



Designation: B250/B250M – 12

## Standard Specification for General Requirements for Wrought Copper Alloy Wire<sup>1</sup>

This standard is issued under the fixed designation B250/B250M; 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 requirements common to wrought copper and copper alloy wire and shall apply to Specifications B16/B16M, B99/B99M, B134/B134M, B159/B159M, B197/B197M, B206/B206M, B272, B301/B301M, B453/B453M, B967/B967M, and B974/B974M to the extent referenced therein.

1.2 The chemical composition, physical and mechanical properties, and all other requirements not included in this specification shall be prescribed in the product specification.

1.3 *Units*—Values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated in each system may not be 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.

1.4 The following safety hazard caveat pertains only to the test methods 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 and health practices and to determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

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

- B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
- B99/B99M Specification for Copper-Silicon Alloy Wire for General Applications
- B134/B134M Specification for Brass Wire
- B159/B159M Specification for Phosphor Bronze Wire
- B193 Test Method for Resistivity of Electrical Conductor Materials
- B194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
- B197/B197M Specification for Copper-Beryllium Alloy Wire
- B206/B206M Specification for Copper-Nickel-Zinc (Nickel Silver) Wire and Copper-Nickel Alloy Wire
- B272 Specification for Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)
- B301/B301M Specification for Free-Cutting Copper Rod, Bar, Wire, and Shapes
- B453/B453M Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes
- B846 Terminology for Copper and Copper Alloys
- B900 Practice for Packaging of Copper and Copper Alloy Mill Products for U.S. Government Agencies
- B967/B967M Specification for Copper-Zinc-Tin-Bismuth Alloy Rod, Bar and Wire
- B974/B974M Specification for Free-Cutting Bismuth Brass Rod, Bar and Wire
- E3 Guide for Preparation of Metallographic Specimens
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E18 Test Methods for Rockwell Hardness of Metallic Materials
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- 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
- E118 Test Methods for Chemical Analysis of Copper-Chromium Alloys (Withdrawn 2010)<sup>3</sup>
- E121 Test Methods for Chemical Analysis of Copper-Tellurium Alloys (Withdrawn 2010)<sup>3</sup>

<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 Oct. 1, 2012. Published November 2012. Originally approved in 1951. Last previous edition approved in 2007 as B250–07. DOI: 10.1520/B0250\_B0250M-12.

<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.

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

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

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

**E581 Test Methods for Chemical Analysis of Manganese-Copper Alloys**

### 3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology **B846**.

### 4. Materials and Manufacture

#### 4.1 Materials:

4.1.1 The materials of manufacture shall be a form (cast bar, billet, rod, etc.) of the copper or copper alloy covered by the product specification, of such purity and soundness as to be suitable for processing into the products required.

4.1.2 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 always practical to identify specific casting analysis with a specific quantity of finished material.

#### 4.2 Manufacture:

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

4.2.2 The product shall be hot or cold worked to the finished size, and subsequently annealed when required, to meet the temper properties specified in the product specification.

4.2.3 Edges—The edges shall be drawn or rolled: refer to Dimensions and Permissible Variations section.

### 5. Chemical Composition

5.1 The material of manufacture shall conform to the chemical composition requirements prescribed in the product specification.

5.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance specified in the product specification.

5.2 The composition limits established for the Copper Alloy UNS No. designation specified in the product specification do not preclude the presence of other elements. By agreement between the manufacturer and the purchaser, limits may be established and analysis required for unnamed elements.

5.3 When chemical composition has been determined during the course of manufacture, analysis of the finished product by the manufacturer is not required unless specifically stipulated in the contract or purchase order.

### 6. Dimensions and Permissible Variations

6.1 *General*—For the purpose of determining conformance with the dimensional requirements prescribed in this specification, any measured value outside the specified limiting value for any dimension may be cause for rejection.

