| TM08 | XHMS |
| TM10 | SHMS |