Designation: B159/B159M – 11

Standard Specification for Phosphor Bronze Wire[1]

This standard is issued under the fixed designation B159/B159M; 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 establishes the requirements for round, square and flat phosphor bronze wire of UNS Alloy Nos. C51000, C52100, and C52400 for general and spring applications.

1.1.1 Rectangular and square wire of the three alloys are generally available in sizes up to a maximum of 0.188 in. [5 mm] thick and 1.250 in. [32 mm] wide.

1.1.2 Round wire from Copper Alloy UNS No. C51000 is generally available in sizes up to 0.500 in. [13 mm] in diameter.

1.2 *Units*—Values stated in either inch-pound units or in SI units are to be regarded separately as standard. Within the text, the 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 specification.

1.3 Additional requirements for these products are established in Specification B250/B250M, see Section 3.

1.4 *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.*

NOTE 1—It is to be understood that this specification is general. Since the product is used for many applications where the requirements of the operations used are too particular to be specified by any of the ordinary mechanical tests, it is frequently advisable to submit samples or drawings to the manufacturer and secure an adjustment of temper to suit the actual application for which the product is intended.

NOTE 2—Product in rod, bar and shape form is produced to Specification B139/B139M.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B139/B139M Specification for Phosphor Bronze Rod, Bar, and Shapes

B250/B250M Specification for General Requirements for Wrought Copper Alloy Wire

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

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E290 Test Methods for Bend Testing of Material for Ductility

E478 Test Methods for Chemical Analysis of Copper Alloys

3. General Requirements

3.1 The following sections of Specification B250/B250M are 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,
3.1.8 Significance of Numerical Limits,
3.1.9 Inspection,
3.1.10 Rejection and Rehearing,
3.1.11 Certification,
3.1.12 Mill Test Reports,
3.1.13 Packaging and Package Markings, and
3.1.14 Supplementary Requirements.

3.2 In addition, when a section with a title identical to one of those referenced in 3.1 appears in this specification, it

[1] 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, 2011. Published November 2011. Originally approved in 1941. Last previous edition approved in 2005 as B159 – 05. DOI: 10.1520/B0159_B0159M-11.

[2] 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.

[3] 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**

contains additional requirements which supplement those appearing in Specification B250/B250M.

4. Terminology

4.1 *Definitions of Terms Specific to This Standard:*

4.1.1 *Cast, n*—The maximum diameter of coiled wire when one complete circumference rests completely on a flat surface as a table, workbench, or floor.

4.1.2 *Camber Offset, n*—The axial component of curvature of wire in an unrestrained state.

NOTE—The camber is measured as the offset in the ends of one turn of freely hanging wire.

4.2 For other definitions of terms related to copper and copper alloys, refer to Terminology B846.

5. Ordering Information

5.1 Include the following information when placing orders for product under this specification.

5.1.1 ASTM designation and year of issue (for example, B159/B159M – XX),

5.1.2 Copper Alloy UNS No. (for example, C51000),

5.1.3 Temper designation (Section 8),

5.1.4 Dimensions (diameter, distance between parallel surfaces, and so forth),

5.1.5 Type of edge (square corners, rounded corners, and so forth),

5.1.6 How furnished (coil spool, reel, specific lengths, and so forth), and

5.1.7 When product is purchased for agencies of the U.S. government (Section 11).

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

5.2.1 Heat identification or traceability details,

5.2.2 Certification,

5.2.3 Mill Test Reports,

5.2.4 Special packaging and package markings,

5.2.5 Cast and camber offset requirements if specified.

6. Materials and Manufacture

6.1 *Materials:*

6.1.1 The material of manufacturer shall be a casting billet of Copper Alloy UNS No. C51000, C52100, or C52400 of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.1.2 In the event heat identification or traceability is required, the purchaser shall specify the details desired.

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.

7. Chemical Composition

7.1 The material shall conform to the chemical composition requirements of Table 1 for the Copper Alloy UNS No. specified in the ordering information.

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

TABLE 1 Chemical Requirements

Copper Alloy UNS No.	C51000	C52100	C52400
	Composition, %		
Copper, incl silver	remainder	remainder	remainder
Lead, max	0.05	0.05	0.05
Iron, max	0.10	0.10	0.10
Tin	4.2–5.8	7.0–9.0	9.0–11.0
Zinc, max	0.30	0.20	0.20
Phosphorus	0.03–0.35	0.03–0.35	0.03–0.35

7.2 Copper listed as the "remainder" is the difference between the sum of results for all elements determined and 100 %.

7.3 When all elements listed in Table 1are determined, the sum of results shall be 99.5 % min.

8. Temper

8.1 Tempers, as defined in Classification B601, available under this specification are O61 (annealed), H01 (¼ hard), H02 (½ hard), H03 (¾ hard), H04 (hard), H06 (extra hard), H08 (spring), and H10 (extra spring).

8.1.1 Tempers not covered by this specification shall be by agreement between purchaser and supplier.

NOTE 3—The purchaser shall confer with the supplier for availability of product in specific alloy, temper, form, and size.

9. Mechanical Property Requirements

9.1 *Tensile Strength Requirements :*

9.1.1 When tested in accordance with Test Methods E8/E8M:

9.1.1.1 Round and square wire for general application produced from Copper Alloy UNS Nos. C51000, C52100, and C52400 shall conform to the requirements prescribed in Table 2.

