



Standard Specification for Annealed Copper-Clad Steel Wire¹

This standard is issued under the fixed designation B 910/B 910M; 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 copper-clad steel for the following applications: electrical, electronic, grounding, telecommunications, and other applications.

1.2 Four conductivities are covered as follows: 21, 30, 40, and 70 %.

1.3 Temper is designated as annealed.

1.4 The values stated in inch-pound or SI units are to be regarded separately as the standard. Each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. For conductor sizes designated by AWG, 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.

1.5 The following precautionary statement pertains to the test method portion only, Section 7, of this specification: *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 and health practices and determine the applicability of regulatory limitations prior to use.*

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*:

B 193 Test Method for Resistivity of Electrical Conductor Materials²

B 258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors²

2.3 *NIST Document*:

NBS Handbook 100 - Copper Wire Tables³

3. Ordering Information

3.1 Orders for material under this specification shall include

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

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² *Annual Book of ASTM Standards*, Vol 02.03.

³ Available from the National Institute of Standards and Technology (NIST), Gaithersburg, MD 20899.

the following information:

3.1.1 Quantity of each size;

3.1.2 Wire size: diameter in inches (see 5.2);

3.1.3 Conductivity (see Table 1);

3.1.4 Wire to be used for redraw or not;

3.1.5 Packaging and shipping (see 10);

3.1.6 Place of inspection (see 6.1).

4. Material

4.1 The wire shall consist of a core of homogeneous open-hearth, electric-furnace, or basic-oxygen steel with a continuous outer cladding of copper thoroughly bonded to the core throughout and shall be of such quality as to meet the requirements of this specification.

5. General Requirements

5.1 *Tensile Strength and Elongation*—The copper-clad steel wire shall conform to the tensile strength requirements of Table 2. Because there are many carbon steel and copper thickness combinations available, the desired tensile strength should be agreed upon between the purchaser and manufacturer prior to placing an order. The elongation shall be 15.0 % minimum for all diameters listed in 5.2.

5.2 *Dimensions*—The wire size range for this specification shall be from 0.0253 (0.643 mm) to 0.2294 in. (5.827 mm) diameter (see Note 1).

5.2.1 *Permissible Variations*—The wire sizes shall meet the following tolerances:

5.2.1.1 For diameters 0.1000 in. (2.54 mm) and over, the wire shall not vary from the specified diameter by more than $\pm 1\frac{1}{2}\%$, expressed to the nearest 0.0001 in. (0.003 mm).

5.2.1.2 For diameters under 0.1000 in. (2.54 mm) and above 0.0253 in. (0.643 mm), the wire shall not vary from the specified diameter by more than $\pm 1\%$, expressed to the nearest 0.0001 in. (0.003 mm).

NOTE 1—The values of the wire diameters in 5.2 are given to the nearest 0.0001 in. (0.003 mm) and correspond to the standard sizes given in Specification B 258. The use of gage numbers to specify wire sizes is not recognized in this specification because of the possibility of confusion. An excellent discussion of wire gages and related subjects is contained in *NBS Handbook 100*.

5.3 *Adhesion and Surface Defects*—The copper-clad steel wire, when tested in accordance with 7.4, shall not reveal any seams, pits, slivers, or other imperfection of sufficient magnitude to indicate inherent defects or imperfections. Examination

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TABLE 1 Density (nom.) and Resistivity, (max.), at 20°C (Nominal Conductivity, Minimum Conductivity, and Nominal Density for Reference Only)

Nominal Conductivity (% IACS)	Nominal Density		Maximum Resistivity at 20°C		Minimum Conductivity (% IACS)
	lb/in ³	(g/cm ³)	Ohm cmil/ft	(ohm mm ² /m)	
21	0.2881	(7.98)	54.58	(0.097408)	19.00
30	0.2908	(8.06)	35.26	(0.058616)	29.41
40	0.2941	(8.15)	26.45	(0.043970)	39.21
70	0.3101	(8.58)	15.96	(0.026524)	65.00

TABLE 2 Tensile and Minimum Copper Thickness (Conductivity and Nominal Copper Thickness for Reference Only)

Nominal Conductivity (% IACS)	Minimum Tensile Strength		Minimum Copper Thickness	Nominal Copper Thickness
	psi	(N/mm ²)	(% of Diameter)	(% of Diameter)
21	55 000	(379)	1.5	3
30	50 000	(345)	3.0	7
40	45 000	(310)	5.0	9
70	35 000	(241)	15.0	20

of the wire at the break with the unaided eye (normal spectacles excepted) shall show no separation of copper from the steel.

