



Designation: **B591—09 B591 – 15**

# Standard Specification for Copper-Zinc-Tin and Copper-Zinc-Tin-Iron-Nickel Alloys Plate, Sheet, Strip, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B591; 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.

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

## 1. Scope\*

1.1 This specification covers the requirements for specified copper-zinc-tin alloys and copper-zinc-tin-iron-nickel alloys in the form of plate, sheet, strip, and rolled bar. The alloys and nominal compositions are as follows:

Copper Alloy UNS No.	Copper, %	Tin, %	Zinc, %	Phos., %%	Iron, %	Nickel, %
C40500	95	1	4			
C40810	95.5	2.0	2.2	0.03	0.1	0.15
C40850	95.5	3.0	1.3	0.1	0.1	0.1
C40860	94.8	2.0	3	0.03	0.03	0.1
C41100	91	0.5	8.5			
C41300	91	1	8			
C41500	91	2	7			
C42200	87	1	12			
C42500	88	2	10			
C42520	89.8	2.0	8	0.1	0.1	0.1
C43000	85	2	13			
C43400	85	0.7	14.3			

1.2 *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 that which are provided for information only and are not considered standard.

## 2. Referenced Documents

2.1 The following documents in the current issue of the *Annual Book of ASTM Standards* form a part of this specification to the extent referenced herein:

### 2.2 *ASTM Standards*:<sup>2</sup>

[B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar](#)

[B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast](#)

[B846 Terminology for Copper and Copper Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E62 Test Methods for Chemical Analysis of Copper and Copper Alloys \(Photometric Methods\) \(Withdrawn 2010\)](#)<sup>3</sup>

[E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys \(Withdrawn 2003\)](#)<sup>4</sup>

[E112 Test Methods for Determining Average Grain Size](#)

[E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition](#)

[E478 Test Methods for Chemical Analysis of Copper Alloys](#)

[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

### 3. General Requirements

3.1 The following sections of Specification **B248** constitute a part of this specification:

- 3.1.1 Terminology—Definitions,
- ~~3.1.2 Materials and Manufacturing,~~
- 3.1.2 Workmanship, Finish, and Appearance,
- ~~3.1.3 Sampling—except for chemical analysis, Sampling,~~
- 3.1.4 Number of Tests and Retests,
- 3.1.5 Specimen Preparation,
- 3.1.6 Test Methods—except for chemical analysis,
- 3.1.7 Significance of Numerical Limits,
- 3.1.8 Inspection,
- 3.1.9 Rejection and Rehearing,
- 3.1.10 Certification,
- 3.1.11 Test Reports (Mill),
- ~~3.1.12 Packaging and Package Marking, and~~
- 3.1.13 Supplementary Requirements.

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

### 4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology **B846**.

### 5. Ordering Information

5.1 Include the following ~~information-specified~~ choices when placing orders for product under this specification, as applicable:

- 5.1.1 ASTM designation and year of issue (for example, B591—~~XX~~); ~~—XX~~),
- 5.1.2 Copper [Alloy] UNS No. Designation (for example, ~~€42500~~); C42500),
- 5.1.3 Temper (see Section ~~8~~); 2),
- 5.1.4 Dimensions, that is, thickness, width, length, and so forth (see Section ~~12~~); 2),
- 5.1.5 ~~Form, that is, Form:~~ Form: plate, sheet, strip, or rolled bar; ~~bar~~,
- 5.1.6 ~~How furnished, that is, rolls, furnished:~~ coils, specific or stock lengths, with or without ends; ~~ends~~,
- 5.1.7 ~~Quantity, that is, Quantity:~~ total weight each form, temper, and size; ~~size~~, and
- 5.1.8 ~~When material is purchased for agencies of the U.S. Government the requirements of Section~~ Intended application. ~~It shall apply.~~

5.2 The following options are available ~~under this specification and should be specified in the contract or purchase but may not be included unless specified at the time of placing of the order when required:~~

