



Designation: B 272 – 01

## Standard Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)<sup>1</sup>

This standard is issued under the fixed designation B 272; 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 Department of Defense.*

### 1. Scope \*

1.1 This specification establishes the requirements for copper products, flat wire and strip, with rolled or drawn finished edges produced for general application.

1.1.1 The product is produced in UNS Copper Nos. C10100, C10200, C10300, C10500, C10700, C10800, C11000, C12200, and C14200 unless otherwise established by agreement between manufacturer and purchaser.

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are for information only.

NOTE 1—When a copper other than that listed in 1.1.1 is designated by the purchaser, the resulting product shall conform to the physical, mechanical, performance, dimensional, and tolerance requirements per agreement between the manufacturer and purchaser.

### 2. Referenced Documents

#### 2.1 *ASTM Standards:*

- B 5 Specification for High Conductivity Tough-Pitch Copper Refinery Shapes<sup>2</sup>
- B 170 Specification for Oxygen-Free Electrolytic Copper Refinery Shapes<sup>2</sup>
- B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>3</sup>
- B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar<sup>2</sup>
- B 250/B 250M Specification for General Requirements for Wrought Copper-Alloy Wire<sup>2</sup>
- B 379 Specification for Phosphorized Coppers—Refinery Shapes<sup>2</sup>
- B 577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper<sup>2</sup>
- B 846 Terminology for Copper and Copper Alloys<sup>2</sup>

- E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>
- E 53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry<sup>5</sup>
- E 62 Test Method for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>5</sup>
- E 290 Test Method for Bend Testing of Material for Ductility<sup>4</sup>
- E 478 Test Method for Chemical Analysis of Copper Alloys<sup>6</sup>

### 3. General Requirements

3.1 The following sections of Specification B 248 constitute a part of this specification for strip products and of Specification B 250 for flat wire products:

- 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,
- 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, and
- 3.1.14 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 that supplement those appearing in Specifications B 248 or B 250/B 250M, or both.

### 4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology B 846.

<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 B05.02 on Rod, Bar, Wire, Shapes, and Forgings.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 02.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.06.

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

**4.2 Definitions of Terms Specific to This Standard:**

4.2.1 *capable of*—possessing the required properties or characteristics, or both, necessary to conform to specification requirements when subjected to specified tests.

**5. Ordering Information**

5.1 When placing orders for product to this specification, include the following information:

- 5.1.1 ASTM designation and year of issue,
- 5.1.2 Copper UNS No. designation (Section 1),
- 5.1.3 *Temper*—O61 (annealed), H00 (eight hard), H01 (quarter hard), H02 (half hard), H03 (three-quarter hard), H04 (hard), H06 (extra hard), H08 (spring) (Section 8),
- 5.1.4 *Dimensions*—Width and thickness (Section 13),
- 5.1.5 *Quantity*—Total weight, footage, or number of pieces,
- 5.1.6 *How Furnished*—Lengths, coils, spools, and so forth, and
- 5.1.7 When purchased for agencies of the U.S. government (Section 12).
- 5.1.8 Edge contours required, see 13.6.

5.2 The following options are available under this specification and should be included in the contract or purchase order when required:

- 5.2.1 Electrical resistivity (Section 9),
- 5.2.2 Hydrogen embrittlement susceptibility test (Section 11),
- 5.2.3 Bend test (Section 11),
- 5.2.4 Certification (Specification B 248 or Specification B 250/B 250M, or both),
- 5.2.5 Mill test reports (Specification B 248 or Specification B 250/B 250M, or both).

**6. Material and Manufacture**

**6.1 Material:**

6.1.1 The material of manufacture shall be a copper billet, cake, wire bar, or rod produced to Specifications B 5, B 170, or B 379.

6.1.2 Copper other than that listed in 1.1.1 is permitted only upon agreement between the manufacturer and the purchaser (see Note 1).

**6.2 Manufacture:**

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

6.3 *Edges*—The edges shall be finished by rolling or drawing per 13.6.

**7. Chemical Composition**

7.1 The material shall conform to the chemical composi-

tional requirements in Table 1 for the coppers ordered.

7.1.1 These compositional limits do not preclude the presence of other elements. When required, limits shall be established and analysis required for unnamed elements by agreement between the manufacturer and the purchaser.

**8. Temper**

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

8.1.1 Annealed temper O61.

8.1.2 Cold-worked tempers H00, H01, H02, H03, H04, H06, and H08.

**9. Physical Property Requirement**

**9.1 Electrical Resistivity:**

9.1.1 Conductive alloys shall conform to the resistivity requirements in Table 2 when tested in accordance with Test Method B 193.