5.4 *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.

5.5 *Finish*—The wire shall be free from copper discontinuities and all imperfections not consistent with good commercial practice (see 7.5).

5.6 *Copper Thickness*—The minimum copper thickness due to eccentricity shall not be less than shown in Table 2.

5.7 *Resistivity*—The electrical resistivity at a temperature of 20°C shall not exceed the values prescribed in Table 1. See Note 2 for calculating electrical resistance.

NOTE 2—Relationships which may be useful in connection with the values of electrical resistivity prescribed in this specification are shown in Table 2. Resistivity units are based on the International Annealed Copper Standard (IACS) adopted by IEC in 1913, which is 1/58 S·mm²/m at 20°C for 100 % conductivity. The value of 0.017241 S·mm²/m and the value of 0.15328 S·g/m² at 20°C are respectively the international equivalent of volume and weight resistivity of annealed copper equal to 100 % conductivity. The latter term means that a copper wire 1 in. in length and weighing 1 g would have a resistance of 0.15328 S. This is equivalent to a resistivity value of 875.20S·lb/mile², which signifies the resistance of a copper wire 1 mile in length weighing 1 lb. It is also equivalent, for example, to 1.7241 :S/cm of length of a copper bar 1 cm² in cross section. A complete discussion of this subject is contained in *NBS Handbook 100*. The use of five significant figures in expressing resistivity does not imply the need for greater accuracy of measurement than that specified in Test Method B 193. The use of five significant figures is required for complete reversible conversion from one set of resistivity units to another.

6. Inspection

6.1 *General*—All tests and inspections shall be made at the place of manufacture unless otherwise agreed upon between the manufacturer and the purchaser at the time of the purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification (Note 3).

NOTE 3—Cumulative results secured on the product of a single manufacturer, indicating continued conformance to the criteria, are necessary to ensure an over-all product meeting the requirements of this specification. The sample sizes and conformance criteria given for the various characteristics are applicable only to lots produced under these conditions.

6.1.1 Unless otherwise agreed by the manufacturer and the purchaser, conformance of the wire to the various requirements listed in Section 5 shall be determined on samples taken from each lot of wire presented for acceptance.

6.1.2 The manufacturer shall, if requested prior to inspection, certify that all wire in the lot was made under such conditions that the product as a whole conforms to the requirements of this specification as determined by regularly made and recorded tests.

6.2 Definitions:

6.2.1 *lot*—any amount of wire of one class and size presented for acceptance at one time, such amount, however, not to exceed 40 000 lb (18 144 kg) (Note 4).

NOTE 4—A lot should comprise 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.

6.2.2 *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.

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

6.3 *Sample Size*—The number of production units in a sample (see Note 3) shall be as follows:

6.3.1 For tensile strength, elongation, resistivity, adhesion, and other defects, the sample shall consist of four production units. 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. Samples found defective shall not be used.

7. Test Methods

7.1 *Tensile Strength and Elongation*—Obtain the tensile strength, expressed in pounds per square inch (or kilograms-force per square millimetre), 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.

7.1.1 The elongation of wire may be determined as the permanent increase in length, expressed in percent of the

TABLE 3 Sampling for Surface Finish and Packaging Inspection

Number of Units in Lot	Number of Units in Sample, <i>n</i>	Allowable No. of Defective Units, <i>c</i>
1 to 30, incl	All	0
31 to 50, incl	30	0
51 to 100, incl	37	0
101 to 200, incl	40	0
201 to 300, incl	70	1
301 to 500, incl	100	2
501 to 800, incl	130	3
Over 800	155	4