



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.

Current edition approved Nov. 10, 2001. Published February 2002. Originally published as B 272 – 52T. Last previous edition B 272 – 96.

<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	Temper Name	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 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)

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

**TABLE 4 Width Tolerances**  
(For squares, use thickness tolerances in Table 2)

Width, in. (mm)	Tolerances, Plus and Minus, <sup>A</sup> 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 <sup>B</sup>

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

<sup>B</sup>Percent of the width expressed to the nearest 0.001 in. (0.025 mm).

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 8.

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 9. 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 10.

13.6.4 *Full Rounded Edge*—When specified, the material shall be finished with substantially uniform round edges, the

radius of curvature being approximately 1/2 the thickness of the product as shown in Fig. 3, but in no case to exceed 1/2 the thickness of the product by more than 25 %.

**14. Test Methods**

14.1 *Chemical Analysis:*

14.1.1 Chemical composition shall be determined as directed in the annex of the following product specifications:

UNS No.	Specification
C10100	B 170
C10200	B 170

14.1.2 For UNS Nos. C11000, C 10300, C10500, C10700, C10800, C12200, or C14200 the following test methods shall be used:

Element	Test Method
Copper	E 53
Phosphorous	E 62
Arsenic	E 62
Silver	E 478

14.1.3 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. Keywords**

15.1 copper flat products; copper flat wire; copper strip; copper wire; flat wire; general purpose strip; general purpose wire; strip; UNS Copper No. C10100; UNS Copper No. C10200; UNS Copper No. C10300; UNS Copper No. C10500; UNS Copper No. C10700; UNS Copper No. C10800; UNS Copper No. C11000; UNS Copper No. C12200; UNS Copper No. C14200; wire



**TABLE 5 Schedule of Lengths (Specific and Stocks) with Ends**

Squares, Side in in. (mm)	Rectangles, Area, <sup>A</sup> in. <sup>2</sup> (cm <sup>2</sup> )	Nominal Length, ft (m)	Shortest Permissible Length, <sup>B</sup> 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

<sup>A</sup>Width times thickness, disregarding any rounded corners or edges.

<sup>B</sup>Expressed to the nearest 1/2 ft (150 mm).

**TABLE 6 Length Tolerances for Material Furnished Straight**

Length Classification	Length Tolerances, All Plus, <sup>A</sup> 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) <sup>B</sup>

<sup>A</sup>If all minus tolerances are desired, use the same values; if tolerances plus and minus are desired, halve the values given.

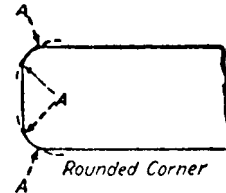
<sup>B</sup>As stock lengths are cut and placed in stock in advance of orders, departure from this tolerance is not practicable.

**TABLE 7 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. <sup>2</sup> (0.0645 cm <sup>2</sup> ) and over and a thickness of 0.010 in. (0.254 mm) and over, furnished in straight lengths, in rolls, or in bucks	1/2-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. <sup>2</sup> (0.0645 cm <sup>2</sup> ), 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 8 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)

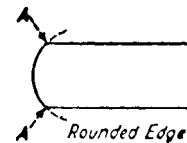


NOTE 1—The arc shall not necessarily be tangent at Points A, but the product shall be commercially free from sharp, rough, or projecting edges.

**FIG. 1 Rounded Corners**

**TABLE 9 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)



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**





**TABLE 10 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 $\frac{3}{16}$ (4.76), incl	$1\frac{1}{4} \times$ thickness	$\frac{1}{2} \times$ thickness



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**

## 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 ( $N = \text{kg}\cdot\text{m}/\text{s}^2$ ). The derived SI unit for pressure or

stress is the newton per square metre ( $\text{N}/\text{m}^2$ ), 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  $\text{MN}/\text{m}^2$  and  $\text{N}/\text{mm}^2$ .

## SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue, B 272-96, that may impact the use of this standard.

- |   |  |
|---|--|
| (1) Referenced Documents—Chemical Test Methods added.             | requirements by alloy and temper. Requirements added to Table 2. |
| (2) Table 1, Chemical Requirements added.                         |  |
| (3) Electrical Resistivity section has been revised to to clarify | (4) Table 2 revised to include additional tempers.               |

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*