9.1.1.2 Round or square wire produced from Copper Alloy UNS No. C51000 in H08 (spring) temper shall conform to the requirements prescribed in Table 3.

TABLE 2 Mechanical Requirements for Round or Square Wire for General Purposes

Temper		Tensile Strength, ksi [Mpa][A]		
Standard	Name	Copper Alloy UNS No.		
		C51000	C52100	C52400
O61	annealed	48.0–63.0 [330–435]	53.0–68.0 [365–470]	60.0–75.0 [415–515]
H01	quarter-hard	60.0–76.0 [415–525]	74.0–91.0 [510–625]	83.0–102.0 [570–705]
H02	half-hard	80.0–97.0 [550–670]	95.0–115.0 [655–795]	108.0–129.0 [745–890]
H03	three-quarter-hard	96.0–115.0 [660–795]	113.0–135.0 [780–930]	125.0–148.0 [860–1020]
H04	hard	108.0–128.0 [745–885]	125.0–150.0 [860–1035]	135.0–160.0 [930–1105]
H08	spring	see Table 3	...	...

[A] ksi = 1000 psi.

TABLE 3 Mechanical Requirements for H08 (Spring Temper) UNS No. C51000 Round or Square Wire

Diameter or Distance Between Parallel Surfaces, in. [mm]	Tensile Strength, min, ksi [Mpa][A]	Elongation in 2 in. [50 mm] min, %
0.025 [0.60] and under	145.0 [1000]	...
Over 0.025 to 0.0625 [0.060 to 1.6]	135.0 [930]	...
Over 0.0625 to 0.125 [1.6 to 3.0]	130.0 [895]	...
Over 0.125 to 0.250 [3.0 to 6.0]	125.0 [860]	...
Over 0.250 to 0.375 [6.0 to 10]	120.0 [825]	5.0
Over 0.375 to 0.500 [10 to 16], incl	105.0 [725]	9.0

[A]ksi = 1000 psi.

9.1.1.3 Rectangular wire produced from Copper Alloy UNS Nos. C51000, C52100, and C52400 shall conform to the requirements prescribed in Table 4.

10. Performance Requirements

10.1 *Bending Requirements:*

10.1.1 Wire in sizes up to 0.250 in. [7 mm] inclusive produced from Copper Alloy UNS No. C51000 shall withstand being bent cold (room temperature) through an angle of 120° on a radius equal to the diameter or distance between parallel surfaces in accordance with Test Method E290. When so bent, tempers H08 and H10 shall not develop cracks or other flaws visible to the unaided eye on the outside surface of the bend.

TABLE 4 Mechanical Requirements for Flat Wire (Other Than Square Wire)

Temper		Tensile Strength, ksi[A]		
Standard	Name	Copper Alloy UNS No.		
		C51000	C52100	C52400
O61	annealed	43–58 [295–400]	53–67 [365–460]	58–73 [400–505]
H02	half-hard	58–73 [400–505]	69–84 [475–580]	76–91 [525–625]
H04	hard	76–91 [525–625]	85–100 [585–690]	94–109 [650–750]
H06	extra hard	88–103 [605–710]	97–112 [670–770]	107–122 [740–840]
H08	spring	95–110 [655–760]	105–119 [725–820]	115–129 [795–890]
H10	extra spring	100–114 [690–785]	116–122 [800–840]	120–133 [825–915]

[A]ksi = 1000 psi.

10.1.2 Other formability requirements, when specified, shall be as agreed upon between purchaser and supplier.

11. Purchases for U.S. Government

11.1 Product purchased for agencies of the U.S. government shall conform to the additional requirements prescribed in the Supplementary Requirements section of Specification B250/B250M (see Section 11).

12. Dimensions, Mass, and Permissible Variations

12.1 The dimensions and tolerances for product produced to this specification shall be as specified in the following tables and related paragraphs or specified titles found in Specification B250/B250M:

12.1.1 *Diameter or Distance Between Parallel Surfaces*—Table 2.

12.1.1.1 *Thickness*—Table 4.

12.1.1.2 *Width*—Table 6.

12.1.1.3 *Length (Flat Wire Product)*—Tables 7 and 8.

12.1.1.4 *Straightness (Flat Wire Product)*— Table 9.

12.1.1.5 *Edge Contours*—Edge Contour section.

12.1.1.6 *Corner Radius*—Figure 4.

13. Cast and Camber Offset

13.1 When specified, the requirements and method shall be as agreed upon between purchaser and supplier.

14. Test Methods

14.1 *Chemical Analysis:*

14.1.1 Product composition shall, in case of dispute, be determined as follows:

Element	Test Methods
Copper	E478
Phosphorus	E62
Lead	E478 (AA)
Iron	E478
Zinc	E478 (Titrimetric)
Tin	E478

14.1.2 Test method(s) to be followed for the determination of elements required by contractual or purchase order agreement shall be as agreed upon between the supplier and the purchaser.

15. Keywords

15.1 phosphor bronze alloy wire; UNS No. C51000 wire; UNS No. C52100 wire; UNS No. C52400 wire

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B159 – 05) that may impact the use of this standard. (Approved Oct. 1, 2011.)

(1) Minor editing throughout.
(2) As noted some of the Metric Values were changed in Table 2, 3 and 4.
(3) Changed tensile range values for O61 temper for C51000 to 48.0-63.0 ksi.
(4) Added definition of "cast" and "camber offset" to Terminology sections.
(5) Added option of specifying "Cast" and "Camber Offset" to Sections 5 and 12.