Designation: B857 – 14

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

This standard is issued under the fixed designation B857; 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 conductors, steel supported (ACSS/TW) for use as overhead electrical conductors (see Explanatory Note 1).

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.2.1 *Exceptions*—For conductor sizes designated by AWG or kcmil sizes, the requirements in SI units are numerically converted from the corresponding requirements in inch-pound units. For conductor sizes designated by SI units only, the requirements are stated or derived in SI units. For density, resistivity, and temperature, the values stated in SI units are to be regarded as standard.

1.3 ACSS/TW is designed to increase the aluminum area for a given diameter of conductor by the use of trapezoidal shaped wires (TW), or to reduce the diameter for a given area of aluminum. The conductors consist of a central core of round steel wire(s) surrounded by two or more layers of trapezoidal aluminum 1350-0 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 (see 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 specified sizes of standard ACSR, ACSS, and ACSR/TW so as to facilitate conductor selection.

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

B498/B498M Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors

B500/B500M Specification for Metallic Coated or Aluminum Clad Stranded Steel Core for Use in Overhead Electrical Conductors

B502 Specification for Aluminum-Clad Steel Core Wire for Use in Overhead Electrical Aluminum Conductors

B549 Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced for Use in Overhead Electrical Conductors

B606 Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced

B609/B609M Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

B802/B802M Specification for Zinc–5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)

B803 Specification for High-Strength Zinc–5 % Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors

B856 Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Supported (ACSS)

B957 Specification for Extra-High-Strength and Ultra-High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Overhead Electrical Conductors

B958 Specification for Extra-High-Strength and Ultra-High-Strength Class A Zinc–5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors

E29 Practice for Using Significant Digits in Test Data to

[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.

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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 Construction Requirements for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Supported[A]

NOTE 1—Sized to have area equal aluminum cross-sectional area to an ACSR or ACSS, Class AA conductor.

