



Designation: ~~B2 – 12~~^{ε1} B2 – 13

Standard Specification for Medium-Hard-Drawn Copper Wire¹

This standard is issued under the fixed designation B2; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—Footnote 3 was editorially updated in February 2013.

1. Scope

1.1 This specification covers medium-hard-drawn round copper wire for electrical purposes (see Explanatory **Note 1**).

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.2.1 ~~Exception—The SI values of density and resistivity~~For density, resistivity and temperature, the values stated in SI units are to be regarded as standard.

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 The following documents of the issue in effect on date of material purchase ~~at the time of reference~~ form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards*:²

~~B5 Specification for High Conductivity Tough-Pitch Copper Refinery Shapes~~

~~B49 Specification for Copper Rod Drawing Stock for Electrical Purposes~~

~~B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes~~

~~B193 Test Method for Resistivity of Electrical Conductor Materials~~

~~B258 Specification for Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors~~

2.3 ~~Other Documents~~Documents:³

~~NBS Handbook 100 Copper Wire Tables of the National Bureau of Standards~~³

3. Ordering Information

3.1 Orders for material under this specification ~~should~~shall include the following information:

3.1.1 Quantity of each size;

3.1.2 Wire size: diameter in inches (see ~~5.4.3~~ and **Table 1**);

3.1.3 Type of copper, if special (see **Section 4**);

3.1.4 Package size (see ~~H.10.1~~);

3.1.5 Special package marking, if required; and

3.1.6 Place of inspection (**Section 4.7**).

¹ This specification is under the jurisdiction of ASTM Committee **B01** on Electrical Conductors and is the direct responsibility of Subcommittee **B01.04** on Conductors of Copper and Copper Alloys.

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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 Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

TABLE 1 Tensile Requirements

Diameter		Area at 20°C		Tensile Strength				Elongation, min, %in-% in 10-in. (250 mm)
in.	mm	cmil	in. ²	mm ²	psi		MPa	
					Min	Max	Min Max	
0.4600	11.684	211 600	0.1662	107.0	42 000	49 000	290 340	3.8
0.4096	10.404	167 800	0.1318	85.0	43 000	50 000	295 345	3.6
0.3648	9.266	133 100	0.1045	67.4	44 000	51 000	305 350	3.2
0.3249	8.252	105 600	0.08291	53.5	45 000	52 000	310 360	3.0
0.2893	7.348	83 690	0.06573	42.4	46 000	53 000	315 365	2.8
0.2576	6.543	66 360	0.05212	33.6	47 000	54 000	325 370	2.5
0.2294	5.827	52 620	0.04133	26.7	48 000	55 000	330 380	2.2
0.2043	5.189	41 740	0.03278	21.2	48 330	55 330	335 380	1.9
0.1819	4.620	33 090	0.02599	16.8	48 660	55 660	335 385	1.7
0.1620	4.115	26 240	0.02061	13.3	49 000	56 000	340 385	1.5
0.1443	3.665	20 820	0.01635	10.5	49 330	56 330	340 390	1.4
0.1285	3.264	16 510	0.01297	8.37	49 660	56 660	340 390	1.3
0.1144	2.906	13 090	0.01028	6.63	50 000	57 000	345 395	1.3
0.1019	2.588	10 380	0.00816	5.26	50 330	57 330	345 395	1.2
0.0907	2.304	8 230	0.00646	4.17	50 660	57 600	350 400	1.2
0.0808	2.052	6 530	0.00513	3.31	51 000	58 000	350 400	1.1
0.0720	1.829	5 180	0.00407	2.63	51 330	58 330	355 400	1.1
0.0641	1.628	4 110	0.00323	2.08	51 660	58 660	355 405	1.0
0.0571	1.450	3 260	0.00256	1.65	52 000	59 000	360 405	1.0
0.0508	1.290	2 580	0.00203	1.31	52 330	59 330	360 410	1.0
0.0453	1.151	2 050	0.00161	1.04	52 660	59 660	365 410	1.0
0.0403	1.024	1 620	0.00128	0.823	53 000	60 000	365 415	1.0

4. Materials and Manufacture

4.1 The material shall be copper of such quality and purity that the finished product shall have the properties and characteristics prescribed in this specification.

NOTE 1—Specifications [B5](#), [B49](#), and [B170](#) define the materials copper suitable for use.

4.2 Copper bars of special qualities, forms, or types, as may be agreed upon between the manufacturer and the purchaser, and which will conform to the requirements prescribed in this specification, may also be used.

5. Dimensions and Permissible Variations

5.1 The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.0001 in. (0.1 mil) or in millimetres to the nearest 0.001 mm (Explanatory [Note 2](#)).

5.2 Within the range of diameters included in [Table 1](#) the wire shall not vary from the specified diameter by more than $\pm 1\%$, expressed to the nearest 0.0001 in. (0.1 mil) 0.001 mm.

5.3 Ten percent, but not less than five coils or spools (or all if the lot is less than five) from any lot of wire shall be gaged at three places. If accessible, one gaging shall be taken near each end and one near the middle. If any of the selected coils or spools fails to conform to the requirements prescribed in [5.2](#), all coils or spools shall be gaged in the manner specified.

