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Standard Specification for Aluminum-Clad Steel Core Wire for Use in Overhead Electrical Aluminum Conductors[1]

This standard is issued under the fixed designation B502/B502M; 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 round, aluminum-clad steel core wire with two designations of tensile strengths, AW2 (Normal Strength) and AW3 (High Strength).

1.2 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.

1.2.1 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.

1.3 *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 date of material purchase form a part of this specification to the extent referenced herein.

2.2 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

E8 Test Methods for Tension Testing of Metallic Materials

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 6.1),

3.1.3 Core Wire Strength, AW2 (Normal Strength) or AW3 (High Strength) (see Table 1 and Table 2),

3.1.4 Package size: (see 17.1),

3.1.5 Special packaging and package marking if required (see 16.1), and

3.1.6 Place of inspection if other than place of manufacture (see 14.1).

4. Materials and Manufacture

4.1 The base metal shall be steel produced by the open-hearth, electric-furnace, or basic-oxygen process and shall be of such composition that the finished clad wire shall have the properties and characteristics prescribed in this specification.

4.2 The aluminum used for cladding shall have a purity and quantity sufficient to meet thickness and resistance requirements of this specification (see 7.1 and 9.1).

5. Tensile Properties

5.1 *Requirements*—The aluminum-clad steel core wire shall conform to the tensile requirements prescribed in Table 1 and Table 2. Purchasers of core intended for use in conductor constructions with annealed aluminum wires, such as ACSS/AW3, ACSS/TW/AW3 may request the stranded steel core be compliant only with ultimate tensile strength and may waive compliance with the 1 % extension tensile requirement. This use of the ultimate tensile requirement as an alternate to the 1 % extension requirement shall be by agreement between the purchaser and producer and shall be noted on product compliance documentation. In computing stress at 1 % extension and ultimate tensile strength, the actual diameter of the finished wire shall be used.

5.2 *Elongation Test*—The elongation shall be determined by an extensometer suitable for measuring elongation in 10.0 in. [250 mm] and equipped with a vernier or other instrument reading to 0.001 in. [0.025 mm]. It shall be attached to the test specimen at a load equal to the initial tensile stress shown in Table 3 and Table 4. At this load the extensometer shall be

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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.

TABLE 1 Tensile Requirements for Normal Strength (AW2) For ACSR/AW2, ACSR/TW/AW2 and ACSS/AW2, ACSR/TW/AW2 Type Conductors

Nominal Diameter, in. [mm]	Stress at 1.0 % Extension min, psi (MPa)	Ultimate Tensile Strength, min, psi (MPa)	Elongation, min, %, 10 in. [250 mm]
0.0770 to 0.1289 [1.956 to 3.274], incl	175 000 (1206)	195 000 (1344)	1.5
0.1290 to 0.1369 [3.275 to 3.477], incl	170 000 (1172)	190 000 (1310)	1.5
0.1370 to 0.1443 [3.478 to 3.665], incl	165 000 (1137)	185 000 (1275)	1.5
0.1444 to 0.1549 [3.666 to 3.934], incl	160 000 (1103)	180 000 (1241)	1.5
0.1550 to 0.1620 [3.935 to 4.115], incl	160 000 (1103)	175 000 (1206)	1.5
0.1621 to 0.1729 [4.116 to 4.392], incl	155 000 (1068)	170 000 (1172)	1.5
0.1730 to 0.1819 [4.393 to 4.620], incl	150 000 (1034)	165 000 (1137)	1.5
0.1820 to 0.1880 [4.621 to 4.775], incl	145 000 (1000)	160 000 (1103)	1.5

TABLE 2 Tensile Requirements for High Strength (AW3) For ACSS/AW3 and ACSS/TW/AW3 Type Conductors

