



# Standard Specification for Copper-Iron Alloy Plate, Sheet, Strip, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B465; 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 establishes the requirements for copper-iron alloy plate, sheet, strip, and rolled bar for Copper [Alloy] UNS Nos. C19200, C19210, C19400, C19500, C19700, and C19720.

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, which are provided for information only and are not considered standard.

## 2. Referenced Documents

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

**B193** Test Method for Resistivity of Electrical Conductor Materials

**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

**E54** Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)<sup>3</sup>

**E62** Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)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**E75** Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)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>

**E112** Test Methods for Determining Average Grain Size

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

<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, 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

## 3. General Requirements

3.1 The following sections of Specification **B248** 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

3.1.5 Number of Tests and Retests

3.1.6 Specimen Preparation

3.1.7 Test Methods (except chemical analysis)

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 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 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 (Section 8),

5.1.4 *Dimensions*—Thickness, width, length, and edges (Section 12),

5.1.5 *How Furnished*—Straight lengths or coils,

5.1.6 *Quantity*—total weight or total length or number of pieces of each size, and

5.1.7 Intended application.

5.2 The following options are available but may not be included unless specified at the time of placing of the order when required:

5.2.1 Heat identification or traceability details,

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

- 5.2.2 Certification,
- 5.2.3 Test Report,
- 5.2.4 Type of edge (slit, sheared, sawed, square corners, round corners, rounded edges, or full-rounded edges),
- 5.2.5 Width and straightness tolerances (appropriate tables in Specification **B248**), and
- 5.2.6 If product is purchased for agencies of the U.S. Government (see the Supplemental section of Specification **B248** 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. C19200, C19210, C19400, C19500, C19700, or C19720 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 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not 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. designation 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 elements determined and 100 %.

7.4 When all elements in **Table 1** are determined, the sum of results shall be 99.8 % min, except for C19720 which shall be 99.5 % min.

## 8. Temper

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

8.1.1 Cold-rolled tempers H01 to H14.

8.1.2 Annealed tempers O50, O60, or O82.

8.1.3 Cold-worked and stress-relieved tempers HR02 to HR06.

NOTE 2—The purchaser should confer with the manufacturer or supplier for the availability of product in a specific alloy, temper, and form, since all tempers are subject to manufacturing limitations.

NOTE 3—Properties of special tempers not listed in this specification are subject to agreement between the manufacturer and purchaser.

## 9. Grain Size for Annealed Tempers

9.1 *Grain Size*—No grain size requirements have been established for tempers O50, O60, and O61; however, the product material shall be fully recrystallized when examined in accordance with Test Methods **E112**.

## 10. Physical Property Requirements

### 10.1 Electrical Resistivity Requirement:

10.1.1 The product furnished shall conform to the electrical mass resistivity requirement prescribed in **Table 2** when tested in accordance with Test Method **B193**.

10.1.2 Products produced in temper O60 from Copper Alloy UNS No. C19400 are not required to conform to the electrical mass resistivity requirements of **Table 2**.

## 11. Mechanical Property Requirements

### 11.1 Tensile Strength Requirements:

11.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in **Table 3** when tested in accordance with Test Methods **E8/E8M**.

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

**TABLE 1 Chemical Requirements**

Element	Composition, %					
	Copper Alloy UNS No.					
	C19200	C19210	C19400	C19500	C19700	C19720
Copper	98.5 min	remainder	97.0 min	96.0 min	remainder	remainder
Iron	0.8–1.2	0.05–0.15	2.1–2.6	1.0–2.0	0.30–1.2	0.05–0.50
Phosphorus	0.01–0.04	0.025–0.04	0.015–0.15	0.01–0.35	0.10–0.40	0.05–0.15
Zinc	0.20 max	...	0.05–0.20	0.20 max	0.20 max	0.20 max
Lead, max	0.03	...	0.03	0.02	0.05	0.05
Tin	...	...	...	0.10–1.0	0.20 max	0.20 max
Cobalt	...	...	...	0.30–1.3	0.05 max	...
Aluminum	...	...	...	0.02 max	...	...
Magnesium	...	...	...	...	0.01–0.20	0.06–0.20
Nickel, max	...	...	...	...	0.05	0.10 <sup>A</sup>
Manganese, max	...	...	...	...	0.05	0.05

<sup>A</sup> Includes cobalt.