6.1.1 The dimensions and tolerances for products referenced to this specification, shall be as noted in the following paragraphs and tables, where the product specification is noted in the table heading.

NOTE 2—Blank spaces in the tolerance tables indicate either that the product is not generally available or that no tolerances have been established.

6.2 *Diameter or Distance Between Parallel Surfaces*—The method of specifying wire diameter or distances between parallel surfaces shall be in decimal fractions of an inch or in millimeters.

**Tables 1 and 2**—List the tolerances for diameter or distances between parallel surfaces of wire in round, hexagonal and octagonal cross sections.

6.3 *Thickness*—The method of specifying thickness of wire shall be in decimal fractions of an inch or in millimeters.

**Tables 3 and 4**—List the thickness tolerances for flat wire in rectangular and square cross sections.

6.4 *Width*—The method of specifying width shall be in decimal fractions of an inch or in millimeter.

**Tables 5 and 6**—List the width tolerances for flat wire in rectangular and square cross sections.

#### 6.5 Length:

6.5.1 Round, hexagonal, and octagonal wire shall be furnished in coils or reels, consisting of a single length as may be agreed upon between the manufacturer and the purchaser.

6.5.2 Flat (rectangular and square) wire when furnished in straight, specific, or stock lengths shall not exceed the length tolerances in **Table 7**.

6.5.3 Stock lengths with short lengths included as specified in **Table 8** shall be furnished, unless the contract or purchase order specifically states stock or specific lengths are required.

**Table 8**—Lists the schedule of lengths, specific or stock, with ends, for flat (rectangular or square) wire furnished in straight lengths.

6.6 *Straightness*—For flat (rectangular and square) wire furnished in straight lengths in applicable specifications the deviation from straightness shall not exceed the limitations specified in **Table 9**.

6.6.1 To determine compliance with this tolerance, the lengths shall, in case of disagreement, be checked by placing

**TABLE 1 Tolerances for Diameter or Distance Between Parallel Surfaces of Wire**

(Applicable to Specifications **B16/B16M**, **B99/B99M** Copper Alloy UNS No. C65100, **B134/B134M**, **B301/B301M**, **B453/B453M**, **B967/B967M**, and **B974/B974M**.)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus <sup>A</sup>			
	Round, in. [mm]		Hexagonal, Octagonal, in. [mm]	
Up to 0.010 [0.25], incl	0.0001	[0.003]	...	...
Over 0.010–0.020 [0.25–0.50], incl	0.0002	[0.005]	...	...
Over 0.020–0.030 [0.50–0.75], incl	0.0003	[0.008]	...	...
Over 0.030–0.040 [0.75–1.0], incl	0.0004	[0.010]	0.0008	[0.020]
Over 0.040–0.050 [1.0–1.2], incl	0.0005	[0.013]	0.0010	[0.025]
Over 0.050–0.060 [1.2–1.5], incl	0.0006	[0.015]	0.0012	[0.030]
Over 0.060–0.080 [1.5–2.0], incl	0.0008	[0.020]	0.0016	[0.040]
Over 0.080–0.150 [2.0–3.8], incl	0.0010	[0.025]	0.002	[0.050]
Over 0.150–0.500 [3.8–12], incl	0.0015	[0.040]	0.003	[0.075]
Over 0.500–0.750 [12–20], incl	0.002	[0.050]	0.004	[0.10]

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

**TABLE 2 Tolerances for Diameter or Distance Between Parallel Surfaces of Wire**

(Applicable to Specifications B99/B99M Copper Alloy UNS No. C65500, B159/B159M, B197/B197M, and B206/B206M.)

