Designation: B 779 – 03

Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Steel-Reinforced (ACSR/TW)[1]

This standard is issued under the fixed designation B 779; 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 shaped wire compact concentric-lay-stranded aluminum conductor, steel-reinforced (ACSR/TW) and its component wires for use as overhead electrical conductors (Explanatory Note 1 and Note 2).

1.2 The values stated in inch-pound units are to be regarded as the standard with the exception of temperature, density, and resistivity. The SI equivalents of inch-pound units may be approximate.

NOTE 1—ACSR/TW is designed to increase the aluminum area for a given diameter of conductor by the use of trapezoidally shaped wires (TW). The conductors consist of a central core of round steel wire(s) surrounded by two or more layers of trapezoidal aluminum 1350-H19 wires. Different strandings of the same size of conductor are identified by type, which is the approximate ratio of steel area to aluminum area expressed in percent (Table 1, Table 2 and Table 3). For the purpose of this specification, the sizes listed in Table 1 and Table 2 are tabulated on the basis of the finished conductor having an area or outside diameter equal to that of specific sizes of standard ACSR so as to facilitate conductor selection.

NOTE 2—The aluminum and temper designations conform to ANSI Standard H 35.1. Aluminum 1350 corresponds to Unified Numbering System (UNS) A91350 in accordance with Practice E 527.

2. Referenced Documents

2.1 *ASTM Standards:*

B 230 Specification for Aluminum 1350-H19 Wire for Electrical Purposes[2]

B 232 Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACSR)[2]

B 263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors[2]

B 341 Specification for Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR/AZ)[2]

B 354 Terminology Relating to Uninsulated Metallic Electrical Conductors[2]

B 498 Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)[2]

B 500 Specification for Metallic Coated Stranded Steel Core for Aluminum Conductors, Steel Reinforced (ACSR)[2]

B 502 Specification for Aluminum-Clad Steel Core Wire for Aluminum Conductors, Aluminum-Clad Steel Reinforced[2]

B 549 Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced (ACSR/AW)[2]

B 606 Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum Alloy Conductors, Steel Reinforced[2]

B 802 Specification for Zinc-5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)[2]

B 803 Specification for High-Strength Zinc-5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[3]

E 527 Practice for Numbering Metals and Alloys (UNS)[4]

2.2 *Other Documents:*

ANSI H35.1 American National Standard Alloy and Temper Designation Systems for Aluminum[5]

NBS *Handbook 100—Copper Wire Tables of the National Bureau of Standards*[6]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 ACSR/TW covered by this specification has five types of coated core wire and one type of aluminum-clad core wire which are designated by abbreviations as follows (Explanatory Note 2):

3.1.1.1 *ACSR/TW/AW*—ACSR/TW using aluminum-clad steel wire (Specification B 502).

[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.07 on Conductors of Light Metals.

Current edition approved April 10, 2003. Published June 2003. Originally approved in 1987. Last previous edition approved in 1996 as B 779 – 96.

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

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 01.01.

[5] Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

[6] Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

TABLE 1 Construction Requirements for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Reinforced Size to Have Area Equal to ACSR, Class AA

