



Designation: B 502—~~98~~ — 02

# Standard Specification for Aluminum-Clad Steel Core Wire for Aluminum Conductors, Aluminum-Clad Steel Reinforced<sup>1</sup>

This standard is issued under the fixed designation B 502; 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.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B1 B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.06 on Composite Conductors.

Current edition approved ~~March~~ Oct. 10, 1998; ~~2002~~. Published ~~September 1998~~; October 2002. Originally published as B 502 – 70. Last previous edition B 502 – ~~93~~ 8

## 1. Scope

1.1 This specification covers round, aluminum-clad steel core wire used for mechanical reinforcement in the manufacture of aluminum conductors, aluminum-clad steel reinforced.

1.2 The values stated in inch-pound or SI units are to be regarded separately as the standard. ~~The SI equivalents~~ 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 may be approximate only, the requirements are stated or derived in SI units.

## 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:*

B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>2</sup>

E 8 Test Methods ~~of~~ for Tension Testing of Metallic Materials<sup>3</sup>

## 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 Package size: (see 17.1),

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

3.1.5 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. 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 2. At this load the extensometer shall be adjusted to the initial setting shown in Table 2. Upon application of further load, the tension shall be read at an extensometer reading of 1.0 % to determine

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.01.

**TABLE 1 Tensile Requirements**

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 Initial Settings for Determining at 1 % Extension**

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)

conformance with the requirement in Table 1. 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 E 8. The method for determining elongation is described in the Procedures Section of Test Methods E 8.

## 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 3 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.

**TABLE 3 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 %

## 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.<sup>3</sup> (6.590 g/cm<sup>3</sup>) 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 the resistivity value of 51.01Ω·cmil/ft (0.08480 Ω·mm<sup>2</sup>/m) at 20°C. Electrical resistance is calculated by the following equations:

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

where:

$R$  = resistivity, r-c mil/ft, and

$S$  = nominal diameter, mils

or,

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

where:

$R$  = resistivity, r-mm<sup>2</sup>/m, and

$C$  = nominal cross section, mm<sup>2</sup>

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 B 193.

## 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.

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~~ 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; ASCR; clad steel core wire

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