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tolerances, Plus and Minus <sup>A</sup>			
	Round, in. [mm]		Hexagonal, Octagonal, in. [mm]	
Up to 0.010 [0.25], incl	0.0002	[0.005]	...	...
Over 0.010–0.020 [0.25–0.50], incl	0.0003	[0.008]	...	...
Over 0.020–0.030 [0.50–0.75], incl	0.0005	[0.013]	...	...
Over 0.030–0.040 [0.75–1.0], incl	0.0007	[0.018]	0.002	[0.050]
Over 0.040–0.050 [1.0–1.2], incl	0.0008	[0.020]	0.003	[0.075]
Over 0.050–0.060 [1.2–1.5], incl	0.0010	[0.025]	0.003	[0.075]
Over 0.060–0.080 [1.5–2.0], incl	0.0015	[0.040]	0.004	[0.10]
Over 0.080–0.150 [2.0–3.8], incl	0.002	[0.050]	0.004	[0.10]
Over 0.150–0.500 [3.8–12], incl	0.002	[0.050]	0.004	[0.10]
Over 0.500–0.750 [12–20], incl	0.003	[0.075]	0.005	[0.13]

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

**TABLE 3 Thickness Tolerances for Flat (Rectangular and Square) Wire**

(Applicable to Specification B134/B134M.)

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus, <sup>A</sup> in. [mm] for Widths Given in Inches [mm]	
	Up to ½ [12], incl	Over ½ [12] to 1¼ [32], incl
Up to 0.013 [0.33], incl	0.0010 [0.025]	0.0013 [0.033]
Over 0.013–0.050 [0.33–1.25], incl	0.0013 [0.033]	0.0015 [0.040]
Over 0.050–0.090 [1.25–2.30], incl	0.0015 [0.040]	0.002 [0.050]
Over 0.090–0.130 [2.30–3.30], incl	0.002 [0.050]	0.0025 [0.065]
Over 0.130–0.188 [3.30–4.80], incl	0.003 [0.075]	0.0035 [0.090]

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

**TABLE 4 Thickness Tolerances for Flat (Rectangular and Square) Wire**

(Applicable to Specifications B159/B159M, B197/B197M, and B206/B206M.)

Thickness, in. [mm]	Thickness Tolerances, Plus and Minus, <sup>A</sup> in. [mm] for Widths Given in Inches [mm]	
	Up to ½ [12], incl	Over ½ to 1¼ [12 to 32], incl
Up to 0.050 [1.2], incl	0.0015 [0.040]	0.002 [0.050]
Over 0.050–0.090 [1.2–2.3], incl	0.002 [0.050]	0.003 [0.075]
Over 0.090–0.130 [2.3–3.3], incl	0.003 [0.075]	0.004 [0.10]
Over 0.130–0.188 [3.3–4.8], incl	0.004 [0.10]	0.0045 [0.11]

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

**TABLE 5 Width Tolerances for Flat (Rectangular) Wire**

(Applicable to Specification B134/B134M.)  
(For Square Wire Use Thickness Tolerances in Table 3.)

Width, in. [mm]	Tolerances, Plus and Minus, <sup>A</sup> in. [mm]
Up to 0.050 [1.25], incl	0.0013 [0.025]
Over 0.050–0.090 [1.25–2.30], incl	0.0015 [0.040]
Over 0.090–0.130 [2.30–3.30], incl	0.002 [0.050]
Over 0.130–0.188 [3.30–4.80], incl	0.003 [0.075]
Over 0.188–0.500 [4.80–12.5], incl	0.0035 [0.090]
Over 0.500–1.25 [12.5–32.0], incl	0.005 [0.125]

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

**TABLE 6 Width Tolerances for Flat (Rectangular) Wire**

(Applicable to Specifications B159/B159M, B197/B197M, and B206/B206M.)

(For Square Wire Use Thickness Tolerances in Table 4.)