ACSR/TW Conductor Size		Size and Stranding of ACSR with Equal Area		Number of Aluminum Wires	Number of Layers	Steel Core Stranding		Mass per Unit Length,[A] lb/1000 ft	Rated Strength, 1000 lb[B]	Nominal Outside Diameter, in.
kcmil	Type	kcmil	Stranding			Number of Wires	Diameter, in.			
336.4	6	336.4	18/1	14	2	1	0.1367	365	8.6	0.63
477.0	13	477.0	24/7	18	2	7	0.0940	613	17.2	0.78
477.0	16	477.0	26/7	18	2	7	0.1053	655	19.4	0.79
556.5	13	556.5	24/7	18	2	7	0.1015	715	20.0	0.84
556.5	16	556.5	26/7	20	2	7	0.1138	765	22.6	0.85
636.0	3	636.0	36/1	27	3	1	0.1329	646	13.5	0.85
636.0	13	636.0	24/7	18	2	7	0.1085	816	22.9	0.89
636.0	16	636.0	26/7	20	2	7	0.1216	874	25.4	0.91
795.0	7	795.0	45/7	17	2	7	0.0886	892	21.0	0.96
795.0	10	795.0	22/7	18	2	7	0.1108	975	25.9	0.98
795.0	13	795.0	54/7	20	2	7	0.1213	1021	28.2	0.99
795.0	16	795.0	26/7	20	2	7	0.1360	1092	31.8	1.01
954.0	5	954.0	42/7	30	3	7	0.0837	1029	23.7	1.05
954.0	7	954.0	45/7	32	3	7	0.0971	1075	25.9	1.06
954.0	13	954.0	54/7	20	2	7	0.1329	1226	33.5	1.08
1033.5	5	1033.5	42/7	30	3	7	0.0871	1115	25.7	1.09
1033.5	7	1033.5	45/7	32	3	7	0.1010	1165	28.1	1.10
1033.5	13	1033.5	54/7	21	2	7	0.1363	1327	36.3	1.13
1113.0	5	1113.0	42/7	30	3	7	0.0904	1201	27.5	1.13
1113.0	7	1113.0	45/7	33	3	7	0.1049	1254	30.3	1.14
1113.0	13	1113.0	54/19	38	3	19	0.0862	1429	39.1	1.19
1192.5	5	1192.5	42/7	30	3	7	0.0936	1286	29.5	1.17
1192.5	7	1192.5	45/7	33	3	7	0.1085	1343	32.4	1.18
1192.5	13	1192.5	54/19	38	3	19	0.0892	1530	41.9	1.22
1272.0	5	1272.0	42/7	30	3	7	0.0967	1372	31.4	1.20
1272.0	7	1272.0	45/7	35	3	7	0.1121	1433	34.6	1.22
1272.0	13	1272.0	54/19	39	3	19	0.0921	1632	44.1	1.26
1351.5	7	1351.5	45/7	35	3	7	0.1155	1522	36.7	1.26
1351.5	13	1351.5	54/19	39	3	19	0.0949	1734	46.8	1.30
1431.0	7	1431.0	45/7	36	3	7	0.1189	1613	38.9	1.29
1431.0	13	1431.0	54/19	39	3	19	0.0977	1836	49.6	1.34
1590.0	7	1590.0	45/7	36	3	7	0.1253	1792	42.2	1.36
1590.0	13	1590.0	54/19	42	3	19	0.1030	2040	55.1	1.41
1780.0	8	1780.0	84/19	37	3	19	0.0874	2063	50.7	1.45
2156.0	8	2156.0	84/19	64	4	19	0.0961	2515	61.1	1.61

[A] Mass per unit length is based on Class A zinc-coated steel.

[B] Rated strengths were calculated in accordance with 9.1 using steel stresses at 1 % for Class A coating in accordance with Specification B 498 (1 kip = 1000 lbf = 4.448 kN).

3.1.1.2 *ACSR/TW/AZ*—ACSR/TW using aluminum-coated (aluminized) steel wire (Specification B 341).

3.1.1.3 *ACSR/TW/GA*—ACSR/TW using Class A zinc-coated steel wire (Specification B 498).

3.1.1.4 *ACSR/TW/GB*—ACSR/TW using Class B zinc-coated steel wire (Specification B 498).

3.1.1.5 *ACSR/TW/GC*—ACSR / TW using Class C zinc-coated steel wire (Specification B 498).

3.1.1.6 *ACSR/TW/HS*—ACSR/TW using extra high-strength steel wire (Specification B 606).

3.1.1.7 *ACSR/TW/MA*—ACSR/TW using Class A zinc-5 % aluminum-mischmetal alloy-coated steel core wire (Specification B 802).

3.1.1.8 *ACSR/TW/MB*—ACSR/TW using Class B zinc-5 % aluminum-mischmetal alloy-coated steel core wire (Specification B 802).

3.1.1.9 *ACSR/TW/MC*—ACSR/TW using Class C zinc-5 % aluminum-mischmetal alloy-coated steel core wire (Specification B 802).

3.1.1.10 *ACSR/TW/MS*—ACSR/TW using high-strength zinc-5 % mischmetal alloy-coated steel core wire (Specification B 803).