Nominal Diameter, in. [mm]	Stress at 1.0 % Extension min, psi (MPa)	Ultimate Tensile Strength, min, psi (MPa)	Elongation, min, %, 10 in. [250 mm]
0.0770 to 0.0899 [1.956 to 2.283], incl	190 000 (1310)	210 000 (1450)	1.5
0.0900 to 0.1199 [2.284 to 3.045], incl	185 000 (1280)	205 000 (1410)	1.5
0.1200 to 0.1399 [3.046 to 3.553], incl	180 000 (1240)	200 000 (1380)	1.5
0.1400 to 0.1880 [3.554 to 4.775], incl	170 000 (1170)	195 000 (1340)	1.5

TABLE 3 Initial Settings for Determining at 1 % Extension for Normal Strength (AW2)

Nominal Diameter, in. [mm]	Initial Stress, psi (MPa)	Initial Setting of Extensometer, % in./in. [cm/cm]
0.0770 to 0.0999 [1.956 to 2.537], incl	11 800 (81)	0.0005 (0.05 % extension)
0.1000 to 0.1299 [2.538 to 3.299], incl	23 500 (162)	0.0010 (0.10 % extension)
0.1300 to 0.1880 [3.300 to 4.775], incl	35 300 (243)	0.0015 (0.15 % extension)

TABLE 4 Initial Settings for Determining at 1 % Extension for High Strength (AW3)

Nominal Diameter, in. [mm]	Initial Stress, psi (MPa)	Initial Setting of Extensometer, % in./in. [cm/cm]
0.0770 to 0.0899 [1.96 to 2.283], incl	14 000 (100)	0.0005 (0.05 % extension)
0.0900 to 0.1199 [2.284 to 3.045], incl	28 000 (190)	0.0010 (0.10 % extension)
0.1200 to 0.1880 [3.046 to 4.775], incl	42 000 (290)	0.0015 (0.15 % extension)

adjusted to the initial setting shown in Table 3 and Table 4. Upon application of further load, the tension shall be read at an extensometer reading of 1.0 % to determine conformance with the requirement in Table 1 and Table 2. Further elongation shall be observed while applying a tension load to the specimen. The elongation thus determined shall be not less than 1.5 % in 10.0 in. [250 mm]. A test in which the extensometer reading is less than 1.5 % shall be disregarded if the fracture occurs less than 1.0 in. [25 mm] from either attachment. In this case, another specimen from the same reel or coil shall be tested.

5.3 The tension tests shall be made in accordance with Test Methods E8. The method for determining elongation is described in the Procedures Section of Test Methods E8.

6. Dimensions and Permissible Variations

6.1 The size shall be expressed by the wire diameter in decimals of an inch to the nearest 0.0001 in. [0.003 mm].

6.2 Within the range of diameters included in Table 5 the wire shall not vary from the nominal diameter by more than the amounts shown in this table. In computing permissible variations, diameters shall be rounded to the nearest 0.0001 in. [0.003 mm].

6.3 If accessible, one measurement shall be taken near each end and one near the middle of the coil or reel. In the case of reels, the center and one end may not be accessible and the prescribed measurement shall be taken along the length of the accessible material. If any of the selected coils or reels fail to conform to the requirements as prescribed in 6.2, all coils or reels shall be measured in the manner specified.

7. Thickness of Aluminum

7.1 The aluminum thickness at any point shall be not less than 10 % of the nominal wire radius. Measurements shall be read to the nearest 0.001 in. [0.03 mm]. In determining the required or measured thickness, fractions of 0.0005 in. [0.013 mm] or less shall be dropped and for fractions of greater than 0.0005 in. [0.013 mm], the next larger 0.001 in. [0.003 mm] shall be used.

7.2 Measurements shall be made by using suitable electrical indicating instruments operating on the permeameter principle, or by direct measurement. For referee purposes, direct measurement shall be used to determine aluminum thickness on specimens taken from the ends of the coils.

8. Density

8.1 For the purpose of calculating mass, cross sections, etc., the density of the wire shall be taken as 0.2381 lb/in.^{3} (6.590 g/cm^3) at 20°C.

