



Designation: B246 – 15 (Reapproved 2021)

Standard Specification for Tinned Hard-Drawn and Medium-Hard-Drawn Copper Wire for Electrical Purposes¹

This standard is issued under the fixed designation B246; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers tinned hard-drawn and medium-hard-drawn round copper wire for electrical purposes.

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*—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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For hazard statement, see Sections 10 and 13.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase 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 for Electrical Purposes](#)

[B170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes](#)

[B193 Test Method for Resistivity of Electrical Conductor Materials](#)

2.3 *National Bureau of Standards*:³

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

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 [5.1](#) and [Table 1](#)),

3.1.3 Type of copper, if special (see [4.2](#)),

3.1.4 Temper (see [7.1](#) and [Table 1](#)),

3.1.5 Package size (see [18.1](#)),

3.1.6 Special package marking, if required, and

3.1.7 Place of inspection (Section [16](#)).

4. Materials

4.1 The tinned wire shall be made by coating hard-drawn and medium-hard-drawn copper wire with commercially pure tin (see [Note 1](#)). For purposes of this specification, the tin shall be considered commercially pure if the total of other elements, exclusive of copper, does not exceed 1 %. Notwithstanding the previous sentence, chemical analysis of the tin coating or of the tin used for coating shall not be required under this specification. Adequacy of the tin coating is ensured by the continuity of coating and adherence of coating requirements (Sections [9](#) and [13](#), respectively).

4.2 The copper 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 copper suitable for use.

4.3 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.

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 Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, <http://www.ntis.gov>.

TABLE 1 Tensile Requirements

| Diameter | | | | | Tinned Hard-Drawn Wire | | | Tinned Medium-Hard-Drawn Wire | | | | |
|---------------|-------|--------|------------------|-----------------|------------------------|-------|--------------------------------------|-------------------------------|--------|--------------------------------------|-------|-----|
| | | | | | Tensile Strength, min | | Elongation in 10 in. (250 mm), % min | Tensile Strength, min | | Elongation in 10 in. (250 mm), % min | | |
| in. | mm | cmil | in. ² | mm ² | psi | Mpa | | psi | Mpa | | | |
| Area at 20 °C | | | | | | | | | | | | |
| | | | | | | | min | max | min | max | | |
| 0.2043 | 5.189 | 41 738 | 0.03278 | 21.15 | 54 100 | 370.6 | 1.7 | 42 400 | 55 300 | 290.4 | 378.8 | 1.9 |
| 0.1819 | 4.620 | 33 088 | 0.02599 | 16.77 | 55 100 | 377.4 | 1.6 | 43 300 | 55 700 | 296.6 | 381.5 | 1.7 |
| 0.1620 | 4.115 | 26 244 | 0.02061 | 13.30 | 55 900 | 382.9 | 1.4 | 44 100 | 56 000 | 302.1 | 383.6 | 1.5 |
| 0.1443 | 3.665 | 20 822 | 0.01635 | 10.55 | 56 700 | 388.4 | 1.3 | 44 900 | 56 300 | 307.6 | 385.6 | 1.4 |
| 0.1285 | 3.264 | 16 512 | 0.01297 | 8.367 | 57 300 | 392.5 | 1.3 | 45 500 | 56 700 | 311.7 | 388.4 | 1.3 |
| 0.1144 | 2.906 | 13 087 | 0.01028 | 6.632 | 57 900 | 396.6 | 1.2 | 46 000 | 57 000 | 315.1 | 390.4 | 1.3 |
| 0.1019 | 2.588 | 10 384 | 0.008155 | 5.262 | 58 400 | 400.0 | 1.2 | 46 500 | 57 300 | 318.5 | 392.5 | 1.2 |
| 0.0907 | 2.304 | 8226 | 0.006461 | 4.1684 | 58 900 | 403.5 | 1.1 | 46 900 | 57 700 | 321.3 | 395.2 | 1.2 |
| 0.0808 | 2.052 | 6529 | 0.005128 | 3.308 | 59 100 | 404.8 | 1.1 | 47 200 | 58 000 | 323.3 | 397.3 | 1.1 |
| 0.0720 | 1.829 | 5184 | 0.004072 | 2.627 | 59 300 | 406.2 | 1.1 | 47 300 | 58 300 | 324.0 | 399.3 | 1.1 |
| 0.0641 | 1.628 | 4109 | 0.003227 | 2.082 | 59 600 | 408.2 | 1.0 | 47 600 | 58 700 | 326.1 | 402.1 | 1.0 |
| 0.0571 | 1.450 | 3260 | 0.002561 | 1.652 | 59 800 | 409.6 | 1.0 | 47 800 | 59 000 | 327.4 | 404.1 | 1.0 |
| 0.0508 | 1.290 | 2581 | 0.002027 | 1.308 | 59 900 | 410.3 | 1.0 | 47 900 | 59 300 | 328.1 | 406.2 | 1.0 |

