



Designation: B 3 – 01

Standard Specification for Soft or Annealed Copper Wire¹

This standard is issued under the fixed designation B 3; 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.

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.

1.2.1 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*:

B 49 Specification for Copper Redraw Rod for Electrical Purposes²

B 193 Test Method for Resistivity of Electrical Conductor Materials³

B 258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors³

2.3 *National Institute of Standards and Technology*:

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

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² *Annual Book of ASTM Standards*, Vol 02.01.

³ *Annual Book of ASTM Standards*, Vol 02.03.

*NBS Handbook 100—Copper Wire Tables*⁴

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.

NOTE 1—The following standards define the materials suitable for use: Specification B 49.

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 20°C shall not exceed 875.20 $\Omega \cdot \text{lb}/\text{mile}^2$ (0.15328 $\Omega \cdot \text{g}/\text{m}^2$).

⁴ Available from the National Technical Information Service, 5285 Port Royal Rd, Springfield, VA 22161.

TABLE 1 Tensile Requirements

| Diameter | | | Area at 20°C | | Elongation in 10 in. (254 mm), % min |
|----------|--------|---------|------------------|-----------------|---|
| in. | 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 |

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) (see Explanatory Note 3). For diameters under 0.0100 in. (0.2540 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. 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 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 0.0808 in. (2.052 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, 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 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 jaws of the testing machine 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 B 193 (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.