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: kcmil area and diameter,

4.1.3 Conductor type and number of wires, aluminum and steel (Tables 1-3),

4.1.4 Type of steel core wire and if zinc or Zn-5 % -MM alloy coated, Class (A, B, and C) of coating (see 5.2),

4.1.5 Special tension test, if required (see 9.2),

4.1.6 Place of inspection (Section 15),

4.1.7 Package size and type (see 16.1),

4.1.8 Special package markings, if required (Section 16), and

4.1.9 Heavy wood lagging, if required (see 16.3).

5. Requirement for Wires

5.1 Before stranding, the trapezoidal aluminum wires (see Terminology B 354) shall conform to the requirements of Specification B 230 except for shape and diameter tolerance. The tensile strength and elongation requirements of trapezoidal wires shall be the same as for round wires of equal area. The

TABLE 2 Construction Requirements for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Reinforced Sized to Have Diameter Equal to ACSR, Class AA

Code Word[A]	ACSR/TW Conductor Size		Size and Stranding of ACSR with Equal Diameter		Number of Aluminum Wires	Number of Layers	Steel Core Stranding		Mass per Unit Length,[B] lb/1000 ft	Rated Strength, 1000 lb[C]	Nominal Outside Diameter, in.[D]
	kcmil[E]	Type	kcmil[E]	Stranding			Number of Wires	Diameter, in.[D]			
Monongahela/TW	405.1	6	336.4	18/1	14	2	1	0.1520	441	10.2	0.68
Mohawk/TW	571.7	13	477.0	24/7	18	2	7	0.1030	735	20.6	0.85
Calumet/TW	565.3	16	477.0	26/7	20	2	7	0.1146	776	22.9	0.86
Mystic/TW	666.6	13	556.5	24/7	20	2	7	0.1111	856	24.0	0.91
Oswego/TW	664.8	16	556.5	26/7	20	2	7	0.1244	913	26.6	0.93
Maumee/TW	768.2	13	636.0	24/7	20	2	7	0.1195	988	27.7	0.98
Wabash/TW	762.8	16	636.0	26/7	20	2	7	0.1331	1047	30.5	0.99
Nechako/TW	768.9	3	636.0	36/1	27	3	1	0.1520	785	16.4	0.93
Kettle/TW	957.2	7	795.0	45/7	32	3	7	0.0973	1079	26.0	1.06
Fraser/TW	946.7	10	795.0	22/7	35	3	7	0.1154	1142	29.6	1.08
Columbia/TW	966.2	13	795.0	54/7	21	2	7	0.1338	1241	34.0	1.09
Suwannee/TW	959.6	16	795.0	26/7	22	2	7	0.1493	1318	37.0	1.11
Cheyenne/TW	1168.1	5	954.0	42/7	30	3	7	0.0926	1260	28.9	1.16
Genesee/TW	1158.0	7	954.0	45/7	33	3	7	0.1078	1308	31.6	1.17
Hudson/TW	1158.4	13	954.0	54/7	25	2	7	0.1467	1489	39.6	1.20
Catawba/TW	1272.0	5	1033.5	42/7	30	3	7	0.0967	1372	31.4	1.20
Nelson/TW	1257.1	7	1033.5	45/7	35	3	7	0.1115	1417	34.2	1.21
Yukon/TW	1233.6	13	1033.5	54/7	38	3	19	0.0910	1586	42.9	1.25
Truckee/TW	1372.5	5	1113.0	42/7	30	3	7	0.1004	1481	33.4	1.25
Mackenzie/TW	1359.7	7	1113.0	45/7	36	3	7	0.1159	1530	36.9	1.26
Thames/TW	1334.6	13	1113.0	54/19	39	3	19	0.0944	1713	46.3	1.29
St. Croix/TW	1467.8	5	1192.5	42/7	33	3	7	0.1041	1585	35.8	1.29
Miramichi/TW	1455.3	7	1192.5	45/7	36	3	7	0.1200	1640	39.2	1.30
Merrimack/TW	1433.6	13	1192.5	54/19	39	3	19	0.0978	1840	49.7	1.34
Platte/TW	1569.0	5	1272.0	42/7	33	3	7	0.1074	1693	38.2	1.33
Potomac/TW	1557.4	7	1272.0	45/7	36	3	7	0.1241	1755	41.9	1.35
Rio Grande/TW	1533.3	13	1272.0	54/19	39	3	19	0.1012	1968	53.2	1.38
Schuylkill/TW	1657.4	7	1351.5	45/7	36	3	7	0.1280	1868	44.0	1.39
Pecos/TW	1622.0	13	1351.5	54/19	39	3	19	0.1064	2107	57.5	1.42
Pee Dee/TW	1758.6	7	1431.0	45/7	37	3	7	0.1319	1982	46.7	1.43
James/TW	1730.6	13	1431.0	54/19	39	3	19	0.1075	2221	59.4	1.47
Athabaska/TW	1949.6	7	1590.0	45/7	42	3	7	0.1392	2199	51.9	1.50
Cumberland/TW	1926.9	13	1590.0	54/19	42	3	19	0.1133	2471	65.3	1.55
Powder/TW	2153.8	8	1780.0	84/19	64	4	19	0.0961	2498	61.1	1.60
Santee/TW	2627.3	8	2156.0	84/19	64	4	19	0.1062	3048	74.5	1.76