Width, in. [mm]	Tolerances, Plus and Minus, <sup>A</sup> in. [mm]
Up to 0.050 [1.2], incl	0.0015 [0.040]
Over 0.050–0.090 [1.2–2.3], incl	0.002 [0.050]
Over 0.090–0.130 [2.3–3.3], incl	0.003 [0.075]
Over 0.130–0.188 [3.3–4.8], incl	0.004 [0.10]
Over 0.188–0.500 [4.8–12], incl	0.005 [0.13]
Over 0.500–1.25 [12–32], incl	0.007 [0.18]

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

**TABLE 7 Length Tolerances for Straight Lengths (Specific and Stock) of Flat (Rectangular and Square) Wire**

(Applicable to Specifications B134/B134M, B159/B159M, B197/B197M, and B206/B206M.)

Lengths	Length Tolerances Applicable Only to Full Length Pieces <sup>A</sup> in. [mm]
Specific lengths	⅜ [10]
Specific lengths with ends	1 [25]
Stock lengths with or without ends	1 [25] <sup>B</sup>

<sup>A</sup>Tolerances are all plus; 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 8 Schedule of Lengths (Specific and Stock) With Ends for Flat (Rectangular and Square) Wire Furnished in Straight Lengths**

(Applicable to Specifications B134/B134M, B159/B159M, B197/B197M, and B206/B206M.)

Nominal Length, ft [mm]	Shortest Permissible Length <sup>A</sup> (in % of Nominal Length)	Maximum Permissible Weight of Ends (in % of Lot Weight)
6–14 [2000–4500], incl	75	20

<sup>A</sup>Expressed to the nearest ½ ft [150 mm].

the lengths on a level table so that the arc or departure from straightness is horizontal. Measure the depth of the arc to the nearest ½ in. [1 mm] using a straight-edge.

**6.7 Edge Contours**—Flat (rectangular and square) wire applicable to listed specifications shall, unless otherwise specified in the contract or purchase order, be finished with commercially square corners with a maximum permissible radius of ⅓ in. [0.3 mm] for wire ⅓ to ⅓ in. [1 to 1.5 mm] inclusive in thickness, and of ¼ in. [0.4 mm] for wire over ⅓ to ⅓ in. [1.5 to 5 mm] inclusive in thickness.

**6.7.1 Sharp Corners**—When specified in the contract or purchaser order, the corner radius shall be 0.003 in. [0.080 mm] maximum on all sizes of flat wire up to and including 0.188 in. [5 mm] between flats.

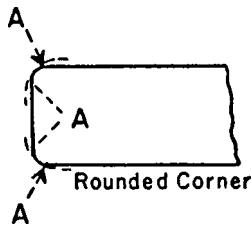
**6.7.2 Rounded Corners**—When specified in the contract or purchase order, flat wire over ⅓ to ⅓ in. [3 to 5 mm], inclusive in thickness may be finished with corners rounded as shown in Fig. 1 to a quarter of a radius of ⅓ in. [1 mm]. The tolerance on the radius shall be ±25 %. Wire up to ⅓ in. [3

**TABLE 9 Straightness Tolerances for Flat (Rectangular and Square) Wires**

(Applicable Specifications B134/B134M, B159/B159M, B197/B197M, and B206/B206M.)

Applicable to any longitudinal edge of material supplied in flat straight lengths and on reels or coils.

For material having a cross-sectional area of 0.010 in. <sup>2</sup> [6.5 mm <sup>2</sup> ] and over and a thickness of 0.010 in. [0.25 mm] and over, furnished in straight lengths, on reels or coils	½ in. [12 mm] maximum edgewise curvature (depth of arc) in any 6-ft [2000 mm] portion of the total length
For material having a cross-sectional area of less than 0.010 in. <sup>2</sup> [6.5 mm <sup>2</sup> ], or a thickness of less than 0.010 in. [0.25 mm], and all material furnished on reels or coils	No straightness tolerances established.



**FIG. 1 Rounded Corners**

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

mm] inclusive in thickness, may be finished with a full rounded edge as described in 6.7.4.