5. Dimensions, Mass, and Permissible Variations

5.1 The wire sizes shall be expressed as the diameter of the coated wire in decimal fractions of an inch to the nearest 0.0001 in. (0.001 mm) (Explanatory Note 5).

5.2 The coated wire shall not vary from the specified diameter by more than +3 % or –1 %.

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 taken near each end and one near the middle. If any of these 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.

6. Workmanship, Finish, and Appearance

6.1 The tin coating shall consist of a smooth continuous layer, firmly adhering to the surface of the copper.

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

7. Tensile Properties

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

7.2 For wire the nominal diameter of which 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.

7.3 Tension tests shall be made on representative samples. 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 (Explanatory Note 2).

7.4 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.

7.5 Retests—If upon testing a specimen from any coil or spool of wire, the results do not conform to the requirements prescribed in Table 1, two additional specimens 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 specimens by resistance measurements made in accordance with Test Method B193. At a temperature of 20 °C the resistivity of coated wire shall not exceed the values prescribed in Table 2 (Explanatory Note 3).

9. Continuity of Coating

9.1 The continuity of coating on the wire shall be determined on representative samples taken before stranding or insulating (Explanatory Note 4).

TABLE 2 Electrical Resistivity Requirements

| Nominal Diameter | | Resistivity at 20 °C | | | |
|-----------------------------|------------------------|----------------------|-------------|------------------|-------------|
| | | lb/mile ² | | g/m ² | |
| in. | mm | Hard | Medium-Hard | Hard | Medium-Hard |
| 0.2043 to 0.103, incl | 5.2 to 2.6, incl | 943.92 | 938.85 | 0.1653 | 0.1644 |
| Under 0.103 to 0.0508, incl | Under 2.6 to 1.3, incl | 910.15 | 946.06 | 0.1594 | 0.1657 |

9.2 The continuity of the tin coating shall be determined by the sodium polysulfide test, which shall be applied as specified in Sections 10 – 12.

10. Specimens for Coating Tests

10.1 *Length of Specimens*—Test specimens shall each have a length of about 6 in. They shall be tagged or marked to correspond with the coil, spool, or reel from which they were cut.

10.2 *Treatment of Specimens*—The specimens shall be thoroughly cleaned by immersion in a suitable solvent for the appropriate time required to remove oil or grease from surface; then removed and wiped dry with a clean soft cloth (**Warning**—see Explanatory Note 6). The specimens thus cleaned shall be kept wrapped in a clean, dry cloth until tested. That part of the specimen to be immersed in the test solution shall not be handled. Care shall be taken to avoid abrasion by the cut ends.

11. Special Solutions Required

11.1 *Hydrochloric Acid Solution* (sp gr 1.088)—Commercial HCl (sp gr 1.12) shall be diluted with distilled water to a specific gravity of 1.088 measured at 15.6 °C. A portion of HCl solution having a volume of 180 mL shall be considered to be exhausted when the number of test specimens prescribed in Table 3 of a size as indicated in Section 12 have been immersed in it for two cycles.