[A] Code words shown in this column are obtained from "Publication 50, Code Words for Overhead Aluminum Electrical Conductors," by the Aluminum Association. They are provided for information only.
[B] Mass per unit length is based on Class A zinc-coated steel. To convert to kg/km, multiply the lb/1000 ft value x 1.4887.
[C] Rated strength was calculated in accordance with 9.1 using steel stresses at 1 % for Class A coating in accordance with Specification B 498 (1 kip = 1000 lbf = 4.445 kN).
[D] To convert the diameter (inches) to mm, multiply the inch value x 25.4.
[E] To convert from kcmil to mm^2 area, multiply the kcmil value x 5.067 x 10^{-4}.

TABLE 3 Construction Requirements for Shaped Wire Compact Concentric-Lay Stranded Aluminum Conductors Coated, Steel Reinforced

ACSR/TW Conductor Size	Number of Aluminum Wires	Number of Layers	Steel Core Stranding		Mass per Unit Length, lb/1000 ft	Rated Strength, 1000 lb	Nominal Outside Diameter, in.
kcmil			Number of Wires	Diameter, in.			
795.5	17	2	7	0.0866	886.0	21.2	0.95
1109.7	17	2	7	0.0700	1132.0	23.6	1.10
1524.1	33	3	7	0.0966	1617.0	35.8	1.30
1935.4	31	3	7	0.0866	1958.0	41.0	1.45

area tolerances shall be such that the finished conductor conforms to Section 12.

5.2 Before stranding, the steel core wire shall meet the requirements of Specifications B 341, B 498, B 502, B 606, B 802, or B 803, whichever is applicable.

5.3 Following stranding, the steel core shall meet the requirements of Specification B 500.

6. Joints

6.1 Electric-butt welds, electric-butt cold-upset welds, or cold-pressure welds may be made in the individual aluminum wires during the stranding process. No weld shall occur within 50 ft (15 m) of any other weld in the completed conductor (Explanatory Note 3).

6.2 There shall be no joints made in the finished steel wires.

7. Lay

7.1 The preferred lay of the outside layer of aluminum wires of shaped wire compact aluminum conductors, steel-reinforced, having a steel core of 7 or 19 wires and having multiple layers of aluminum wires, is 11 times the outside diameter of the conductor but the lay shall not be less than 10 nor more than 13 times that diameter (Explanatory Note 4).

7.2 The preferred lay of the layer immediately beneath the outside layer of aluminum wires is 13 times the outside diameter of such layer but the lay shall be not less than 10 nor more than 16 times that diameter.

7.3 The lay of the inner layers of aluminum wires shall be not less than 10 nor more than 17 times the outside diameter of such layer.

7.4 The preferred lay of the 6-wire layer of 7- and 19-wire steel cores is 25 times the outside diameter of the 6-wire layer but the lay shall be not less than 18 nor more than 30 times that diameter.

7.5 The preferred lay of the 12-wire layer of 19-wire steel core is 20 times the outside diameter of the core but the lay shall be not less than 16 nor more than 24 times that diameter.

7.6 The direction of lay of the outside layer of aluminum wires shall be right-hand.

7.7 The direction of lay of the aluminum and steel wires shall be reversed in successive layers.

7.8 For the purpose of this specification the lay factor is the length of lay of a given layer divided by its outside diameter.

8. Construction

8.1 The nominal aluminum cross-sectional area, conductor type, the nominal number of aluminum wires, the number of layers, the number and diameter of the steel core wire, the mass per unit length, the rated strength and the outside diameter of the shaped wire compact concentric-lay-stranded aluminum conductors, steel-reinforced, shall be as shown in Tables 1-3.

NOTE 3—Exception to 8.1. Because the final design of a shaped wire compact conductor is contingent on several factors such as layer diameter, wire width and thickness, etc., the actual configuration of a given size may vary between manufacturers. This might result in a slight variation in the number of wires from that shown in Tables 1-3, and also in the dimensions of the individual wires (See Table 4).