- 5.2.1 ~~Type of edge, that is, edge:~~ slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges, ~~and~~
- 5.2.2 ~~Width and straightness tolerances (see Section~~ 12); ~~),~~
- 5.2.3 ~~Heat Identification or traceability details (see~~ 6.1.2); ~~),~~
- 5.2.4 ~~Certification, and~~
- 5.2.5 ~~Mill Test Report.~~
- 5.2.6 ~~If product is purchased for agencies of the U.S. Government, see Section~~ 11 ~~of this specification and the Supplementary Requirements section of Specification~~ **B248** ~~for additional requirements, if specified.~~

### 6. Materials and Manufacture

#### 6.1 Material:

6.1.1 The material of manufacture shall be a form (cast bar, cake, or slab) of Copper Alloy UNS No. C40500, C40810, C40850, C40860, C41100, C41300, C41500, C42200, €42000, €43300, €43400, €40810, €40850, €40860, or C42520 as specified in the ~~ordering information.~~ C42500, C42520, C43000, or C43400 of such purity and soundness as to be suitable for processing into products prescribed herein.

6.1.2 ~~In the event~~ ~~When specified in the contract or purchase order, that heat identification or traceability is required, the purchaser shall specify the details~~ required. ~~desired.~~

NOTE 1—~~Because of~~ Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

#### 6.2 Manufacture:

6.2.1 The product shall be manufactured by such hot working, cold working, and annealing processes as to produce a uniform wrought structure in the finished product.

6.2.2 The product shall be hot or cold worked to the finished size and subsequently annealed, when required, to meet the temper properties ~~specified in the ordering information specified.~~

6.2.3 *Edges*—Slit edges shall be furnished unless otherwise specified in the contract or purchase order.

## 7. Chemical Composition

7.1 The material shall conform to the chemical compositional requirements specified in **Table 1** for the copper alloy UNS No. designation specified in the ordering information.

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

7.2 Zinc, given as the “Remainder,” is the ~~For alloys in which zinc is listed as “remainder,” either copper or zinc may be taken as the difference between the sum of the results for all elements determined and 100 %.~~ When all elements in **Table 1** are determined, the sum of the results shall be 99.7 % min.

7.2.1 Copper may be determined by difference; however, when so determined, the results must conform to the requirements of **Table 1**.

7.3 When all elements specified in **Table 1** for the designated alloy are determined, the sum of results shall equal at least 99.7 %.

## 8. Temper

8.1 The standard tempers for products described in this specification are given in **Table 2** and **Table 3**.

8.1.1 *As-Hot Rolled (M20) Material—Temper (M20)*. This standard temper of sheet and plate produced by hot rolling, where applicable, is shown in **Table 2**. (See **Table 4** for SI equivalents.)

8.1.2 *H (Rolled Material)—Cold Rolled Tempers H01 to H10*—The standard tempers of rolled materials are as designated in **Table 2** with the prefix “H.” Special tempers not listed in this specification are subject to agreement between the manufacturer and the purchaser.

8.1.3 *Annealed Material—Tempers OS015 to OS035*—The standard tempers of annealed material are as designated in **Table 3** in the column entitled “Nominal Grain Size.” Special tempers not listed in this specification are subject to agreement between the manufacturer and the purchaser.

8.1.4 Temper designations are defined in Classification **B601**.

## 9. Grain Size for Annealed Tempers

9.1 Grain size shall be the standard requirement for all products in the annealed tempers.

9.2 Acceptance or rejection based upon grain size shall depend only on the average grain size of test specimen taken from each of two sampling portions and each specimen shall be within the limits prescribed in **Table 3** when determined in accordance with Test Methods **E112**.

9.3 Grain size shall be determined on a plane parallel to the flat surfaces of the product.

## 10. Mechanical Property Requirements

10.1 *Tensile Strength Requirements of Rolled Tempers:*

10.1.1 Product in “H” (rolled) tempers furnished under this specification shall conform to the tensile requirements prescribed in **Table 2** for the temper and UNS Alloy Number specified in the ordering information when tested in accordance with Test Methods **E8E8/E8M**.

