



Designation: ~~B3—01 (Reapproved 2007)~~ B3 – 12

Standard Specification for Soft or Annealed Copper Wire¹

This standard is issued under the fixed designation B3; 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 drawn and annealed or soft round bare copper wire for electrical purposes (see Explanatory [Note 1](#)).

1.2 The values stated in inch-pound or SI units are to be regarded separately as standard. Each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the specification. For conductor sizes designated by AWG or kcmil sizes, the requirements in SI units are numerically converted from the corresponding requirements in inch-pound units. For conductor sizes designation by AWG or kcmil, the requirements in SI units have been numerically converted from corresponding values stated or derived in inch-pound units. For conductor sizes designated by SI units only, the requirements are stated or derived in SI units 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*—For density, resistivity and temperature, the values stated in SI units are to be regarded as standard.

2. Referenced Documents

2.1 The following documents of the issue in effect at the time of reference form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards*:²

[B49 Specification for Copper Rod Drawing Stock for Electrical Purposes](#)

[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 *National Institute of Standards and Technology*: [ASTM B3-12](#)

[NBS Handbook 100—Copper Wire Tables](#)³

3. Ordering Information

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

3.1.1 Quantity of each size,

3.1.2 Wire size: diameter in inches (see [5.4](#) and [Table 1](#)),

3.1.3 Type of copper, if special (Section [4](#)),

3.1.4 Package size (see [10.1](#)),

3.1.5 Special package marking, if required, and

3.1.6 Place of inspection (see [9.1](#)).

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.

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 the National Technical Information Service, 5285 Port Royal Rd, Springfield, VA 22161.

TABLE 1 Tensile Requirements

in.	Diameter		Area at 20°C		Elongation in 10 in. (254 mm), % min
	mm	cmils	in. ²	mm ²	
0.4600	11.684	211 600	0.1662	107.0	35
0.4096	10.404	167 800	0.1318	85.0	35
0.3648	9.266	133 100	0.1045	67.4	35
0.3249	8.252	105 600	0.08291	53.5	35
0.2893	7.348	83 690	0.06573	42.4	30
0.2576	6.543	66 360	0.05212	33.6	30
0.2294	5.827	52 620	0.04133	26.7	30
0.2043	5.189	41 740	0.03278	21.2	30
0.1819	4.620	33 090	0.02599	16.8	30
0.1620	4.115	26 240	0.02061	13.3	30
0.1443	3.665	20 820	0.01635	10.5	30
0.1285	3.264	16 510	0.01297	8.37	30
0.1144	2.906	13 090	0.01028	6.63	30
0.1019	2.588	10 380	0.008155	5.26	25
0.0907	2.304	8 230	0.00646	4.17	25
0.0808	2.052	6 530	0.00513	3.31	25
0.0720	1.829	5 180	0.00407	2.63	25
0.0641	1.628	4 110	0.00323	2.08	25
0.0571	1.450	3 260	0.00256	1.65	25
0.0508	1.290	2 580	0.00203	1.31	25
0.0453	1.151	2 050	0.00161	1.04	25
0.0403	1.024	1 620	0.00128	0.823	25
0.0359	0.912	1 290	0.00101	0.654	25
0.0320	0.813	1 020	0.000804	0.517	25
0.0285	0.724	812	0.000638	0.411	25
0.0253	0.643	640	0.000503	0.324	25
0.0226	0.574	511	0.000401	0.259	25
0.0201	0.511	404	0.000317	0.205	20
0.0179	0.455	320	0.000252	0.162	20
0.0159	0.404	253	0.000199	0.128	20
0.0142	0.361	202	0.000158	0.102	20
0.0126	0.320	159	0.000125	0.081	20
0.0113	0.287	128	0.000100	0.065	20
0.0100	0.254	100	0.0000785	0.051	15
0.0089	0.226	79.2	0.0000622	0.040	15
0.0080	0.203	64.0	0.0000503	0.032	15
0.0071	0.180	50.4	0.0000396	0.026	15
0.0063	0.160	39.7	0.0000312	0.020	15
0.0056	0.142	31.4	0.0000246	0.016	15
0.0050	0.127	25.0	0.0000196	0.013	15
0.0045	0.114	20.2	0.0000159	0.010	15
0.0040	0.102	16.0	0.0000126	0.0081	15
0.0035	0.089	12.2	0.00000962	0.0062	15
0.0031	0.079	9.61	0.00000755	0.0049	15

NOTE 1—The following standards define the materials suitable for use: Specification B49.

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. General Requirements (see Section 7)

5.1 *Tensile Strength and Elongation*—The wire shall conform to the requirements for elongation prescribed in Table 1 (see Explanatory Note 2). No requirements for tensile strength are specified. For wire whose nominal diameter is more than 0.001 in. (0.025 mm) greater than a size listed in Table 1, but less than that of the next larger size, the requirements of the next larger size shall apply.