6.7.3 *Round Edge*—When specified in the contract or purchase order, flat wire may be finished with edges rounded as shown in Fig. 2, the radius of curvature being 1¼ times the thickness for flat wire with a thickness up to 3/16 in. [5 mm] inclusive. The tolerance on the radius is ±½ times the wire thickness.

6.7.4 *Full Rounded Edge*—When specified in the contract or purchase order, flat wire may be finished with a substantially uniform round edge, the radius of curvature being approximately ½ the thickness of the wire, as shown in Fig. 3, but in no case to exceed ½ the thickness by more than 25 % (see also Fig. 4).

**7. Workmanship, Finish, and Appearance**

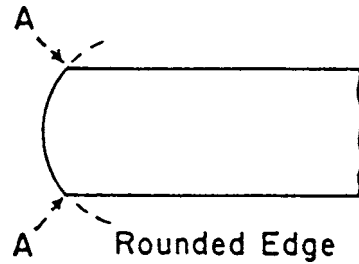
7.1 *Workmanship:*



**Full Rounded Edge**

NOTE 1—The arc of the rounded edge 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.

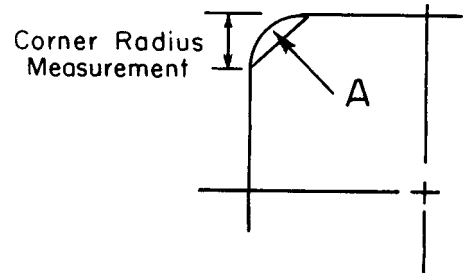
**FIG. 2 Full Rounded Edge**



**Rounded Edge**

NOTE 1—The arc of the rounded edge 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. 3 Rounded Edge**



NOTE 1—Any configuration within A is a corner radius.

**FIG. 4 Corner Radius**

7.1.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable. The product shall be free of dirt.

7.2 *Finish:*

7.2.1 Necessary joints in the wire shall be made prior to final drawing and in accordance with current practice.

7.3 *Appearance:*

7.3.1 The surface finish and appearance shall be the normal quality for product ordered.

7.3.2 When application information is provided with the contract or purchase order, the surface condition shall be suitable for the application.

7.3.3 Superficial films of discoloration, such as lubricants or tarnish inhibitors, are permissible unless otherwise specified.

**8. Sampling**

8.1 The lot size, portion size, and selection of sample pieces shall be as follows:

8.1.1 *Lot Size*—An inspection lot shall be 10 000 lbs [5000 kg] or less, of the same mill form, alloy, temper and nominal dimensions, subject to inspection at one time. Alternatively, a lot shall be the product of one cast bar from a single melt charge, or one continuous casting run whose weight does not exceed 20 000 lb [10 000 kg] that has been continuously processed and subject to inspection at one time.

8.1.2 *Portion Size*—The portion shall be four or more pieces selected so as to be representative of each lot. Should the lot consist of less than five pieces, representative samples shall be taken from each piece.

8.2 *Chemical Analysis:*

8.2.1 The sample for chemical analysis shall be taken in accordance with Practice E255 for product in the final form from the pieces selected in 8.1.2 and combined into one composite sample. The minimum weight of the composite sample shall be 150 g.

8.2.2 Instead of sampling as directed in 8.2.1, the manufacturer shall have the option of sampling at the time castings are poured or from the semifinished product. When samples are taken during the course of manufacture, sampling of the finished product by the manufacturer is not required. The number of samples taken for the determination of composition shall be as follows:

8.2.2.1 When samples are taken at the time the castings are poured, at least one sample shall be taken for each group of castings poured from the same source of molten metal.

8.2.2.2 When samples are taken from semifinished product, a sample shall be taken to represent each 10 000 lb [5000 kg], or fraction thereof, except that not more than one sample shall be required per piece.

8.2.2.3 Only one sample need be taken from the semifinished product of one cast bar from a single, continuously processed melt charge.