**TABLE 2 Electrical Resistivity Requirements and Equivalent Conductivity**

Temper	Copper Alloy UNS No.	Resistivity at 20°C (68°F)	Equivalent Conductivity at 20°C (68°F),
		$\Omega$ g/m <sup>2</sup>	% IACS
O50, O60 <sup>A</sup> , O61, and O82	C19200	0.235 81 max	65 min
	C19210	0.170 31 max	90 min
	C19400	0.383 26 – 0.204 37	40 – 75
	C19500	0.305 65 max	50 min
	C19700	0.191 60 max	80 min
H01, H02, H03, H04, H06, H08, H10, H14, HR02, HR04, and HR06	C19200	0.255 47 max	60 min
	C19210	0.180 33 max	85 min
	C19400	0.255 47 max	60 min
	C19500	0.340 62 max	45 min
	C19700	0.199 06 max	77 min
	C19720	0.199 06 max	77 min

<sup>A</sup> O60 temper of Copper Alloy UNS No. C19400 is not required to conform with the resistivity requirement of this table.

**TABLE 3 Mechanical Requirements**

Temper Designation (B601)		Tensile Strength, ksi [MPa] <sup>A</sup>	Approximate Rockwell Hardness			
			B Scale		Superficial 30T	
			0.020 in. (0.508 mm) to 0.036 in. (0.914 mm) Incl	Over 0.036 in. (0.914 mm)	0.012 in. (0.305 mm) to 0.028 in. (0.711 mm) Incl	Over 0.028 in. (0.711 mm)
Copper Alloy UNS No. C19200						
O61	annealed	40–50 [275–345]	...	...	...	...
H01	¼ hard	45–55 [310–380]	...	...	...	...
H02	½ hard	52–62 [360–425]	53–69	...	53–66	...
H04	hard	60–70 [415–485]	68–74	...	66–71	...
H06	extra hard	67–74 [460–510]	71–75	...	69–73	...
H08	spring	70–78 [485–540]	73–76	...	69–74	...
H10	extra spring	74–80 [510–550]	73–76	...	69–74	...
Copper Alloy UNS No. C19210						
O61	annealed	27–42 [185–290]	...	...	...	...
H01	¼ hard	43–53 [295–365]	...	...	...	50 max
H02	½ hard	47–60 [325–415]	...	...	...	35–60
H03	¾ hard	52–62 [360–425]	...	...	...	52–67
H04	hard	56–66 [385–455]	...	...	...	54–69
H06	extra hard	60–70 [415–485]	...	...	...	56–71
H08	spring	64–74 [440–510]	...	...	...	58–73
H10	extra spring	66 min [445 min]	...	...	...	60–75
Copper Alloy UNS No. C19400						
O60	soft anneal	40–50 [275–345]	...	...	...	...
O50	light anneal	45–55 [310–380]	...	...	...	...
O82	annealed to temper—½ hard	53–63 [365–435]	...	...	...	...
H02	½ hard	53–63 [365–435]	49–69	57–70	52–63	51–66
H04	hard	60–70 [415–485]	67–73	68–76	61–68	64–69
H06	extra hard	67–73 [460–505]	72–75	75–77	67–69	68–69
H08	spring	70–76 [485–525]	73–78	76–79	68–69	69–72
H10	extra spring	73–80 [505–550]	75–79	77–80	69–70	69–72
H14	super spring	80 min [550 min]	...	...	70 min	...
Copper Alloy UNS No. 19500						
O60	soft anneal	50–60 [345–415]	...	...	...	...
H01	¼ hard	60–72 [415–495]	63–79	...	61–71	...
H02	½ hard	68–78 [470–540]	76–81	...	69–73	...
H03	¾ hard	75–85 [515–585]	80–83	...	72–74	...
H04	hard	82–90 [565–620]	82–85	...	73–75	...
H08	spring	88–97 [605–670]	84–87	...	74–77	...
Copper Alloy UNS No. C19700						
O60	soft anneal	43–53 [295–365]	...	...	...	...
H02	½ hard	53–63 [365–435]	62–71	...	62–68	...
H04	hard	60–70 [415–485]	66–73	...	65–70	...
H06	extra hard	67–73 [460–505]	70–75	...	68–71	...
H08	spring	70–76 [485–525]	71–77	...	69–72	...
H10	extra spring	73–80 [505–550]	72–78	...	70–74	...
Copper Alloy UNS No. C19720						
HR02	½ hard	53–63 [365–435]	65–71	...	62–68	...
HR04	hard	60–70 [415–485]	66–73	...	65–70	...
HR06	extra hard	67–73 [460–505]	70–78	...	65–75	...