9. Resistance

9.1 The electrical resistance of the wire shall be determined by resistance measurements and maximum allowable resistance shall be based on the nominal diameter of the wire and

TABLE 5 Wire Diameter Variations

Nominal Diameter, in. [mm]	Permissible Variations in Nominal Diameter,
0.0770 to 0.0999 [1.956 to 2.537], incl	0.0015 in. [0.038 mm]
0.1000 to 0.1880 [2.538 to 4.775], incl	1.5 %

the resistivity value of 51.01 Ω·cmil/ft [0.08480 Ω·mm^2/m] at 20°C. Electrical resistance is calculated by the following equations:

$$\text{Resistance } (\Omega/\text{ft}) = R/S \quad (1)$$

where:

R = resistivity, Ω·cmil/ft, and
S = nominal diameter, mils

or,

$$\text{Resistance } (\Omega/\text{m}) = R/C \quad (2)$$

where:

R = resistivity, Ω·mm^2/m, and
C = nomimal cross section, mm^2

9.2 When resistance measurements are made at temperatures other than 20°C, corrections shall be based on a temperature coefficient of resistance of 0.0036/°C (0.0020/°F).

9.3 Tests to determine conformance to the resistivity of 9.1 shall be made in accordance with Test Method B193.

10. Joints

10.1 There shall be no joints of any kind made in the finished wire.

10.2 Joints may be made in the rods or semifinished wires prior to drawing to final size. The finished wire at such joints shall meet the requirements of 7.1.

10.3 Welding equipment and procedure shall be such that it can be demonstrated that the ultimate tensile strength of a finished wire specimen containing the welded section shall be not less than the stress at 1.0 % extension as shown in Table 1 and Table 2.

10.4 A welded section, wherever encountered, shall not be required to meet the stress at 1 % extension, elongation, and torsion tests.

11. Finish

11.1 The surface of the wire shall be smooth and free from imperfections not consistent with good commercial practice.

12. Number of Tests

12.1 One test specimen shall be taken from each lot of ten coils as clad and drawn, before splitting into individual coils, and tested to determine compliance with Sections 5, 6, 7, 9, and 13.

13. Torsion Test

13.1 The wire shall withstand without fracture not less than 20 twists in a length equivalent to 100 times the nominal diameter of the wire. In this test, the specimen shall be gripped at its ends in vises, one of which shall be free to move longitudinally during the test. A small tensile load of approximately 15 lb [67 N] shall be applied to the specimen during testing. The specimen shall be twisted by rotating one of the vises at a rate of approximately 15 twists/min in the same direction until fracture occurs. The number of twists shall be indicated by a counter or other suitable device.

13.2 Specimens after twisting to destruction shall not reveal any seams, pits, slivers, or surface imperfections of sufficient magnitude to indicate inherent defects or imperfections in the wire. Examination of the wire at the break shall show no separation of the aluminum from the steel.

14. Inspection

14.1 Unless otherwise agreed upon, all tests and inspections shall be made at the place of manufacture. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities necessary to ensure that the material is being furnished in accordance with this specification.

15. Rejection

15.1 If the wire fails in the first test to meet any requirements of this specification, two additional tests for these requirements shall be made on specimens of wire from the same coil or reel. If failure occurs in either of these tests, the lot of wire shall be rejected. However, the lot may be resubmitted for inspection by testing every coil or reel for the requirement which caused the specimen to fail and sorting out the defective coils or reels.

16. Product Marking

16.1 A weather-resistant tag shall be attached to the outside of each coil or reel showing the manufacturer's name or trademark with the approximate length, net mass, and nominal size of wire. Each coil shall also have a tag inside the wrapping showing the manufacturer's name, the size, approximate length, and net mass. If additional information is required this shall be arranged with the manufacturer at the time of purchase.

17. Packaging and Shipping

17.1 Package size shall be agreed upon by the manufacturer and the purchaser in the placing of individual purchase orders.

17.2 The wire shall be protected against damage in ordinary handling and shipping.

18. Keywords

18.1 aluminum-clad steel core wire for aluminum conductors; aluminum-clad steel reinforced; aluminum-clad steel supported; ACSR; ACSR/TW; ACSS; ACSS/TW; clad steel core wire