8.3 *Samples for All Other Tests*—Samples for all other tests shall be taken from the sample portions selected in 8.1.2 and be of a convenient size to accommodate the test and comply with the requirements of the appropriate product specification and test method.

## 9. Number of Tests and Retests

### 9.1 Tests:

9.1.1 *Chemical Analysis*—Chemical composition shall be determined as the per element mean of results from at least two replicate analysis of the sample(s), and the results of each replication shall meet the requirements of the product specification.

### 9.1.2 Other Tests:

9.1.2.1 *Tensile, Grain Size, and Electrical Resistivity*—These tests shall be reported as the average of results obtained from specimens prepared from each of two pieces selected in 8.1.2, and each specimen shall meet the requirements of the product specification. In the case of copper-beryllium alloy, two specimens shall be taken for each required test from each of the two sample pieces selected. One specimen from each piece shall be tested without further treatment, and the other two specimens shall be tested after precipitation hardening.

9.1.2.2 *Rockwell Hardness*—The value of the hardness number of each specimen shall be established as the arithmetical average of at least three readings, and each specimen shall meet the requirements of the product specification.

9.1.2.3 *Bend and Hydrogen Embrittlement Tests*—At least two individual specimens shall be subjected to test for each requirement and each specimen shall conform to the test requirement.

### 9.2 Retests:

9.2.1 When requested by the manufacturer or supplier, a retest shall be permitted when test results obtained by the purchaser fail to conform with the product specification requirement(s).

9.2.2 Retesting shall be as directed in the product specification for the initial test except for the number of test specimens which shall be twice that normally required for the test. Test results for all specimens shall conform to the product specification requirement(s) in retest, and failure to comply shall be cause for lot rejection.

9.2.3 *Chemical Analysis*—If one, or more, of the elements with specified limits fail to meet the compositional requirement of the product specification when determined from the sample prepared in accordance with Practice E255, one retest cycle shall be permitted with a second composite sample prepared in accordance with Practice E255.

9.2.4 *Other Tests*—If a test specimen fails to conform to a test requirement of the product specification, one recycle test shall be permitted with specimens prepared from two of the remaining pieces of the finished product selected in 8.1.2.

9.2.4.1 If the percent elongation of any tensile test-specimen is less than that specified and any part of the fracture is outside of the middle two thirds of the gage length or in a punched or scribed mark within the reduced section, a retest shall be allowed.

9.3 All test specimens shall conform to the product specification requirements in retest. Failure to comply shall be cause for rejection.

## 10. Specimen Preparation

10.1 *Chemical Analysis*—Sample preparation shall be in accordance with Practice E255.

10.1.1 Analytical specimen preparation shall be the responsibility of the reporting laboratory.

10.2 *Tensile Test*—The test specimen shall conform to the requirements prescribed for the product in the Test Specimen Section of Test Methods E8/E8M. (Round specimens: specimens for wire, rod, and bar).

10.3 *Grain Size*—The test specimen shall be prepared in accordance with Practice E3.

10.4 *Rockwell Hardness*—The test specimen shall be of a size and shape to permit testing by the available test equipment and shall be taken to permit testing in a plane parallel or perpendicular to the direction of deformation given to the product.

10.4.1 The surface of the test specimen shall be sufficiently smooth and even to permit the accurate determination of hardness.

10.4.2 The specimen shall be free of scale and foreign matter and care shall be taken to avoid any change in condition, that is, heating or cold working.

10.5 *Electrical Resistivity*—Test specimens are to be full size where practical and shall be the full cross section of the material it represents.

10.5.1 When the test specimen is cut from material in bulk, care should be taken that the properties are not appreciably altered in the preparation. Plastic deformation may work harden a material and tend to raise the resistivity, while heating tends to anneal the material with a consequent reduction in resistivity.

10.5.2 When necessary, products are to be rolled or cold drawn to a wire approximately 0.080 in. [2 mm] (12 gage AWG) and at least 180 in. [4 500 mm] in length. The specimen shall be annealed at approximately 935°F [500°C] for 30 min in an inert atmosphere and cooled to ambient temperature in the same inert atmosphere.