5. General Requirements (see [Section 8](#))

5.1 *Tensile Strength and Elongation*—The wire shall conform to the requirements as to tensile properties prescribed in [Table 1](#) (Explanatory [Note 3](#) and [Note 4](#)). For wire whose nominal diameter is more than 0.001 in. (0.025 mm) greater than a size listed in [Table 1](#), but which is less than that of the next larger size, the requirements of the next larger size shall apply.

5.1.1 Tests on a specimen containing a joint shall show at least 95 % of the minimum tensile strength given in [Table 1](#). Elongation tests shall not be made on a specimen containing a joint.

5.2 *Resistivity*—Electrical resistivity at 20°C shall not exceed the following values (see Explanatory [Note 5](#)):

Nominal Diameter, in.	Resistivity at 20°C,	
	Ω -lb/mile ²	Ω -g/m ²
0.460 to 0.325 (11.684 to 8.255 mm), incl	896.15	0.15694
Under 0.325 to 0.0403 (8.255 to 1.024 mm), incl	905.44	0.15857

5.3 *Dimensions and Permissible Variations*—Within the range of diameters included in [Table 1](#) the wire shall not vary from the specified diameter by more than $\pm 1\%$, expressed to the nearest 0.0001 in. (0.001 mm) (see Explanatory [Note 2](#)).

5.4 *Joints*—No joints shall be made in the completed wire (Explanatory [Note 7](#)). Joints in wire and rods, prior to final drawing, shall be made in accordance with the best commercial practice and shall conform to the requirements prescribed in [5.1](#).

5.5 *Finish*—The wire shall be free of all imperfections not consistent with the best commercial practice.

6. Workmanship, Finish, and Appearance

6.1 The wire shall be free from all imperfections not consistent with the best commercial practice.

6. Test Methods

6.1 Tensile Strength and Elongation:

6.1.1 Obtain the tensile strength, expressed in pounds per square inch, by dividing the maximum load carried by the specimen during the tension test, by the original cross-sectional area of the specimen. Tensile strength and elongation may be determined simultaneously on the same specimen (see Explanatory Note 4).

6.1.2 Determine the elongation of the wire as the permanent increase in length due to the breaking of the wire in tension, measured between gage marks placed originally 10 in. (250 mm) apart upon the test specimen.

6.1.3 If any part of the fracture takes place outside the gage marks or in the jaws of the testing machine, or if an examination of the specimen indicates a flaw, the value obtained may not be representative of the material. In such cases the test may be discarded and a new test made.

6.2 Resistivity—Determine the electrical resistivity of the material in accordance with Test Method B193 (see Explanatory Note 5). The purchaser may accept certification that the wire was drawn from rod stock meeting the International Standard for Annealed Copper instead of resistivity tests on the finished wire.

6.3 Dimensional Measurements—Dimensional measurements shall be made with a micrometer caliper equipped with a vernier graduated in 0.0001 in. (0.0025 mm). Measurements shall be made on at least three places on each unit selected for this test. If accessible, one measurement shall be taken on each end and one near the middle. The average of the three measurements shall determine compliance with the requirements.

6.4 Surface Finish—Make a surface-finish inspection with the unaided eye (normal spectacles accepted).

7. Tensile Properties

7.1 The wire shall conform to the requirements as to tensile properties prescribed in Table 1 (Explanatory Note 3 and Note 4).

7.2 Tests on a specimen containing a joint shall show at least 95 % of the minimum tensile strength given in Table 1. Elongation tests shall not be made on a specimen containing a joint.

7.3 For wire the nominal diameter of which is more than 0.001 in. (1 mil) (0.025 mm) greater than a size listed in Table 1, but which is less than that of the next larger size, the requirements of the next larger size shall apply.

7.4 Determine the elongation of the wire as the permanent increase in length due to the breaking of the wire in tension, measured between gage marks placed originally 10 in. (254 mm) apart upon the test specimen (Explanatory Note 4).

7.5 If any part of the fracture takes place outside the gage marks or in the jaws of the testing machine, or if an examination of the specimen indicates a flaw, the value obtained may not be representative of the material. In such cases the test may be discarded and a new test made.

7.6 Retests—If, upon testing a sample from any coil or spool of wire, the results do not conform to the requirements prescribed in Table 1, two additional samples shall be tested and the average of the three tests shall determine the acceptance or rejection of the coil or spool.

8. Resistivity

8.1 Electrical resistivity shall be determined on representative samples by resistance measurements (Explanatory Note 5 and Note 6). At a temperature of 20°C the resistivity shall not exceed the following values:

Nominal Diameter, in.	Ω -lb/mile ²	Resistivity at 20°C,	Ω -g/m ²
0.460 to 0.325 (11.684 to 8.255 mm), incl	896.15		0.15694
Under 0.325 to 0.0403 (8.255 to 1.024 mm), incl	905.44		0.15857

8.2 Tests to determine conformance to the electrical resistance requirements shall be made in accordance with Test Method B193.

9. Joints

9.1 No joints shall be made in the completed wire (Explanatory Note 7). Joints in wire and rods, prior to final drawing, shall be made in accordance with the best commercial practice and shall conform to the requirements prescribed in 7.2.

7. Inspection

10.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified (Explanatory Note 8).

10.2 All inspections and tests shall be made at the place of manufacture unless otherwise especially agreed to between the manufacturer and the purchaser at the time of the purchase.