NOTE 2—The International Annealed Copper Standard electrical conductivity equivalents are as follows:

Electrical Resistivity, $\Omega\text{-g/m}^2$	Conductivity, %
0.151 76	101.00
0.153 28	100.00
0.156 14	98.16
0.157 75	97.16
0.159 40	96.16

**10. Mechanical Property Requirements**

**10.1 Tensile Requirements:**

10.1.1 Product 0.035 in. (0.90 mm) and under in thickness shall conform to the tensile strength and elongation requirements prescribed in Table 2, when tested in accordance with Test Methods E 8.

10.1.1.1 Tensile strength test results shall be the basis for acceptance or rejection for mechanical properties for product 0.035 in. (0.90 mm) and under in thickness.

10.1.2 Product over 0.035 in. (0.90 mm) in thickness shall conform to the requirements prescribed in Table 2 when tested in accordance with Test Methods E 8.

**10.2 Rockwell Hardness:**

10.2.1 Product over 0.035 in. (0.90 mm) in thickness shall conform to the hardness requirements prescribed in Table 2 when tested in accordance with Test Methods E 18.

10.2.1.1 Rockwell hardness test results shall be the basis for acceptance or rejection for mechanical properties for product over 0.035 in. (0.90 mm) in thickness.

**TABLE 1 Chemical Requirements**

Element	Composition, % Copper UNS No.								
	C10100 <sup>A</sup>	C10200 <sup>B</sup>	C10300	C10500	C10700	C10800	C11000	C12200	C14200
Copper (incl silver), min	99.99	99.95	99.95 <sup>C</sup>	99.95	99.95	99.95 <sup>C</sup>	99.90	99.9	99.4
Phosphorus	...	...	0.001–0.005	...	...	0.005–0.012	...	0.015–0.040	0.015–0.040
Arsenic	...	...	...	...	...	...	...	...	0.15–0.50
Silver, min	...	...	...	0.034	0.085	...	...	...	...
Oxygen, max	0.0005	0.0010	...	0.0010	0.0010	...	...	...	...

<sup>A</sup>Refer to Table 1, Chemical Requirements, Grade 1 of Specification B 170 for impurity limits for Copper UNS No. C10100.

<sup>B</sup>Refer to Table 1, Chemical Requirements, Grade 2 of Specification B 170 for impurity limits for Copper UNS No. C10200.

<sup>C</sup>Copper + silver + phosphorus, min.



**TABLE 2 Mechanical (All Alloys) and Electrical Requirements (Conductor Alloys Only)**

Standard	Name	Temper	Thickness, in. (mm)	Rockwell	Tensile		Elongation	Bend	Electrical Resistivity, max,		
				F Scale	ksi (MPa)		Min in 2 in %	Angle, degree	Ω·g/m <sup>2</sup> at 20°C (68°F)		
					Min	Max			C10100	C10300	C10200, C11000, C10500, C10700
O61	annealed		up to 0.010 (0.254), incl	...	...	...	20	180	0.151 76	0.156 14	0.153 28
			over 0.010 (0.0254) to 0.035 (0.900), incl	...	...	40 (275)	25	180	0.151 76	0.156 14	0.153 28
			over 0.035 (0.900) to 0.050 (1.25), incl	65 max	...	38 (260)	25	180	0.151 76	0.156 14	0.153 28
			over 0.050 (1.25) to 0.188 (4.80)	65 max	...	37 (255)	25	180	0.151 76	0.156 14	0.153 28
H00	1/8-hard		up to 0.035 (0.900), incl	...	32 (220)	40 (275)	18	120	0.156 14	0.159 40	0.157 75
			over 0.035 (0.900) to 0.188 (4.80)	54-82	32 (220)	40 (275)	20	120	0.156 14	0.159 40	0.157 75
H01	1/4-hard		up to 0.035 (0.900), incl	...	34 (235)	42 (290)	15	120	0.156 14	0.159 40	0.157 75
			over 0.035 (0.900) to 0.188 (4.80)	60-86	34 (235)	42 (290)	15	120	0.156 14	0.159 40	0.157 75
H02	1/2-hard		up to 0.035 (0.900), incl	...	37 (255)	46 (315)	10	120	0.156 14	0.159 40	0.157 75
			over 0.035 (3.20) to 0.188 (4.80)	77-91	37 (255)	46 (315)	10	120	0.156 14	0.159 40	0.157 75
H03	3/4-hard		up to 0.035 (0.900), incl	...	41 (280)	50 (345)	6	120	0.156 14	0.159 40	0.157 75
			over 0.035 (3.20) to 0.188 (4.80)	82-94	41 (280)	50 (345)	6	120	0.156 14	0.159 40	0.157 75
H04	hard		up to 0.035 (0.900), incl	...	43 (295)	58 (400)	4	120	0.156 14	0.159 40	0.157 75
			over 0.035 (0.900) to 0.125 (3.20), incl	85-97	43 (295)	...	4	120	0.156 14	0.159 40	0.157 75
			over 0.125 (3.20) to 0.188 (4.80)	80-95	43 (295)	...	4	120	0.156 14	0.159 40	0.157 75
H06	extra hard		up to 0.035 (0.900), incl	...	47 (325)	56 (385)	...	...	0.156 14	0.159 40	0.157 75
			over 0.035 (3.20) to 0.188 (4.80)	88-97	47 (325)	56 (385)	...	...	0.156 14	0.159 40	0.157 75
H08	spring		up to 0.035 (0.900), incl	...	50 (345)	58 (400)	...	...	0.156 14	0.159 40	0.157 75
			over 0.035 (3.20) to 0.188 (4.80)	91-98	50 (345)	58 (400)	...	...	0.156 14	0.159 40	0.157 75