10.5.3 For heat-treatable material, diameter and heat treatment shall be agreed upon between the manufacturer and purchaser.

10.6 Should any test specimen show defective machining or develop flaws, it may be discarded and another specimen substituted.

10.7 *Bend Test:*

10.7.1 The specimen shall be of a length sufficient for the test. The preparation of copper-beryllium test specimens shall be as prescribed in the product specification to which the item is being produced.

**11. Test Methods**

11.1 The test methods used for quality control or production control, or both, for the determination of conformance with product property requirements are discretionary.

11.1.1 The test method(s) used to obtain data for the preparation of certification or test report, or both, shall be made available to the purchaser on request.

11.2 *Chemical Composition:*

11.2.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser.

11.2.1.1 The specific test method to be used for each specified element may be referenced, or given, in the product specification. An applicable test method may be found in the following documents: E54, E62, E75, E118, E121, E478, and E581.

11.2.1.2 The test methods for the determination of composition for copper-beryllium alloys shall be as described in Annex A1 of Specification B194.

11.2.2 The test method(s) used for the determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

11.3 *Other Tests:*

11.3.1 The product in final form shall conform with physical, mechanical, and other requirements specified in the product specification when subjected to test in accordance with the appropriate method in the following table:

Test	Test Methods
Tensile	E8/E8M
Rockwell hardness	E18
Grain size	E112
Electrical resistivity	B193
Bend	Section 11.3.5
Corner radius	Section 11.3.6

11.3.2 *Tensile:*

11.3.2.1 The test method to be used for determining yield strength shall be specified in the product specification.

11.3.2.2 Elongation shall be determined in accordance with the first two paragraphs of the subsection titled “Elongation” of the Procedure section of Test Methods E8/E8M.

11.3.2.3 Whenever test results are obtained from both full-size and machined specimens and they differ, the test results from the full-size specimens shall prevail.

11.3.2.4 Test results are not seriously affected by variations in speed of testing. A considerable range of testing speed is permitted; however, the rate of stressing to the yield strength should not exceed 100 ksi/min [690 MPa/min]. Above the yield strength the movement per minute of the testing machine head under load should not exceed 0.5 in./in. [0.5 mm/mm] of gage length or distance between grips for full-section specimens.

11.3.3 *Grain Size*—In case of dispute, the intercept procedure shall be used.

11.3.4 *Electrical Resistivity*—The limit of measurement uncertainty for Test Method B193 shall be ±0.15 % as an umpire method and ±0.30 % as a routine method.

11.3.5 *Bend Test*—The specimens shall be bent cold over a mandrel radius and to the bend requirements prescribed in the product specification.

11.3.6 *Corner Radius*—Square or rectangular wire shall be measured by transverse sectioning and optically measuring the radius at 40× magnification; refer to Fig. 4.

**12. Significance of Numerical Limits**

12.1 For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29.

Property	Rounded Unit for Observed or Calculated Value
Dimensions	nearest unit in the last right-hand significant digit used in expressing the limiting value
Chemical composition	
Hardness	
Electrical resistivity/conductivity	
Tensile strength	nearest ksi [5 MPa]
Yield strength	
Elongation	
Below 5 %	nearest multiple of 0.5 %
5 % and over	nearest 1 %
Grain size	
Under 0.060 mm	nearest multiple of 0.005 mm
0.060 mm and over	nearest 0.01 mm

**13. Inspection**

13.1 The manufacturer, or supplier, shall inspect and make tests necessary to verify the furnished product conforms to the specification requirements.

13.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer, or supplier, and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector representing the purchaser, that the product is being furnished in accordance with the product specification, shall be included in the agreement. All testing and inspection shall be conducted so as not to interfere unnecessarily with the operations of the works.