



Designation: B1 – 01(Reapproved 2007)

## Standard Specification for Hard-Drawn Copper Wire<sup>1</sup>

This standard is issued under the fixed designation B1; 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 covers hard-drawn round copper wire for electrical purposes.

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 designated 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 *ASTM Standards:*<sup>2</sup>

**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

2.2 *National Institute of Standards and Technology: NBS Handbook 100—Copper Wire Tables*<sup>3</sup>

<sup>1</sup> 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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<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> Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

### 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 (5.4 and Table 1),

3.1.3 Type of copper, if special (Section 4),

3.1.4 Whether certification of resistivity of rod stock is acceptable instead of resistivity tests on the finished wire (6.2),

3.1.5 Package size (8.1),

3.1.6 Special package marking, if required, and

3.1.7 Place of inspection (7.1).

### 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—Specification B49 defines the materials suitable for use.

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

5.1 *Tensile Strength and Elongation*—The wire shall conform to the requirements as to tensile strength and elongation prescribed in Table 1 (see Explanatory Note 1 and Note 2). For wire whose nominal diameter is more than 0.001 in. (1 mil) (0.025 mm) greater than a size listed in Table 1 and less than that of the next larger size, the requirements of the next larger size shall apply.

5.2 *Joints*—No joints shall be made in the completed wire (see Explanatory Note 3). Joints in the wire and rods made prior to final drawing shall be in accordance with the best commercial practice. Tests on a specimen containing a joint shall show at least 95% of the tensile strength given in Table 1. Elongation tests shall not be made on a specimen containing a joint.

5.3 *Resistivity*—The electrical resistivity at 20°C shall not exceed the following values:

| Nominal Diameter, in.       | Resistivity at 20°C,<br>$\Omega$ -lb/mile <sup>2</sup> |
|-----------------------------|--|
| 0.460 to 0.325, incl        | 900.77   |
| Under 0.325 to 0.0403, incl | 910.15   |
| Nominal Diameter, in.       | Resistivity at 20°C,<br>$\Omega$ -g/m <sup>2</sup>     |
| 11.68 to 8.25, incl         | 0.15775  |
| Under 8.25 to 1.02, incl    | 0.15940  |

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**TABLE 1 Tensile Properties**

| Diameter <sup>A</sup> |        | Area at 20°C |                  | Nominal Tensile Strength <sup>B</sup> (see Explanatory Note 2) |        | Nominal Elongation,% <sup>B</sup> |                    |
|-----------------------|--------|--------------|------------------|--|--------|-----------------------------------|--------------------|
| in.                   | mm     | cmil         | in. <sup>2</sup> | mm <sup>2</sup>  | psi    | MPa                               | in 10 in. (250 mm) |
| 0.4600                | 11.684 | 211 600      | 0.1662           | 107.0  | 49 000 | 340                               | 3.8                |
| 0.4096                | 10.464 | 167 800      | 0.1318           | 85.0   | 51 000 | 350                               | 3.3                |
| 0.3648                | 9.266  | 133 100      | 0.1045           | 67.4   | 52 800 | 365                               | 2.8                |
| 0.3249                | 8.252  | 105 600      | 0.08291          | 53.5   | 54 500 | 375                               | 2.4                |
| 0.2893                | 7.348  | 83 690       | 0.06573          | 42.4   | 56 100 | 385                               | 2.2                |
| 0.2576                | 6.543  | 66 360       | 0.05213          | 33.6   | 57 600 | 395                               | 2.0                |
| 0.2294                | 5.827  | 52 620       | 0.04133          | 26.7   | 59 000 | 405                               | 1.8                |
| 0.2043                | 5.189  | 41 740       | 0.03278          | 21.2   | 60 100 | 415                               | 1.7                |
| 0.1819                | 4.620  | 33 090       | 0.02599          | 16.8   | 61 200 | 420                               | 1.6                |
| 0.1650*               | 4.191  | 27 220       | 0.02138          | 13.8   | 62 000 | 425                               | 1.5                |
| 0.1620                | 4.115  | 26 240       | 0.02061          | 13.3   | 62 100 | 430                               | 1.4                |
| 0.1443                | 3.665  | 20 820       | 0.01635          | 10.5   | 63 000 | 435                               | 1.3                |
| 0.1340*               | 3.404  | 17 960       | 0.01410          | 9.10   | 63 400 | 435                               | 1.3                |
| 0.1285                | 3.264  | 16 510       | 0.01297          | 8.37   | 63 700 | 440                               | 1.3                |
| 0.1144                | 2.906  | 13 090       | 0.01028          | 6.63   | 64 300 | 445                               | 1.2                |
| 0.1040*               | 2.642  | 10 820       | 0.008495         | 5.48   | 64 800 | 445                               | 1.2                |
| 0.1019                | 2.588  | 10 380       | 0.008155         | 5.26   | 64 900 | 445                               | 1.2                |
| 0.0920*               | 2.387  | 8 460        | 0.00665          | 4.29   | 65 400 | 450                               | 1.1                |
| 0.0907                | 2.304  | 8 230        | 0.00646          | 4.17   | 65 400 | 450                               | 1.1                |
| 0.0808                | 2.052  | 6 530        | 0.00513          | 3.31   | 65 700 | 455                               | 1.1                |
| 0.0800*               | 2.032  | 6 400        | 0.00503          | 3.24   | 65 700 | 455                               | 1.1                |
| 0.0720                | 1.829  | 5 180        | 0.00407          | 2.63   | 65 900 | 455                               | 1.1                |
| 0.0650*               | 1.651  | 4 220        | 0.00332          | 2.14   | 66 200 | 455                               | 1.0                |
| 0.0641                | 1.628  | 4 110        | 0.00323          | 2.08   | 66 200 | 455                               | 1.0                |
| 0.0571                | 1.450  | 3 260        | 0.00256          | 1.65   | 66 400 | 460                               | 1.0                |
| 0.0508                | 1.290  | 2 580        | 0.00203          | 1.31   | 66 600 | 460                               | 1.0                |
| 0.0453                | 1.151  | 2 050        | 0.00161          | 1.04   | 66 800 | 460                               | 1.0                |
| 0.0403                | 1.024  | 1 620        | 0.00128          | 0.823  | 67 000 | 460                               | 1.0                |

<sup>A</sup> The diameters marked by asterisks (\*) are often employed by purchasers for communication lines, but are not in the American Wire Gage (B & S Wire Gage) series, as are the other diameters listed (see Explanatory Note 4).

<sup>B</sup> These values are subject to the requirements of conformance criteria in Section 8 in determining acceptability of wire under this specification. They are intended to be used as the “minimum values” in design and in all dependent specifications.

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**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. (or 0.001 mm) (see Explanatory Note 4). Within the range of diameters given in Table 1, the wire shall not vary from the specified diameter by more than plus and minus 1 %, expressed to the nearest 0.0001 in. (or 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 :

**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.

**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 (see Explanatory Note 5).

**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 6). 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 equipment capable of measuring to a graduation of 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 accepted).

## 7. Inspection

**7.1 General** (see Explanatory Note 7)—Unless otherwise specified in the contract or purchaser order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

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

**7.1.2** The manufacturer shall afford the inspector representing the purchaser all reasonable manufacturer’s facilities to