**11. Performance Requirements**

11.1 *Hydrogen Embrittlement Susceptibility:*

11.1.1 Test specimens of finished flat wire and strip of Copper UNS Nos. C10100, C10200, C10300, C10500, C10700, C10800, C12200, and C14200 shall be significantly free of cuprous oxide when tested in accordance with Test Method B of Test Methods B 577.

11.1.2 In case of dispute, Test Method C of Test Methods B 577 shall be used.

11.2 *Bend Test Requirement:*

11.2.1 When tested in accordance with Test Method E 290, the specimen shall withstand being bent cold (room temperature) on a radius equal to the minimum cross sectional dimension to the angle prescribed in Table 2. The bend shall be radial to this minimum dimension and after bending, no fracture shall be visible to the unaided eye on the outside bent surface.

**12. Purchases for U.S. Government**

12.1 When specified in the contract or purchase order, product purchased for an agency of the U.S. government shall conform to the special government requirements specified in the Supplementary Requirements section of Specification B 248 or B 250/B 250M, as appropriate.

**13. Dimensions and Permissible Variations**

13.1 *General*—For the purpose of determining conform-

ance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting values for any dimension may be cause for rejection.

NOTE 3—Blank spaces in the tolerance tables indicate either that the material is not generally available or that no tolerances have been established.

13.2 *Thickness*—The standard method of specifying thickness shall be in decimal fractions of an inch. The tolerances shall be as shown in Table 3.

13.3 *Width*—The standard method of specifying width shall be in decimal fractions of an inch. The tolerances shall be as shown in Table 4.

13.4 *Lengths*—Hard temper flat wire and strip, unless otherwise specified, shall be furnished in straight lengths.

13.4.1 Straight lengths shall be furnished in stock lengths with ends included, in accordance with the schedule shown in Table 5, unless the order specifies stock lengths only, specific lengths, or specific lengths with ends.

13.4.2 The length tolerance for full length pieces shall be as shown in Table 6.

13.4.3 Soft temper flat wire and strip, unless otherwise specified, may be furnished, at the manufacturer's option, in rolls, bucks, or reels.

13.5 *Straightness*—The deviation from straightness shall not exceed the limits shown in Table 7.

13.5.1 To determine compliance with this tolerance the

**TABLE 3 Thickness Tolerances**

Thickness, in. (mm)	Thickness Tolerances, Plus and Minus, in. (mm), for Widths Given in Inches (Millimetres) <sup>A</sup>				
	Up to 1/4 (31.8), incl	Over 1/4 (31.8) to 2.00 (50.8), incl	Over 2.00 (50.8) to 4.00 (102), incl	Over 4.00 (102) to 8.00 (203), incl	Over 8.00 (203) to 12.00 (305), incl
0.013 (0.330), incl	0.001 (0.025)	...	...	...	...
Over 0.013 (0.330) to 0.050 (1.27), incl	0.0013 (0.033)	0.0015 (0.038)	...	...	...
Over 0.050 (1.27) to 0.090 (2.29), incl	0.0015 (0.038)	0.002 (0.051)	0.0025 (0.064)	...	...
Over 0.090 (2.29) to 0.130 (3.30), incl	0.002 (0.051)	0.0025 (0.064)	0.003 (0.076)	0.0035 (0.089)	...
Over 0.130 (3.30) to 0.188 (4.78), incl	0.003 (0.076)	0.003 (0.076)	0.0035 (0.089)	0.004 (0.10)	0.005 (0.13)

<sup>A</sup>If tolerances all plus or all minus are desired, double the values given.