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Standard Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)[1]

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 (ε) 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 covers the requirements for flat copper products, flat wire and strip, with finished rolled or drawn edges produced for general application.

1.1.1 The product is normally produced in UNS Copper Nos. C10100, C10200, C10300, C10500, C10700, C10800, C11000, C12200, and C14200.

1.1.2 When a copper other than that listed in 1.1.1 is designated by the purchaser, the resulting product shall conform to the appropriate temper, physical, mechanical, performance, dimensional, and tolerance requirements of this specification.

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

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 5 Specification for High Conductivity Tough-Pitch Copper Refinery Shapes[2]

B 170 Specification for Oxygen-Free Electrolytic Copper Refinery Shapes[2]

B 193 Test Method for Resistivity of Electrical Conductor Materials[3]

B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar[2]

B 250 Specification for General Requirements for Wrought Copper-Alloy Wire[2]

B 379 Specification for Phosphorized Coppers—Refinery Shapes[2]

B 577 Test Methods for Hydrogen Embrittlement of Copper[2]

B 623 Specification for Tough-Pitch Fire-Refined High-Conductivity Copper—Refinery Shapes[2]

B 846 Terminology for Copper and Copper Alloys[2]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[4]

E 290 Test Method for Semi-Guided Bend Test for Ductility of Metallic Materials[4]

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *unaided eye*—without visual enhancement; however, corrective optical lenses necessary to obtain normal vision shall be permitted.

4. Ordering Information

4.1 Contracts or purchase orders for product to this specification should include the following information:

4.1.1 ASTM designation and year of issue,

4.1.2 Copper UNS No. designation (Section 1),

4.1.3 Temper—O61 (annealed) or H04 (hard) (Section 7),

4.1.4 Dimensions—Width and thickness (Section 13),

4.1.5 Quantity—Total weight, footage, or number of pieces,

4.1.6 How furnished—lengths, coils, spools, etc., and

4.1.7 When purchased for agencies of the U.S. Government (Section 12).

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

4.2.1 Electrical resistivity (Section 8),

4.2.2 Hydrogen embrittlement susceptibility test (Section 10),

4.2.3 Bend test (Section 11),

[1] This specification is under the jurisdiction of ASTM Committee B-5 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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[2] *Annual Book of ASTM Standards*, Vol 02.01.

[3] *Annual Book of ASTM Standards*, Vol 02.03.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

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

4.2.4 Certification (Specification B 248 or Specification B 250, or both),

4.2.5 Mill test reports (Specification B 248 or Specification B 250, or both).

5. Material and Manufacture

5.1 *Material*:

5.1.1 The material of manufacture shall be a copper billet, cake, wire bar, or rod produced to Specifications B 5, B 170, B 379 or B 623.

5.1.2 Copper other than that listed in 1.1.1 is permitted only upon agreement between the manufacturer and the purchaser (see 1.1.2).

6. Chemical Composition

6.1 The material shall conform to the requirements of the specification under which it was ordered.

6.1.1 The composition of a special copper designated by the purchaser shall conform to the published requirements of the prescribed Copper UNS No. designation.

6.1.1.1 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.

7. Temper

7.1 Product temper, as defined in Practice B 601, shall be O61 (annealed) or H04 (hard).

8. Physical Property Requirement

8.1 *Electrical Resistivity*:

8.1.1 When specified in the ordering information O61 (annealed) temper product shall have a maximum mass electrical resistivity of 0.15328 ohm·g/m^2 (Conductivity 100 % IACS) and H04 (hard) temper product shall have a maximum mass electrical resistivity of 0.15775 ohm·g/m^2 (Conductivity 97.16 % IACS) when tested in accordance with Test Method B 193.

9. Mechanical Property Requirements

9.1 *Tensile Requirements*:

9.1.1 Product 0.035 in. (0.90 mm) and under in thickness shall conform to the tensile strength and elongation requirements prescribed in Table 1 when tested in accordance with Test Methods E 8.

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

9.1.2 Product over 0.035 in. (0.90 mm) in thickness shall be capable of conforming to the requirements prescribed in Table 1 when tested in accordance with Test Methods E 8.

9.2 *Rockwell Hardness*:

9.2.1 Product over 0.035 in. (0.90 mm) in thickness shall conform to the hardness requirements prescribed in Table 1 when tested in accordance with Test Methods E 8.

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

10. Hydrogen Embrittlement Susceptibility

10.1 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.

10.1.1 In case of dispute, Test Method C of Test Methods B 577 shall be followed.

11. Performance Requirements

11.1 *Bend Test Requirement*:

11.1.1 When tested in accordance with Test Method B 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 1. 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 Product purchased for agencies of the U.S. Government shall conform to the special government requirements stipulated in the Supplemental Requirements section of Specification B 248 or B 250, as appropriate (15.1.6).