5.2 *Joints*—Necessary joints in the completed wire and in the wire and rods prior to final drawing shall be made in accordance with the best commercial practice.

5.3 *Resistivity*—The electrical resistivity at 20°C shall not exceed 875.20 ·lb/mile² (0.15328 ·g/m²).

5.4 *Dimensions and Permissible Variations*—The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.0001 in. (0.001 mm) (0.0025 mm) (or 0.001 mm) (see Explanatory Note 3). For diameters under 0.0100 in. (0.254 mm), the wire shall not vary from the specified diameter by more than plus and minus 0.0001 in. (0.0025 mm), and for diameters of 0.0100 in. (0.254 mm) and over the wire shall not vary from the specified diameter by more than plus and minus 1 %, expressed to the nearest 0.0001 in. (0.001 mm).

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

6. Test Methods

6.1 *Tensile Strength and Elongation*—No test for tensile strength shall be required.

6.1.1 The elongation of wire with a nominal diameter greater than 0.0808 in. (2.052 mm) shall be determined as the permanent increase in length due to the breaking of the wire in tension (see Explanatory Note 4). The elongation shall be measured between gage marks placed originally 10 in. (242 mm) apart upon the test specimen and expressed in percent of the original length.

6.1.2 Determine the elongation of wire whose nominal diameter is larger than 0.0808 in. (2.052 mm) in diameter as the permanent increase in length, expressed in percent of the original 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 (see Explanatory Note 4). The elongation of wire whose nominal diameter is equal to or less than 0.0808 in. (2.052/2.053 mm) and under may be determined as described above or by measurements made between the jaws of the testing machine. When the latter method is used, measurements are made between the jaws, the zero length shall be the distance between the jaws at the start of the tension test and be as near 10 in. (254 mm) as practicable, and the practicable. The final length shall be the distance between the jaws at the time of rupture. The fracture shall be between gage marks in the case of specimens so marked or between the or jaws of the testing machine machine, depending on method used, and not closer than 1 in. (25.4 mm) to either gage mark or either jaw.

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 stock meeting the International Standard for Annealed Copper instead of resistivity tests on the finished wire.

6.3 *Dimensional Measurements*—Make dimensional measurements with a micrometer caliper equipped with a vernier graduated in 0.0001 in. (0.001 mm). Take measurements on at least three places on each unit selected for this test. If accessible, take one measurement 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 acceptable).

7. Conformance Criteria (see Explanatory Note 6)

7.1 Any lot of wire, the samples of which comply with the conformance criteria of this section, shall be considered as complying with the requirements of Section 5. Individual production units that fail to meet one or more of the requirements shall be rejected. Failure of a sample group from a lot to meet one or more of the following criteria shall constitute cause for rejection of the lot. The conformance criteria for each of the prescribed properties given in Section 5 are as follows:

7.1.1 *Elongation*—The lot shall be considered conforming if the average elongation of the four specimens is not less than the appropriate elongation value in Table 1 plus 2.5 percentage points; however any individual production unit, the specimen from which has an elongation less than the appropriate elongation value in Table 1, shall be rejected.

7.1.1.1 The lot shall be considered to have failed to meet the elongation conformance criterion if the average of the four specimens is less than the elongation in Table 1 plus 2.5 percentage points and elongation of any of the individual specimens is less than the value in Table 1.

7.1.1.2 If the average of the four specimens is less than the elongation in Table 1 plus 2.5 percentage points and the elongation of each of the individual specimens is equal to or more than the value in Table 1, six additional specimens from six production units, other than the four originally sampled shall be tested. The lot shall be considered conforming if the elongation of each of the ten specimens is not less than the appropriate elongation value in Table 1, and the average of the ten specimens is not less than that value plus 2.5 percentage points. The lot shall be considered to have failed to meet the elongation requirement if any of the ten specimens is less than the appropriate elongation value in Table 1 or if the average of the ten specimens is less than that value plus 2.5 percentage points.

7.1.2 *Resistivity*—The electrical resistivity of each of the four specimens shall conform to the requirements of 5.3. Failure to meet these requirements shall constitute failure to meet the resistivity conformance criterion.

7.1.3 *Dimensions*—The dimensions of the first sample (Table 2) shall conform to the requirements of 5.4. If there are no failures,

TABLE 2 Sampling for Dimensional Measurements

Number of Units in Lot	First Sample		Second Sample		
	Number of Units in Sample, n_1	Allowable Number of Defects in First Sample, c_1	Number of Units in Sample, n_2	n_1 plus n_2	Allowable Number of Defects in Both Samples, c_2
1 to 30, incl	all	0
15 to 50, incl	14	0
51 to 100, incl	19	0	23	42	1
101 to 200, incl	24	0	46	70	2
201 to 400, incl	29	0	76	105	3
401 to 800, incl	33	0	112	145	4
Over 800	34	0	116	150	4