



Designation: B103/B103M – 23

# Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B103/B103M; 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 copper-tin alloy (phosphor bronze), copper-tin-lead alloy (leaded phosphor bronze), and copper-tin-lead-zinc alloy (bearing bronze), plate, sheet, strip, and rolled bar for general application produced from Copper Alloy UNS Nos. C51000, C51100, C51180, C51900, C52100, C52180, C52400, C53400, and C54400. The phosphor bronzes commonly are used for deep drawing into bellows and stamping and forming into spring devices and into terminals and connectors for electrical apparatus because they combine high strength with high elongation. The leaded phosphor bronzes are used where strength, corrosion resistance, and machinability are required. The bearing bronze is used in bushings, bearings, and load-bearing thrust washers.

NOTE 1—All of the above alloys contain small amounts of phosphorus, used as a deoxidant in melting, and to enhance the mechanical properties.

1.2 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated in each system are not necessarily exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 The following safety hazard caveat pertains only to the test method(s) described in this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

*mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

**B248** Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

**B248M** Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric)

**B601** Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

**B846** Terminology for Copper and Copper Alloys

**B950** Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys

**E8/E8M** Test Methods for Tension Testing of Metallic Materials

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

**E75** Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)<sup>3</sup>

**E255** Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

**E478** Test Methods for Chemical Analysis of Copper Alloys

## 3. General Requirements

3.1 The following sections of Specifications **B248** and **B248M** constitute a part of this specification:

3.1.1 Terminology

3.1.2 Materials and Manufacture

3.1.3 Workmanship, Finish, and Appearance

3.1.4 Sampling, Except for Chemical Analysis

3.1.5 Number of Tests and Retests

3.1.6 Specimen Preparation

3.1.7 Test Methods, Except for Chemical Analysis

<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

- 3.1.8 Significance of Numerical Limits
- 3.1.9 Inspection
- 3.1.10 Rejection and Rehearing
- 3.1.11 Certification
- 3.1.12 Test Reports
- 3.1.13 Packaging and Package Marking
- 3.1.14 Supplementary Requirements

3.2 In addition, when a section with a title identical to that referenced in 3.1, above, appears in this specification, it contains additional requirements, which supplement those appearing in Specifications B248 and B248M

#### 4. Terminology

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

#### 5. Ordering Information

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

- 5.1.1 ASTM designation and year of issue,
- 5.1.2 Copper [Alloy] UNS No. designation,
- 5.1.3 Temper,
- 5.1.4 Dimensions: thickness, width, edges, and length, if applicable,
- 5.1.5 Form: plate, sheet, strip, or rolled bar,
- 5.1.6 How furnished: coils, specific length or stock lengths, with or without ends, and
- 5.1.7 Quantity: total weight each form, temper, and size.

5.2 The following options are available and, when required, shall be specified at the time of placing the order:

- 5.2.1 Type of edge: slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges,
- 5.2.2 Width and straightness tolerances,
- 5.2.3 Heat identification or traceability details,
- 5.2.4 Certification,
- 5.2.5 Test Report, and
- 5.2.6 If product is purchased for agencies of the U.S. Government see the Supplementary Requirements section of Specifications B248 and B248M for additional requirements, if specified.

#### 6. Materials and Manufacture

6.1 *Materials*:

6.1.1 The material of manufacture shall be a form (cast bar, cake, slab, et cetera) of Copper Alloy UNS No. C51000, C51100, C51180, C51900, C52100, C52180, C52400, C53400, or C54400 of such purity and soundness as to be suitable for processing into the products prescribed herein.

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

NOTE 2—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.

6.3 *Edges*:

6.3.1 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 composition requirements in Table 1 for the Copper Alloy UNS No. specified in the ordering information.

7.2 These composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

7.3 For alloys in which copper is listed as “remainder,” copper is the difference between the sum of results of all the elements determined and 100 %. When all the elements in Table 1 are determined, the sum of results for each alloy shall be 99.5 % min.

#### 8. Temper

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

8.1.1 Hot rolled temper M20.

8.1.2 Cold rolled tempers H02 to H10.

NOTE 3—The properties of special and nonstandard tempers are subject to agreement between the manufacturer and purchaser.

**TABLE 1 Chemical Requirements**

Element	Composition, %								
	Copper Alloy UNS No.								
	C51000	C51100	C51180	C51900	C52100	C52180	C52400	C53400 <sup>A</sup>	C54400 <sup>A</sup>
Tin	4.2–5.8	3.5–4.9	3.5–4.9	5.0–7.0	7.0–9.0	7.0–9.0	9.0–11.0	3.5–5.8	3.5–4.5
Phosphorus	0.03–0.35	0.03–0.35	0.01–0.35	0.03–0.35	0.03–0.35	0.01–0.35	0.03–0.35	0.03–0.35	0.01–0.50
Iron, max	0.10	0.10	0.05–0.20	0.10	0.10	0.05–0.20	0.10	0.10	0.10
Lead	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max	0.8–1.2	3.0–4.0
Zinc	0.30 max	0.30 max	0.30 max	0.30 max	0.20 max	0.30 max	0.20 max	0.30 max	1.5–4.5
Nickel	...	...	0.05–0.20	...	...	0.05–0.20	...	...	...
Copper	remainder	remainder	remainder	remainder	remainder	remainder	remainder	remainder	remainder

<sup>A</sup> When specified for bearings, the phosphorus content shall be maintained from 0.01 % to 0.15 %.

**TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values**

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 purchaser at the time of placing the order.