9. Rated Strength of Conductor

9.1 The rated strength of a conductor, as shown in Tables 1-3, shall be taken as the aggregate strength of the aluminum and steel components calculated as follows: The strength contribution of the aluminum 1350-H19 wires shall be taken as the percentage, indicated in Table 5 in accordance with the number of aluminum layers, of the sum of the wire strengths calculated from the specified diameter of the round wires having the same area as the trapezoidal wires used in the manufacture of the conductor, and the appropriate minimum average tensile strength given in Specification B 230. The strength contribution of the steel core wires shall be taken as the percentage, indicated in Table 5, of the sum of the strengths of the steel wires calculated from their specified nominal wire diameter and the appropriate specified minimum stress at 1 % extension given in Specifications B 341, B 498, B 502, B 606, B 802, or B 803, whichever is applicable.

9.1.1 The rated strengths of conductors calculated in accordance with 9.1 and 9.3, using Class A zinc-coated steel wires in accordance with Specification B 498, are listed in Table 1 and Table 2.

9.2 Tests to confirm that the rated strength of the conductor is met are not required by this specification, but shall be made

TABLE 4 Comparison of ACSR/TW with Equivalent Stranding of ACSR[A]

ACSR/TW Type Number[B]	Conventional ACSR Stranding[C]
3	36/1
5	42/7
6	18/1
7	45/7
8	84/19
10	22/7
13	54/7
13	54/19
13	24/7
16	26/7

[A] The equivalent stranding is that stranding of conventional ACSR that has the same area of aluminum and steel as a given ACSR/TW type.

[B] ACSR/TW type number is the approximate ratio of the steel area to the aluminum area in percent.

[C] See Specifications B 232 and B 549.

TABLE 5 Rating Factors

Number of Layers		No. of Steel Wires	Rating Factor, %	
Aluminum	Steel		Aluminum	Steel
Trapezoidal	Round			
2	0	1	95	96
2	1	7	95	96
2	2	19	95	93
3	0	1	93	96
3	1	7	93	96
3	2	19	93	93
4	2	19	92	93

if agreed upon between the manufacturer and the purchaser at the time of placing an order. When tested, the breaking strength of the conductor shall be not less than the rated strength if failure occurs in the free length at least 1 in. (25 mm) beyond the end of either gripping device, or shall be not less than 95 % of the rated strength if failure occurs inside or within 1 in. of the end of either gripping device (Explanatory Note 5).

9.3 Rated strength and breaking strength values shall be rounded to three significant figures in the final value only, in accordance with Practice E 29.

10. Density

10.1 For the purpose of calculating mass per unit length, cross-sections, etc., the density of aluminum 1350 shall be taken as 0.0975 lb/in.^{3}[33](2705 kg/m^3) at 20°C.

10.2 For the purpose of calculating mass per unit length, cross-sections, etc., the density of galvanized or aluminized steel wire shall be taken as 0.2810 lb/in.^{3}(7780 kg/m^3) at 20°C.

10.3 For the purpose of calculating mass per unit length, cross-sections, and the like, the density of aluminum-clad steel wire shall be taken as 0.2381 lb/in.^{3}(6590 kg/m^3) at 20°C.

11. Mass per Unit Length and Electrical Resistance

11.1 The mass per unit length and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The approximate mass per unit length and electrical resistance of a stranded conductor may be determined using the standard increments shown in Table 6. When greater accuracy is desired, the increment based on the actual lay of the conductor may be calculated (Explanatory Note 6).

11.2 In the calculation of the electrical resistance of a completed conductor, the resistivity of zinc-coated or aluminum-coated steel core wires shall be taken as 0.19157 $\Omega \cdot mm^2/m$ at 20°C and the resistivity of aluminum-clad steel core wires shall be taken as 0.0848 $\Omega \cdot mm^2/m$ at 20°C. These are typical values and are not guaranteed.

12. Variations in Area and Diameter

12.1 The area of cross-section of the aluminum wires of the conductor shall be not less than 98 % nor more than 102 % of the area specified in Column 1 of Tables 1-3. The area of each wire shall be determined by Test Method B 263. In applying this method, the increment in linear density resulting from stranding may be the applicable value specified in Table 6, or it may be calculated from the measured dimensions of the sample under test. In case of questions regarding area compliance, the actual mass per unit length increment due to stranding shall be calculated.

