Designation: B 416 – 98

Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors[1]

This standard is issued under the fixed designation B 416; 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 concentric-lay-stranded conductors made from bare, hard-drawn, round, aluminum-clad steel wires of 20.3 % conductivity for general use of electrical purposes. This specification does not apply to stranded conductors for reinforcement in ACSR conductors.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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 354 Terminology Relating to Uninsulated Metallic Electrical Conductors[2]

B 415 Specification for Hard-Drawn Aluminum-Clad Steel Wire[2]

2.3 *Other Documents:*

C8.1 Definitions and General Standards for Wires and Cables[3]

NBS *Handbook 100—Copper Wire Tables of the National Institute of Standards and Technology*[4]

3. Description of Conductor

3.1 The designation of the finished conductor shall be expressed as the number of wires and the diameter of these individual wires, usually expressed as the AWG size of the wires.

4. Ordering Information

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

4.1.1 Quantity of each size,

4.1.2 Conductor size expressed as number and AWG size of individual wires (Section 3 and Table 1),

4.1.3 Direction of lay of outer layer, if other than left-hand (see 6.3),

4.1.4 Package size (see 15.1),

4.1.5 Special package markings if required (see 15.3),

4.1.6 Special lagging if required (see 15.2), and

4.1.7 Place of inspection if other than place of manufacture (Section 13).

5. Joints

5.1 Joints or splices may be made in the finished individual aluminum-clad steel wires composing concentric-lay stranded conductors using more than three wires, provided that such joints or splices have a protection and electrical conductance equivalent to that of the wire itself and that they do not decrease the strength of the finished stranded conductor below the minimum breaking strength shown in Table 1. Such joints or splices shall be not closer than 50 ft (15 m) to any other joint in the same layer in the conductor.

NOTE 1—Joints are made by electrical butt-welding. The ends must be cut and the end of each wire must be straightened for a distance of 12 to 15 in. (300 to 380 mm). The proper sleeve is slipped over the end of one of the wires. The wires are then butt-welded and dressed off to a finished diameter equal to that of the wire. The weld area is then tempered, the sleeve centered over the weld area and compressed to provide a finished joint that is smooth and neat in appearance. This joint has a tensile strength of approximately 90 % of rated breaking strength of the wire, but an allowance is made for this in the rated strength of the conductor as a whole. The completed conductor when containing such joints is required to have the full rated strength.

6. Lay

6.1 For 3-wire conductors, the preferred lay is 16½ times the outside diameter, but the lay shall not be less than 14 times nor more than 20 times this diameter.

6.2 For 7, 19, and 37-wire conductors, the preferred lay is 13½ times the diameter of that layer, but the lay shall not be less than 10 nor more than 16 times this diameter.

6.3 The direction of lay of the outer layer shall be left-hand unless the direction of lay is specified otherwise by the purchaser.

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

Current edition approved March 10, 1998. Published September 1998. Originally published as B 416 – 64 T. Last previous edition B 416 – 93.

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

[3] Available from the American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

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

TABLE 1 Construction Requirements and Breaking Strength of Concentric-Lay Stranded Aluminum-Clad Steel Conductors[A]

Size Designation[B]	Number and Diameter of Individual Wires		Conductor Diameter, in.[C]	Rated Breaking Strength min, lb[D]
	Number	Nominal Diameter, in.		
37 No. 5 AWG	37	0.1819	1.27	142 800
37 No. 6 AWG	37	0.1620	1.13	120 200
37 No. 7 AWG	37	0.1443	1.01	100 700
37 No. 8 AWG	37	0.1285	0.899	84 200
37 No. 9 AWG	37	0.1144	0.801	66 770
37 No. 10 AWG	37	0.1019	0.713	52 950
19 No. 5 AWG	19	0.1819	0.910	73 350
19 No. 6 AWG	19	0.1620	0.810	61 700
19 No. 7 AWG	19	0.1443	0.721	51 730
19 No. 8 AWG	19	0.1285	0.642	43 240
19 No. 9 AWG	19	0.1144	0.572	34 290
19 No. 10 AWG	19	0.1019	0.509	27 190
7 No. 5 AWG	7	0.1819	0.546	27 030
7 No. 6 AWG	7	0.1620	0.486	22 730
7 No. 7 AWG	7	0.1443	0.433	19 060
7 No. 8 AWG	7	0.1285	0.385	15 930
7 No. 9 AWG	7	0.1144	0.343	12 630
7 No. 10 AWG	7	0.1019	0.306	10 020
7 No. 11 AWG	7	0.0907	0.272	7 945
7 No. 12 AWG	7	0.0808	0.242	6 301
3 No. 5 AWG	3	0.1819	0.392	12 230
3 No. 6 AWG	3	0.1620	0.349	10 280
3 No. 7 AWG	3	0.1443	0.311	8 621
3 No. 8 AWG	3	0.1285	0.277	7 206
3 No. 9 AWG	3	0.1144	0.247	5 715
3 No. 10 AWG	3	0.1019	0.220	4 532