13. Dimensions and Permissible Variations

13.1 *General*—For the purpose of determining conformance 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 1—Blank spaces in the tolerance tables indicate either that the

TABLE 1 Mechanical Property Requirements

Temper		Thickness in. (mm)	Rockwell	Tensile		Elongation Bend	
Standard	Name		F Scale	ksi[A] (MPa[B])		%	Angle, deg
				Min	Max		
O61	Annealed	Up to 0.010 (0.254)	...	...	...	20	180
		Over 0.010 (0.254) to 0.035 (0.900)	...	...	40 (275)	25	180
		Over 0.035 (0.900) to 0.050 (1.25)	65 max	...	38 (260)	25	180
		Over 0.050 (1.25) to 0.188 (4.80)	65 max	...	37 (255)	25	180
H04	Hard	Up to 0.035 (0.900), incl	...	43 (295)	58 (400)	...	120
		Over 0.035 (0.900) to 0.125 (3.20)	85–97	43 (295)	...	10	120
		Over 0.125 (3.20) to 0.188 (4.80)	80–95	43 (295)	...	12	120

[A] ksi = 1000 psi.
[B] See Appendix X1.

TABLE 2 Thickness Tolerances

Thickness, in. (mm)	Thickness Tolerances, plus and minus, in. (mm), for Widths given in Inches (Millimetres)[A]				
	Up to 1¼ (31.8), incl	Over 1¼ (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)

[A] If tolerances all plus or all minus are desired, double the values given.

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 2.

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 3.

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 4, 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 5.

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 6.

13.5.1 To determine compliance with this tolerance the length shall, in case of disagreement, be checked by the following method:

13.5.1.1 Place the lengths on a level table so that the arc of departure from straightness is horizontal. Measure the depth of arc to the nearest 1⁄32 in. (0.79 mm) using a metal scale and a straightedge.

13.6 *Edge Contours*:

13.6.1 *Square Corners*—Unless otherwise specified, the material shall be finished with commercially square corners with the maximum permissible radius as shown in Table 7.

13.6.2 *Rounded Corners*—When specified the material may be furnished with corners rounded as shown in Fig. 1 to a quarter circle of a radius as shown in Table 8. The tolerance on the radius shall be ±25 %.

13.6.3 *Rounded Edge*—When specified, the material may be finished with edges rounded as shown in Fig. 2, with a radius of curvature as shown in Table 9.

13.6.4 *Full Rounded Edge*—When specified, the material shall be finished with substantially uniform round edges, the radius of curvature being approximately ½ the thickness of the product as shown in Fig. 3, but in no case to exceed ½ the thickness of the product by more than 25 %.

TABLE 3 Width Tolerances
(For squares, use thickness tolerances in Table 2)

Width, in. (mm)	Tolerances, plus and minus,[A] in. (mm)
Up to 0.050 (1.27), incl	0.0013 (0.033)
Over 0.050 (1.27) to 0.090 (2.29), incl	0.0015 (0.038)
Over 0.090 (2.29) to 0.130 (3.30), incl	0.002 (0.051)
Over 0.130 (3.30) to 0.188 (4.78), incl	0.003 (0.076)
Over 0.188 (4.78) to 0.500 (12.7), incl	0.0035 (0.089)
Over 0.500 (12.7) to 1.25 (31.8), incl	0.005 (0.13)
Over 1.25 (31.8) to 2.00 (50.8), incl	0.008 (0.20)
Over 2.00 (50.8) to 4.00 (102), incl	0.012 (0.30)
Over 4.00 (102) to 12.00 (305), incl	0.30[B]

[A] If tolerances all plus or minus are desired, double the values given.
[B] Percent of the width expressed to the nearest 0.001 in. (0.025 mm).

14. Test Methods

14.1 *Chemical Analysis*:

14.1.1 Chemical composition shall be determined as directed in the product specification to which the material was ordered.

14.1.2 The 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 supplier and the purchaser.

15. General Requirements

15.1 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:

15.1.1 Terminology,
15.1.2 Materials and Manufacture,
15.1.3 Workmanship, finish, and appearance.
15.1.4 Sampling.
15.1.5 Number of tests and retests.
15.1.6 Specimen preparation.
15.1.7 Test methods.
15.1.8 Significance of numerical limits.
15.1.9 Inspection.
15.1.10 Rejection and rehearing.
15.1.11 Certification.
15.1.12 Test reports.
15.1.13 Packaging and Package Marking, and
15.1.14 Supplementary Requirements.

15.2 In addition, when a section with a title identical to that referenced in 15.1 appears in this specification, it contains additional requirements that supplement those appearing in Specifications B 248 or B 250, or both.