TABLE 6 Standard Increments Due to Stranding

Stranding of ACSR/TW		Increment (Increase),%	
		Mass per Unit Length and Electrical Resistance	
Type No.	No. of Steel Wires	Aluminum	Steel
Two Layer Designs			
5	7	2.0	0.4
6	1	2.0	0
7	7	2.0	0.4
10	7	2.1	0.4
13	7	2.15	0.4
13	19	2.15	0.6
16	7	2.25	0.4
Three Layer Designs			
3	1	2.4	0
5	7	2.4	0.4
7	7	2.5	0.4
8	19	2.35	0.6
10	7	2.6	0.4
13	19	2.75	0.6
Four Layer Designs			
8	19	3.2	0.6

12.2 The diameter of the finished conductor shall be not less than 99 % nor more than 101 % of that shown in Table 1 and Table 2 when measured with a diameter tape between the closing dies and the capstan of the strander.

13. Workmanship, Finish, and Appearance

13.1 The conductor shall be clean and free from imperfections not consistent with good commercial practice.

14. Mechanical and Electrical Tests

14.1 Tests for mechanical and electrical properties of aluminum wires shall be made before stranding (Explanatory Note 7).

14.2 Tests for the properties of the steel core wires shall be made before stranding (Explanatory Note 7).

15. Inspection

15.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

15.2 All inspections and tests shall be made at the place of manufacture unless otherwise especially agreed to between the manufacturer and the purchaser at the time of the purchase.

15.3 The manufacturer shall afford the inspector representing the purchaser all reasonable manufacturer's facilities to satisfy him that the material is being furnished in accordance with this specification.

16. Packaging and Package Marking

16.1 Package sizes and kind of package, reels, etc. shall be agreed upon between the manufacturer and the purchaser.

16.2 There shall be only one length of conductor on a reel.

16.3 The conductors shall be protected against damage in ordinary handling and shipping. If heavy wood lagging is required, it shall be specified by the purchaser at the time of placing the order.

16.4 The net mass, length, size, kind of conductor, conductor type, stranding, type of steel coating or cladding, class of zinc or Zn-5 % -MM alloy coating (if used) and any other necessary identification shall be marked on a tag attached to the conductor inside the package. This same information, together with the purchase order number, the manufacturer's serial number (if any), and all shipping marks and other information required by the purchaser shall appear on the outside of the package.

EXPLANATORY NOTES

NOTE 1—In this specification only shaped wire compact concentric-lay-stranded aluminum conductors, steel-reinforced, are specifically designated. Conductor constructions not included in this specification should be agreed upon between the manufacturer and the purchaser when placing the order.

NOTE 2—For definitions of terms relating to conductors, refer to Terminology B 354.

NOTE 3—The behavior of properly spaced joints in aluminum wires in stranded conductors is related to both their tensile strength and elongation. Because of its higher elongation properties, the lower-strength electric-butt weld gives equivalent overall performance to that of a cold-pressure weld or an electric-butt, cold-upset weld in stranded conductors.

NOTE 4—The lay factor with respect to the outside diameter of a layer of wires varies for different layers and for different diameters of conductor, being larger for the inside layers than for the outside layer.

NOTE 5—To obtain the actual breaking strength of ACSR/TW tested as a unit requires special devices for gripping the ends of the aluminum and steel wires without causing damage thereto and resultant failure below the actual strength of the conductor. Various special dead-end devices are available for this purpose, such as compression sleeves. Ordinary jaws or clamping devices usually are not suitable.

NOTE 6—The increment of mass or electrical resistance of a completed concentric-lay-stranded conductor, *k*, in percent is given by the following equation:

$$k = 100(m - 1)$$

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 stranding, 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 conductor, including the straight core wire, if any (for which the stranding factor is unity). The stranding factor (m_{ind}) for any given wire in a concentric-lay-stranded conductor is:

$$m_{ind} = \sqrt{1 + (9.8696/n^2}$$

where

n = length of lay/diameter of helical path of the wire.

This is taken to be ID + *t* for a given layer where *t* equals the thickness of the layer. To be more precise, for trapezoidal wire, this diameter should be that of the centroid (the center of mass of the wire) which is on a diameter slightly larger than the average layer diameter used in the above formula. Using the average layer diameter for the helical path of the wire introduces a small error which is considered to be negligible and may be ignored. The derivation of the above is given in *NBS Handbook 100*.[6] The factors (*k*) and (*m*) for composite conductors are to be determined separately for each different material involved (Section7).

NOTE 7—Wires unlaid from conductors may have different physical properties from those of the wire before stranding because of the deformation brought about by laying and again straightening for test.