[A] For metric equivalents: Diameter (mm)—multiply diameter in inches by 25.4 (round to 4 significant figures).
Breaking Strength (kg)—multiply breaking strength in pounds by 0.45359 (round to 4 significant figures).
[B] The designation is a combination of the number of wires each of the AWG size indicated by" No."
[C] Diameter of circumscribing circle. See Table 3 for complete table of properties.
[D] See Section 7.

6.4 The direction of lay shall be reversed in consecutive layers.

6.5 All wires in the conductor shall lie naturally in their true positions in the completed conductor. They shall tend to remain in position when the conductor is cut at any point and shall permit restranding by hand after being forcibly unraveled at the end of the conductor.

7. Strength of Conductor

7.1 The breaking strength of the completed conductors composed of 7 wires, 19 wires, and 37 wires shall be taken as 90 % of the sum of the breaking strengths of the aluminum-clad wires, calculated from their nominal diameter and the appropriate specified minimum tensile strength given in Table 1, Tensile Requirements, of Specification B 415 (20 % column only). The breaking strength of completed conductors composed of 3 wires shall be taken as 95 % of the sum of the breaking strengths of the aluminum-clad wires calculated in the same manner.

8. Construction

8.1 The number and diameter of the wires in the concentric-lay stranded conductors shall conform to the requirements prescribed in Table 1.

NOTE 2—For definitions of terms relating to conductors, reference should be made to ANSI C8.1 and Terminology B 354.

9. Physical and Electrical Tests

9.1 Tests for physical and electrical properties of wires composing concentric-lay stranded conductors made from aluminum-clad steel wire shall be made before stranding.

9.2 At the option of the purchaser, tension and elongation tests before stranding may be waived and the complete conductors may be tested as a unit. The breaking strength of the conductors so tested shall be not less than that required in Table 1.

9.3 Where breaking strength tests are required on the finished conductor, they shall be made on representative samples not less than 4 ft (1.25 m) in length. For lots of 10 000 lb (4540 kg) or less, two samples shall be taken from separate reels or coils in the lot except that but one sample shall be required where the total amount of conductor is 5000 ft (1525 m) or less. For quantities over 10 000 lb, one sample for each 10 000 lb or fraction thereof, shall be taken, but the minimum number of samples shall be three.

9.4 Specimens of the completed conductor shall be tested in a tension testing machine equipped with jaws suitable for gripping the conductor or equipped for holding properly socketed specimens. Any test in which the result is below the stated value, and which is obviously caused by improper socketing of the specimen or due to the break occurring in or at the gripping jaws of the machine, shall be disregarded and another sample from the same coil or reel shall be tested.

10. Density

10.1 For the purpose of calculating mass per unit length (see Note 4), cross-sections, etc., the density of the aluminum-clad steel wire shall be taken as 0.2381 lb/in.^{3}(6.590 g/cm^3) at 20°C (Note 3). Other constants are given in Table 2.

NOTE 3—The value of the density of aluminum-clad steel wire is an average value which has been found to be in accordance with usual values encountered in practice.

NOTE 4—The term mass per unit length is used in the specification as being more technically correct. It replaces the terms "weights" and "linear density".

11. Mass and Resistance

11.1 The mass and electrical resistance of a stranded conductor are greater than the total of the same characteristics of the wires composing the conductors, depending upon the lay or pitch. The standard increment of mass and resistance shall be taken as shown in Table 3.

11.2 In cases where the lay is definitely known, the increment may be calculated if desired.

NOTE 5—The increment of mass or electrical resistance of a completed concentric-lay stranded conductor, K, in percent is

$$K = 100\,(m - 1)$$

where m is the stranding factor, and is also the ratio of the mass or electrical resistance of a unit length of stranded conductor to that of a solid conductor of the same cross-sectional area or of a stranded conductor with infinite length of lay; that is, all wires parallel to the conductor axis. The stranding factor m for the completed, stranded conductor is the numerical average of the stranding factors for each of the individual wires in the