10.1.2 Test specimens shall be taken so that the longitudinal axis is parallel to the direction of rolling.

10.1.3 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

**TABLE 1 Chemical Requirements**

Copper Alloy UNS No.	Composition, % max (Unless Shown as a Range)						
	Copper	Tin	Lead	Iron	Phosphorus	Nickel	Zinc
C40500	94.0-96.0	0.7-1.3	0.05	0.05	...	...	remainder
C40810	94.5-96.5	1.8-2.2	0.05	0.08-0.12	0.028-0.04	0.11-0.20	remainder
C40850	94.5-96.5	2.6-4.0	0.05	0.05-0.20	0.01-0.20	0.05-0.20	remainder
C40860	94.0-96.0	1.7-2.3	0.05	0.01-0.05	0.02-0.04	0.05-0.20	remainder
C41100	89.0-92.0	0.30-0.7	0.09	0.05	...	...	remainder
C41300	89.0-93.0	0.7-1.3	0.09	0.05	...	...	remainder
C41500	89.0-93.0	1.5-2.2	0.09	0.05	...	...	remainder
C42200	86.0-89.0	0.8-1.4	0.05	0.05	0.35	...	remainder
C42500	87.0-90.0	1.5-3.0	0.05	0.05	0.35	...	remainder
C42520	88.0-91.0	1.5-3.0	0.05	0.05-0.20	0.01-0.20	0.05-0.20	remainder
C43000	84.0-87.0	1.7-2.7	0.09	0.05	...	...	remainder
C43400	84.0-87.0	0.40-1.0	0.05	0.05	...	...	remainder

**TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values for Rolled Tempers**

NOTE 1—Plate is generally available in only the as hot-rolled (M20) temper. Required properties for other tempers shall be agreed upon between the manufacturer and the purchaser at the time of placing the order.

NOTE 2—See Table 4 for SI unit equivalents.