11.2 *Sodium Polysulfide Solution* (sp gr 1.142)—A concentrated solution shall be made by dissolving sodium sulfide cp crystals in distilled water until the solution is saturated at about 21 °C, and adding sufficient flowers of sulfur (in excess of 250 g/L of solution) to provide complete saturation as evidenced by the presence in the solution of an excess of sulfur after the solution has been allowed to stand for at least 24 h. The test solution shall be made by diluting a portion of the concentrated solution with distilled water to a specific gravity of 1.142 at 15.6 °C. The sodium polysulfide test solution shall have sufficient strength to blacken thoroughly a piece of clean untinned copper wire in 5 s. A portion of the test solution used for testing samples shall not be considered to be exhausted until it fails to blacken a piece of clean copper as described here (Explanatory Note 6).

12. Procedure for Coating Continuity Test

12.1 *Immersion of Specimens*—Immerse a length of at least 4½ in. from each of the clean specimens, in accordance with the following cycles, in test solutions maintained at a temperature between 15.6 and 21 °C:

12.1.1 Immerse the specimen for 1 min in the HCl solution described in 11.1, wash, and wipe dry.

12.1.2 Immerse the specimen for 30 s in the sodium polysulfide solution described in 11.2, wash, and wipe dry.

12.1.3 Immerse the specimen for 1 min in HCl solution described in 11.1, wash, and wipe dry.

12.1.4 Immerse the specimen for 30 s in the sodium polysulfide solution described in 11.2, wash, and wipe dry.

12.2 *Washing Specimens*—After each immersion, immediately wash thoroughly the specimens in clean water and wipe dry with a clean, soft cloth.

12.3 *Examination of Specimens*—After the operations described in 12.1 and 12.2, examine the specimens to ascertain if copper exposed through openings in the tin coating has been blackened by action of the sodium polysulfide. The specimens shall be considered to have failed if by such blackening exposed copper is revealed. Pay no attention to blackening within 0.5 in. of the cut end.

13. Mechanical Test for Adhesion of Coating

13.1 *Length of Specimens*—Test specimens shall be approximately 12 in. in length and shall be tagged or marked to correspond with the coil, spool, or reel from which they are cut.

13.2 *Preparation of Specimen*—Thoroughly clean the specimens, if required, by immersion in a suitable solvent for the appropriate time required to remove oil and grease from surface, then remove and dry (**Warning**—Explanatory Note 6). Store the specimens thus cleaned wrapped in a clean, dry cloth until tested. Do not handle that part of the specimens to be immersed in the test solution. Use care to avoid abrasion of the surface to be subjected to test.

13.3 *Wrapping Procedure*—Slowly wrap the test specimen in a suitable manner in an open helix around a polished mandrel having rounded ends and a diameter equal to four times the diameter of the specimens. Use care not to stretch the specimen during the wrapping operation. Make the spacing of the consecutive turns approximately equal to the diameter of the wire. Do not use more than three turns for the test.

13.4 *Immersion Test*—Remove the helically wrapped portion of the test specimen from the mandrel and completely immerse in the sodium polysulfide solution (see 11.2) for 30 s at the temperature in accordance with 12.1. On removal from the sodium polysulfide solution, rinse the specimen immediately in clean water and remove the excess by shaking.

13.5 *Examination of Specimen*—Examine visually the outer peripheral surface of the helically wrapped portion of the specimen. Any cracking or parting of the coating in this area

TABLE 3 Limiting Number of Test Specimens for Coating Tests

| Nominal Diameter | | Maximum Number of Specimens to Be Tested for Two Cycles in 180 mL of Acid Solution |
|------------------------------|------------------------|--|
| in. | mm | |
| 0.2043 to 0.141, incl | 5.2 to 3.6, incl | 2 |
| Under 0.141 to 0.0851, incl | Under 3.6 to 2.2, incl | 4 |
| Under 0.0851 to 0.0508, incl | Under 2.2 to 1.3, incl | 6 |