Temper Designation <sup>A</sup>		Thickness, in. [mm]	Tensile Strength, ksi <sup>B</sup> [MPa]		Approximate Rockwell Hardness	
Code	Name		Min	Max	B Scale	Superficial 30–T
Copper Alloy UNS No. C51000						
M20	as hot-rolled	Over 0.188 [4.775]	40 [275]	60 [415]	...	...
O60	soft	Over 0.039 [0.991]	43 [295]	58 [400]	16-64	...
		Over 0.029 [0.737]			...	32-59
		Over 0.020 [0.508] to 0.039 [0.991] incl			12-60	...
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	24-53
H02	half-hard	0.003 [0.076] to 0.010 [0.254] incl				
		Over 0.039 [0.991]	58 [400]	73 [505]	64-85	...
		Over 0.029 [0.737]			...	59-73
		Over 0.02 [0.508] to 0.039 [0.991] incl			60-82	...
H04	hard	Over 0.010 [0.254] to 0.029 [0.737] incl			...	53-69
		0.003 [0.076] to 0.010 [0.254] incl				
		Over 0.039 [0.991]	76 [525]	91 [625]	86-93	...
		Over 0.029 [0.737]			...	73-78
H06	extra-hard	Over 0.020 [0.508] to 0.039 [0.991] incl			...	84-91
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	71-75
		0.003 [0.076] to 0.010 [0.254] incl				
		Over 0.039 [0.991]	88 [605]	103 [710]	92-96	...
H08	spring	Over 0.029 [0.737]			...	77-81
		Over 0.020 [0.508] to 0.039 [0.991] incl			...	89-95
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	74-78
		0.003 [0.076] to 0.010 [0.254] incl				
H10	extra-spring	Over 0.039 [0.991]	95 [655]	110 [760]	94-98	...
		Over 0.029 [0.737]			...	79-82
		Over 0.020 [0.508] to 0.039 [0.991] incl			92-97	...
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	76-80
H10	extra-spring	0.003 [0.076] to 0.010 [0.254] incl				
		Over 0.039 [0.991]	100 [690]	114 [785]	96-99	...
		Over 0.029 [0.737]			...	80-83
		Over 0.020 [0.508] to 0.039 [0.991] incl			94-98	...
O60	soft	Over 0.010 [0.254] to 0.029 [0.737] incl			...	77-81
		0.003 [0.076] to 0.010 [0.254] incl				
		Over 0.039 [0.991]				
		Over 0.029 [0.737]				
Copper Alloy UNS Nos. C51100, C53400, and C54400						
M20	as hot-rolled	Over 0.188 [4.775]	40 [275]	58 [400]	...	...
O60	soft	Over 0.039 [0.991]	40 [275]	55 [380]	7-50	...
		Over 0.029 [0.737]			...	24-50
		Over 0.020 [0.508] to 0.039 [0.991] incl			...	0-45
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	16-46
H02	half-hard	Over 0.010 [0.254] to 0.029 [0.737] incl			...	60-81
		Over 0.039 [0.991]	55 [380]	70 [485]	60-81	...
		Over 0.029 [0.737]			...	57-73
		Over 0.020 [0.508] to 0.039 [0.991] incl			53-78	...
H04	hard	Over 0.010 [0.254] to 0.029 [0.737] incl			...	52-71
		Over 0.039 [0.991]	72 [495]	87 [600]	82-90	...
		Over 0.029 [0.737]			...	71-77
		Over 0.020 [0.506] to 0.039 [0.991] incl			80-86	...
H06	extra-hard	Over 0.010 [0.254] to 0.029 [0.737] incl			...	69-75
		Over 0.039 [0.991]	84 [580]	99 [685]	88-94	...
		Over 0.029 [0.737]			...	75-80
		Over 0.020 [0.506] to 0.039 [0.991] incl			86-92	...
H08	spring	Over 0.010 [0.254] to 0.029 [0.737] incl			...	73-78
		Over 0.039 [0.991]	91 [625]	106 [730]	90-98	...
		Over 0.029 [0.737]			...	77-81
		Over 0.020 [0.508] to 0.039 [0.991] incl			86-94	...
H10	extra-spring	Over 0.010 [0.254] to 0.029 [0.737] incl			...	75-79
		Over 0.039 [0.991]	96 [660]	108 [745]	92-97	...
		Over 0.029 [0.737]			...	78-82
		Over 0.020 [0.508] to 0.039 [0.991] incl			89-94	...
O60	soft	Over 0.010 [0.254] to 0.029 [0.737] incl			...	76-80
		Over 0.039 [0.991]				
		Over 0.029 [0.737]				
		Over 0.020 [0.508] to 0.039 [0.991] incl				
Copper Alloy UNS No. C51180						
H02	half-hard	Over 0.039 [0.991]	69 [475]	84 [580]	80-90	...
		Over 0.029 [0.737]			...	69-75
		Over 0.020 [0.508] to 0.039 [0.991] incl			78-88	...
H03	¾-hard	Over 0.010 [0.254] to 0.029 [0.737] incl			...	67-73
		Over 0.039 [0.991]	80 [550]	92 [635]	84-92	...
		Over 0.029 [0.737]			...	71-77
H04	hard	Over 0.020 [0.508] to 0.039 [0.991] incl			...	80-88
		Over 0.010 [0.254] to 0.029 [0.737] incl			...	69-75
		Over 0.039 [0.991]	85 [585]	100 [690]	88-95	...
H04	hard	Over 0.029 [0.737]			...	74-80