16. Keywords

16.1 copper flat products; copper flat wire; copper strip; copper wire; flat wire; general purpose strip; general purpose wire; strip; wire

TABLE 4 Schedule of Lengths (Specific and Stocks) with Ends

Squares, Side in in. (mm)	Rectangles, Area,[A] in.^{2}(cm^2)	Nominal Length, ft (m)	Shortest Permissible Length,[B] percent of Nominal Length	Maximum Permissible Weight of Ends percent of Lot Weight
3/16 (4.76) and under	0.250 (1.61) and under	6 (1.83) to 14 (4.27), incl	75	20
	Over 0.250 (1.61) to 1 (6.45), incl	6 (1.83) to 14 (4.27), incl	70	30
	Over 1 (6.45) to 2.25 (14.5), incl	6 (1.83) to 12 (3.66), incl	60	40
	Over 2.25 (14.5) to 4 (25.8), incl	6 (1.83) to 12 (3.66), incl	50	45

[A] Width times thickness, disregarding any rounded corners or edges.
[B] Expressed to the nearest ½ ft (150 mm).

TABLE 5 Length Tolerances for Material Furnished Straight

Length Classification	Length Tolerances, all plus,[A] in. (mm) (Applicable only to Full-Length Pieces)
Specific lengths	3/8(9.5)
Specific lengths with ends	1 (25)
Stock lengths with or without ends	1 (25)[B]

[A] If all minus tolerances are desired, use the same values; if tolerances plus and minus are desired, halve the values given.
[B] As stock lengths are cut and placed in stock in advance of orders, departure from this tolerance is not practicable.

TABLE 6 Straightness Tolerances Applicable to Any Longitudinal Edge of Material Supplied in Nominally Flat Straight Lengths and in Rolls or in Bucks

For material having a cross-sectional area of 0.010 in.^{2}(0.0645 cm^2) and over and a thickness of 0.010 in. (0.254 mm) and over, furnished in straight lengths, in rolls, or on bucks	½-in. (13-mm) maximum edgewise curvature (depth of arc) in any 6-ft (1.83-m) portion of the total length.
For materials having a cross-sectional area of less than 0.010 in.^{2}(0.0645 cm^2), or a thickness of less than 0.010 in. (0.254 mm), and all material furnished on reels or on stagger wound rolls	No straightness tolerances established

TABLE 7 Requirements for Square Corners

Specified Thickness, in. (mm)	Maximum Radius of Corners Allowable for Square Corner, in. (mm)
1/32 (0.794) to 1/16 (1.59), incl	1/100 (0.254)
Over 1/16 (1.59) to 3/16 (4.76), incl	1/64 (0.397)

TABLE 8 Requirements for Rounded Corners

Specified Thickness, in. (mm)	Nominal Radius of Corner, in. (mm)	
	For Widths up to and including 2× Thickness	For Widths more than 2× Thickness
Up to 0.072 (1.83)	0.012 (0.305)	full rounded edges as given in 13.6.4
Over 0.072 (1.83) to 1/8 (3.18), incl	1/64 (0.397)	full rounded edges as given in 13.6.4
Over 1/8 (3.18) to 3/16 (0.794), incl	1/32 (0.794)	1/32 (0.794)

APPENDIX

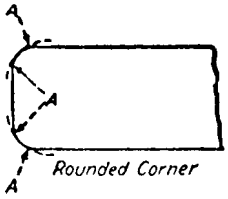
(Nonmandatory Information)

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

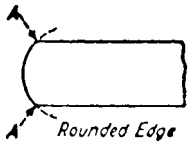
TABLE 9 Requirements for Rounded Edges

Specified Thickness, in. (mm)	Nominal Radius of Rounded Edge, in. (mm)	Tolerances on Radius, plus and minus, in. (mm)
Up to 3⁄16 (4.76), incl	1¼ × thickness	½ × thickness



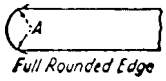
NOTE 1—The arc shall not necessarily be tangent at points *A* but the product shall be commercially free from sharp, rough, or projecting edges.

FIG. 1 Rounded Corners



NOTE 1—The arc shall be substantially symmetrical with the axis of the product. The corners, *A*, will usually be sharp but shall not have rough or projecting edges.

FIG. 2 Rounded Edge



NOTE 1—The arc shall not necessarily be tangent at points *A* but shall be substantially symmetrical with the axis of the product, and the product shall be commercially free from sharp, rough, or projecting edges.

FIG. 3 Full Rounded Edge

kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification that have been incorporated since the 1993 issue as follows:

(1) Scope—This section has been revised to include the coppers that are involved.

(2) Referenced Documents—Introductory statement deleted since it imposed a year of issue on each listed document: Specification B 442 and Practice E 29 have been deleted. Test Method E 290 and Terminology B 846 have been added.

(3) Section 3, Ordering Information, was added.

(4) Mechanical Property Requirements—Section has been broken down into Tensile and Rockwell hardness requirements for clarification. Also, the size ranges have been changed so that Rockwell F hardness requirements no longer apply to metal thicknesses under 0.035 in. for the tempers herein, as prescribed in Test Methods E 18 for hardness testing.