Temper Designation		Tensile Strength, ksi <sup>A</sup> (MPa) <sup>B</sup>		Approximate Rockwell Hardness			
Standard-Code <sup>C</sup>	Former Name	Min	Max	B-Scale		Superficial 30T	
				0.020 to 0.036 in. (0.51 to 0.91 mm), incl	Over 0.036 in. (0.91 mm)	0.012 to 0.028 in. (0.30 to 0.71 mm), incl	Over 0.028 in. (0.711 mm)
Copper Alloy UNS No. C40500							
M20	As hot-rolled	35 (240)	50 (345)	...	...	...	...
H01	Quarter hard	41 (280)	53 (365)	30-54	34-62	36-56	38-58
H02	Half hard	46 (315)	58 (400)	50-66	52-69	49-60	51-62
H03	Three-quarter hard	52 (360)	64 (440)	60-72	62-74	56-66	58-68
H04	Hard	58 (400)	70 (485)	66-76	68-78	60-68	62-70
H06	Extra hard	63 (435)	75 (515)	71-78	72-80	65-71	66-73
H08	Spring	68 (470)	80 (550)	75-81	76-83	67-72	68-74
H10	Extra spring	73 (505)	84 (580)	78-83	79-85	69-73	70-75
Copper Alloy UNS No. C40810							
H02	Half hard	57 (395)	73 (505)	65-80	66-81	60-70	62-72
H04	Hard	76 (525)	88 (605)	78-89	80-90	67-74	69-75
H06	Extra hard	90 (620)	100 (690)	82-90	83-92	69-75	70-76
H08	Spring	94 (650)	102 (705)	85-92	86-94	71-77	72-78
Copper Alloy UNS No. C40850							
H02	Half hard	57 (395)	73 (505)	65-80	67-81	60-69	62-72
H04	Hard	76 (525)	89 (615)	78-88	80-90	67-74	69-75
H06	Extra hard	90 (620)	100 (690)	82-91	83-93	69-75	70-76
H08	Spring	94 (650)	106 (730)	85-92	87-94	72-77	73-78
Copper Alloy UNS No. C40860							
H02	Half hard	56 (385)	72 (495)	64-80	65-80	60-70	61-72
H04	Hard	74 (510)	87 (600)	77-89	79-90	66-74	68-75
H06	Extra hard	88 (605)	98 (675)	81-90	82-91	68-75	69-76
H08	Spring	92 (635)	105 (725)	84-92	85-94	70-77	71-78
Copper Alloy UNS No. C41100							
M20	As hot-rolled	34 (235)	50 (345)	...	...	...	...
H01	Quarter hard	42 (290)	54 (370)	32-60	34-63	37-57	38-64
H02	Half hard	49 (340)	60 (415)	51-68	52-70	50-62	51-67
H03	Three-quarter hard	55 (380)	66 (455)	62-75	63-77	58-66	59-70
H04	Hard	61 (420)	72 (495)	68-79	69-81	62-70	64-71
H06	Extra hard	67 (460)	78 (540)	74-82	76-84	66-73	67-72
H08	Spring	73 (505)	83 (570)	78-84	77-86	69-74	70-73
H10	Extra spring	78 (540)	...	80 and over	80 and over	70 and over	71 and over
Copper Alloy UNS No. C41300							
M20	As hot-rolled	37 (255)	50 (345)	...	...	...	...
H01	Quarter hard	45 (310)	55 (380)	34-62	35-64	40-58	39-60
H02	Half hard	50 (345)	62 (430)	52-70	53-72	51-63	51-64
H03	Three-quarter hard	58 (400)	68 (470)	64-77	66-78	59-68	60-69
H04	Hard	65 (450)	75 (515)	71-80	72-81	63-70	64-70
H06	Extra hard	70 (485)	82 (565)	77-83	78-84	67-71	68-72
H08	Spring	76 (525)	86 (595)	81-86	82-87	70-73	70-74
H10	Extra spring	81 (560)	...	85 and over	86 and over	72 and over	73 and over
Copper Alloy UNS No. C41500							
M20	As hot rolled	38 (260)	50 (345)	...	...	...	...
H01	Quarter hard	46 (315)	56 (385)	48-73	49-75	48-65	49-67
H02	Half hard	53 (365)	63 (435)	68-78	70-80	62-68	63-70
H03	Three-quarter hard	57 (395)	68 (470)	73-80	75-82	65-70	66-71
H04	Hard	64 (440)	75 (515)	78-85	79-87	69-72	69-74
H06	Extra hard	70 (485)	82 (565)	81-87	82-90	70-73	70-75
H08	Spring	78 (540)	89 (615)	86-92	87-93	73-76	73-77
H10	Extra spring	85 (585)	...	89 and over	90 and over	74 and over	75 and over
Copper Alloy UNS No. C42200							
M20	As hot-rolled	40 (275)	53 (365)	...	...	...	...
H01	Quarter hard	47 (325)	57 (395)	42-68	44-70	43-62	46-65
H02	Half hard	54 (370)	65 (450)	64-74	66-76	58-68	61-70
H03	Three-quarter hard	60 (415)	72 (495)	71-80	73-82	64-69	66-71
H04	Hard	67 (460)	79 (545)	76-83	78-85	67-71	69-73
H06	Extra hard	75 (515)	85 (585)	80-85	82-87	69-73	70-74
H08	Spring	82 (565)	92 (635)	83-88	85-90	70-74	71-75
H10	Extra spring	88 (605)	...	86 and over	86 and over	74 and over	74 and over
Copper Alloy UNS No. C42500							
M20	As hot-rolled	40 (275)	54 (370)	...	...	...	...
H01	Quarter hard	49 (340)	59 (405)	46-71	48-73	45-65	47-67
H02	Half hard	57 (395)	69 (485)	67-81	69-83	63-69	65-72
H03	Three-quarter hard	62 (430)	74 (510)	74-84	76-86	66-71	68-73
H04	Hard	70 (485)	82 (565)	81-88	83-90	70-74	72-76
H06	Extra hard	76 (525)	88 (605)	86-92	88-94	71-75	73-77