<sup>A</sup> See Appendix X1.

### 11.2 Rockwell Hardness Requirement:

11.2.1 The approximate Rockwell hardness values given in **Table 3** are for general information and assistance in testing and shall not be used as a basis for product rejection.

NOTE 4—The Rockwell hardness test offers a quick and convenient method of checking for general conformity to the specification requirements for temper, tensile strength, and grain size.

## 12. Dimensions, Mass, and Permissible Variations

12.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification **B248** with particular reference to the following tables and related paragraphs:

12.1.1 *Thickness*—Table 1.

12.1.2 *Width*:

12.1.2.1 *Slit Metal and Slit Metal with Rolled Edges*—Table 2.

12.1.2.2 *Square Sheared Metal*—Table 5.

12.1.2.3 *Sawed Metal*—Table 6.

12.1.3 *Length*:

12.1.3.1 *Length Tolerance for Straight Lengths*—Table 7.

12.1.3.2 *Schedule or Minimum Lengths and Maximum Weights of Ends for Specific Lengths with Ends, and Stock Lengths with Ends*—Table 8.

12.1.3.3 *Length Tolerance for Square Sheared Metal*—Table 9.

12.1.3.4 *Length Tolerance for Sawed Metal*—Table 10.

12.1.4 *Straightness*:

12.1.4.1 *Slit Metal or Slit Metal Either Straightened or Edge Rolled*—Table 11.

12.1.4.2 *Square Sheared Metal*—Table 12.

12.1.4.3 *Sawed Metal*—Table 13.

12.1.5 *Edges Contours*:

12.1.5.1 *Square Corners*—Table 14.

12.1.5.2 *Rounded Corners*—Table 15.

12.1.5.3 *Rounded Edges*—Table 16.

12.1.5.4 *Full-Rounded Edges*—Table 17.

## 13. Test Methods

13.1 *Chemical Analyses*:

13.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement:

Element	ASTM Test Method
Aluminum	E478
Copper	E478
Cobalt	E75
Iron	E54
Lead	E478 (AA)
Manganese	E62
Nickel	E478 (Photometric)
Phosphorus	E62
Tin	E478 (Photometric)
Zinc	E478 (AA)

13.1.2 Test method(s) to be followed for the determination of element(s) resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

13.1.3 Since no recognized test method is known to be published, the determination of magnesium shall be subject to agreement between the manufacturer and the purchaser.

13.2 *Other Tests*:

13.2.1 Test methods for all other properties are given in Specification **B248**.

## 14. Keywords

14.1 copper-iron alloy plate; copper-iron alloy rolled bar; copper-iron alloy sheet; copper-iron alloy strip; UNS No. C19200; UNS No. C19210; UNS No. C19400; UNS No. C19500; UNS No. C19700; UNS No. C19720

## APPENDIX

### (Nonmandatory Information)

#### X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ( $N = \text{kg} \cdot \text{m/s}^2$ ). The derived SI unit for pressure or

stress is the newton per square metre ( $\text{N/m}^2$ ), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since  $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$ , the metric equivalents are expressed as megapascal (MPa), which is the same as  $\text{MN/m}^2$  and  $\text{N/mm}^2$ .

**SUMMARY OF CHANGES**

Committee B05 has identified the principal changes to this specification that have been incorporated since the 2011 issue as follows:

- (1) Updated the specification to ensure it conforms to proper form and style.
- (2) Corrected error in **Table 2** that showed Temper O62 instead of O82.
- (3) Removed Table X1.1 and added SI Equivalents for Tensile Strength to **Table 3**.
- (4) Added footnote in **Table 1** regarding Ni content for alloy C19720 indicating that Ni includes cobalt.

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