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Standard Specification for Copper-Clad Steel Electrical Conductor for Tracer Wire Applications¹

This standard is issued under the fixed designation B1010/B1010M; 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.

1. Scope

1.1 This specification covers bare round 21 % conductivity copper-clad steel wire for the center conductor in tracer wire, also known as locating wire.

1.2 Two grades of copper-clad steel wire are covered as follows:

1.2.1 21EHS: *Nominal 21 % Conductivity Extra High Strength*

1.2.2 21EHS-A: *Nominal 21 % Conductivity Extra High Strength-Annealed*

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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.*

1.5 *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 *ASTM Standards:*²

B193 Test Method for Resistivity of Electrical Conductor Materials

¹ This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.06 on Bi-Metallic Conductors.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E8/E8M Test Methods for Tension Testing of Metallic Materials

2.2 *NIST Standards:*³

NBS Handbook 100 Copper Wire Tables

3. Terminology

3.1 *Definitions:*

3.1.1 *lot*—any amount of wire of one class and size presented for acceptance at one time, such amount, however, not to exceed 10 000 lb [4500 kg].

3.1.1.1 *Discussion*—A lot should comprise of material taken from a product regularly meeting the requirements of this specification. Inspection of individual lots of less than 500 lb [230 kg] of wire cannot be justified economically. For small lots of 500 lb [230 kg] or less, the purchaser may agree to the manufacturer's regular inspection of the product as a whole as evidence of acceptability of such small lots.

3.1.2 *sample*—a quantity of production units (coils, reels, etc.) selected at random from the lot for the purpose of determining conformance of the lot to the requirements of this specification.

3.1.3 *specimen*—a length of wire removed for test purposes from any individual production unit of the sample.

4. Ordering Information

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

4.1.1 Quantity of each size and grade,

4.1.2 Wire size, diameter in inches (**Table 1**),

4.1.3 Packaging and shipping (Section 16),

4.1.4 If inspection is required (Section 15).

5. Materials and Manufacture

5.1 The wire shall consist of a core of homogeneous open-hearth, electric-furnace, or basic oxygen steel with a continuous outer cladding of high conductivity oxygen free copper thoroughly bonded to the core throughout, and shall be of such quality as to meet the requirements of this specification (**Note 1**).

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 Properties of Tracer Wire

Diameter		Cross-Sectional Area at 20 °C			Breaking Strength, lbf [N] ^{A, B}	
in.	mm	cmil	in. ²	mm ²	21EHS-A, minimum	21EHS, minimum
0.1285	3.264	16 512	0.01297	8.367	868.9 [3865]	2 594 [11 540]
0.1019	2.588	10 384	0.008155	5.261	546.4 [2431]	1 631 [7 255]
0.08080	2.052	6 529	0.005128	3.308	343.5 [1528]	1 026 [4 562]
0.06408	1.628	4 106	0.003225	2.081	216.2 [961.8]	645.4 [2 871]
0.05082	1.291	2 583	0.002028	1.309	135.8 [604.1]	405.4 [1 803]
0.04030	1.024	1 624	0.001276	0.8229	85.46 [380.2]	255.1 [1 135]
0.03589	0.912	1 288	0.001012	0.6527	67.82 [301.7]	202.4 [900.5]
0.03196	0.8118	1 021	0.0008022	0.5176	53.88 [239.7]	160.8 [715.5]
0.02846	0.7229	810	0.0006362	0.4104	42.74 [190.1]	127.6 [567.5]
0.02535	0.6439	643	0.0005047	0.3256	33.68 [149.8]	100.5 [447.2]
0.02257	0.5733	509	0.0004001	0.2581	26.88 [119.6]	80.23 [356.9]
0.02010	0.5105	404	0.0003173	0.2047	21.26 [94.57]	63.46 [282.3]

^A Metric equivalents: 1 lbf = 4.448 N.

^B Breaking strengths are calculated using the nominal wire diameter.

NOTE 1—The copper-clad steel wire provides a high-strength conductor for use in wire and cable where greater strength is required and a lower conductivity can be tolerated. At high frequencies the reduced conductivity is less pronounced due to concentration of the current in the outer periphery of the wire.

6. Physical Properties

6.1 For all wire diameters specified in Table 1, a surface finish inspection shall be made with the unaided eye (normal spectacles excepted).

6.2 The wire, when tested in accordance with 9.3, shall be free from pits, slivers, exposed steel, or other imperfections not consistent with good commercial practice.

7. Tensile and Elongation

7.1 Tensile Strength:

7.1.1 The tensile strength for the 21EHS-A product shall be no less than 67 000 psi [461.95 MPa].

7.1.2 The tensile strength for the 21EHS product shall be no less than 200 000 psi [1378.95 MPa].

7.2 Elongation:

7.2.1 Grade 21EHS-A products shall have an elongation no less than 15 % minimum.

7.2.2 Grade 21EHS products shall have an elongation no less than 1 % minimum.

8. Resistivity

8.1 The electrical resistivity at a temperature of 20 °C shall not exceed 54.58 Ω·cmil/ft [0.0907 Ω·mm²/m]. See Test Method B193 for calculating electrical resistivity.

9. Other Requirements

9.1 *Adhesion and Other Defects*—The copper-clad steel wire, when tested in accordance with 13.4 and 13.5, shall not reveal any seams, pits, slivers, or other imperfection of sufficient magnitude to indicate inherent defects or imperfections. Examination of the wire at the break or after reverse torsion with the unaided eye (normal spectacles excepted) shall show no separation of copper from the steel.

9.2 *Joints*—Necessary joints in the wire and rods prior to final drawing shall be made in accordance with good commercial practice. The finished wire shall contain no joints or splices made at finished size.

9.3 *Finish*—The wire shall be free from copper discontinuities and all imperfections not consistent with good commercial practice or agreed upon by the manufacturer and the purchaser.

9.4 *Copper Thickness*—The minimum copper thickness, tested in accordance with 13.7, shall not be less than 1.5 % of the wire diameter or 0.015 times the diameter at any point around the circumference of the wire.

10. Dimensions, Mass, and Permissible Variations

10.1 The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.0001 in. [0.003 mm]. The wire shall not vary from the specified diameter by more than ±1 %, expressed to the nearest 0.0001 in. [0.003 mm].

11. Workmanship, Finish, and Appearance

11.1 For wire diameters of 0.0808 in. [2.053 mm] and larger, surface finish inspection shall be made with the unaided eye (normal spectacles excepted), and for wire diameters smaller than 0.0808 in. [2.053 mm], surface finish inspection shall be made at a magnification not to exceed 10×.

12. Sampling

12.1 The number of production units in a sample shall be as follows:

12.1.1 For tensile strength, elongation, resistivity, and adhesion and other defects, the sample shall consist of four production units. Failure of a specimen tested for tensile strength, elongation, resistivity, or adhesion and other defects shall be considered nonconforming to this specification. For surface finish the sampling shall be in accordance with Table 3. From each unit, one test specimen of sufficient length shall be removed for the performance of the required tests.

12.1.2 For dimensional measurements, the sample shall consist of a quantity of production units shown in Table 2 under heading “First Sample.”