ACSS/TW Conductor Size		Code Word[B]	Size and Stranding of ACSS with Equal Aluminum Cross-Sectional Area		Aluminum Stranding		Steel Core Stranding		Nominal Mass ACSS/TW	ACSS/TW Conductor Rated Strength (by type of steel core wire)						Nominal Outside Diameter
kcmil[C]	Type		kcmil	Stranding	Number of Aluminum Wires	Number of Layers	Number of Wires	Individual Strand Wire Diameter, in.	GAX Core lb/1000 ft	GA2 / MA2 KIPS	GA3 / MA3 KIPS	GA4 / MA4 KIPS	GA5 / MA5 KIPS	AW2 KIPS	AW3 KIPS	in.
266.8	16	Partridge/ACSS/TW	266.8	26/7	18	2	7	0.0788	349	8.90	9.70	10.8	11.4	8.40	8.90	0.58
336.4	23	Oriole/ACSS/TW	336.4	30/7	17	2	7	0.1059	526	14.8	16.3	18.2	19.1	14.2	14.8	0.69
477.0	13	Flicker/ACSS/TW	477.0	24/7	18	2	7	0.0940	612	13.0	14.2	15.7	16.4	12.5	13.0	0.78
477.0	16	Hawk/ACSS/TW	477.0	26/7	18	2	7	0.1053	655	15.6	17.1	18.9	19.8	14.9	15.6	0.79
477.0	23	Hen/ACSS/TW	477.0	30/7	17	2	7	0.1261	746	21.0	22.7	25.4	26.7	20.1	20.5	0.83
556.5	13	Parakeet/ACSS/TW	556.5	24/7	18	2	7	0.1015	714	15.2	16.6	18.3	19.1	14.6	15.2	0.84
556.5	16	Dove/ACSS/TW	556.5	26/7	20	2	7	0.1138	764	18.2	19.9	22.1	23.1	17.5	18.2	0.85
636.0	13	Rook/ACSS/TW	636.0	24/7	18	2	7	0.1085	818	17.3	19.0	20.9	21.9	16.7	17.3	0.89
636.0	16	Grosbeak/ACSS/TW	636.0	26/7	20	2	7	0.1216	873	20.7	22.4	24.8	26.0	19.9	20.3	0.91
795.0	7	Tern/ACSS/TW	795.0	45/7	17	2	7	0.0886	891	14.2	15.2	16.6	17.5	13.5	14.2	0.96
795.0	10	Puffin/ACSS/TW	795.0	22/7	18	2	7	0.1108	974	18.9	20.6	22.6	23.7	18.3	18.9	0.98
795.0	13	Condor/ACSS/TW	795.0	54/7	20	2	7	0.1213	1020	21.7	23.3	25.7	26.9	20.9	21.3	0.99
795.0	16	Drake/ACSS/TW	795.0	26/7	20	2	7	0.1360	1091	25.9	28.0	31.0	32.5	24.4	25.4	1.01
795.0	23	Mallard/ACSS/TW	795.0	30/19	22	2	19	0.0977	1234	34.3	37.9	42.1	44.3	32.9	34.3	1.05
954.0	5	Phoenix/ACSS/TW	954.0	42/7	30	3	7	0.0837	1028	14.2	15.2	16.3	17.1	13.6	14.2	1.05
954.0	7	Rail/ACSS/TW	954.0	45/7	32	3	7	0.0971	1074	16.7	18.0	19.6	20.4	16.2	16.7	1.06
954.0	13	Cardinal/ACSS/TW	954.0	54/7	20	2	7	0.1329	1227	26.0	28.0	30.9	32.3	24.6	25.5	1.08
1033.5	5	Snowbird/ACSS/TW	1033.5	42/7	30	3	7	0.0871	1114	15.4	16.4	17.7	18.5	14.8	15.4	1.09
1033.5	7	Ortolan/ACSS/TW	1033.5	45/7	32	3	7	0.1010	1163	18.1	19.5	21.2	22.0	17.6	18.1	1.10
1033.5	13	Curlew/ACSS/TW	1033.5	54/7	21	2	7	0.1383	1326	28.2	30.3	33.4	35.0	26.1	27.7	1.13
1113.0	5	Avocet/ACSS/TW	1113.0	42/7	30	3	7	0.0904	1199	16.3	17.5	18.8	19.5	15.9	16.3	1.13
1113.0	7	Bluejay/ACSS/TW	1113.0	45/7	33	3	7	0.1049	1253	19.5	21.0	22.9	23.8	18.9	19.5	1.14
1113.0	13	Finch/ACSS/TW	1113.0	54/19	38	3	19	0.0862	1427	30.4	33.2	36.5	38.7	28.8	30.4	1.19
1192.5	5	Oxbird/ACSS/TW	1192.5	42/7	30	3	7	0.0936	1285	17.5	18.7	20.2	20.9	17.0	17.5	1.17
1192.5	7	Bunting/ACSS/TW	1192.5	45/7	33	3	7	0.1085	1342	20.9	22.5	24.5	25.5	20.3	20.9	1.18
1192.5	13	Grackle/ACSS/TW	1192.5	54/19	38	3	19	0.0892	1529	32.6	35.5	39.1	41.5	30.8	32.6	1.22
1272.0	5	Scissortail/ACSS/TW	1272.0	42/7	30	3	7	0.0967	1371	18.7	20.0	21.5	22.3	18.2	18.7	1.20
1272.0	7	Bittern/ACSS/TW	1272.0	45/7	35	3	7	0.1121	1432	22.3	24.0	26.1	27.2	21.6	22.3	1.22
1272.0	13	Pheasant/ACSS/TW	1272.0	54/19	39	3	19	0.0921	1630	34.1	37.3	41.1	43.0	32.8	34.1	1.26
1351.5	7	Dipper/ACSS/TW	1351.5	45/7	35	3	7	0.1155	1521	23.7	25.5	27.7	28.8	23.0	23.7	1.26
1351.5	13	Martin/ACSS/TW	1351.5	54/19	39	3	19	0.0949	1732	36.2	39.6	43.6	45.6	34.9	36.2	1.30
1431.0	7	Bobolink/ACSS/TW	1431.0	45/7	36	3	7	0.1189	1611	25.1	27.0	29.4	30.5	24.3	25.1	1.29
1431.0	13	Plover/ACSS/TW	1431.0	54/19	39	3	19	0.0977	1834	38.4	41.9	46.2	48.3	36.9	38.4	1.34
1590.0	7	Lapwing/ACSS/TW	1590.0	45/7	36	3	7	0.1253	1790	27.9	29.6	32.2	33.5	27.0	27.5	1.36
1590.0	13	Falcon/ACSS/TW	1590.0	54/19	42	3	19	0.1030	2038	42.6	46.6	51.3	53.7	41.1	42.6	1.41
1780.0	8	Chukar/ACSS/TW	1780.0	84/19	37	3	19	0.0874	2061	35.3	38.2	41.6	43.9	33.6	35.3	1.45
2156.0	8	Bluebird/ACSS/TW	2156.0	84/19	64	4	19	0.0961	2512	42.1	45.5	49.6	51.7	40.7	42.1	1.61

[A] Conversion factors:
1 cmil = 5.067E–04 mm ^{2} (0.0005067 mm^3)
1 in. = 2.54E+01 mm (25.4 mm)
1 lb/1000ft = 1.488 kg/km
1 ft = 3.048E–01 m (0.3048 m)
1 lb = 4.536E–01 kg (0.4536 kg)
1 lbf = 4.448E–03 kN (0.0044448 kN)

[B] 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.

[C] See Explanatory Note 4.

TABLE 2 Construction Requirements for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Supported[A]

NOTE 1—Sized to have a diameter equal to a concentric round ACSR or ACSS, Class AA conductor.

ACSS/TW Conductor Size		Code Word[B]	Size and Stranding of ACSS with Equal Overall Conductor Diameter		Aluminum Stranding		Steel Core Stranding		Nominal Mass ACSS/TW	ACSS/TW Conductor Rated Strength (by type of steel core wire)						Nominal Outside Diameter
kcmil[C]	Type		kcmil	Stranding	Number of Aluminum Wires	Number of Layers	Number of Wires	Individual Strand Wire Diameter, in.	GAX Core lb/1000 ft	GA2/MA2 KIPS	GA3/MA3 KIPS	GA4 / MA4 KIPS	GA5 / MA5 KIPS	AW2 KIPS	AW3 KIPS	in.
571.7	13	Mohawk/ACSS/TW	477.0	24/7	18	2	7	0.1030	734	15.6	17.1	18.8	19.7	15.0	15.6	0.85
565.3	16	Calumet/ACSS/TW	477.0	26/7	20	2	7	0.1146	776	18.4	20.2	22.4	23.5	17.7	18.4	0.86
666.6	13	Mystic/ACSS/TW	556.5	24/7	20	2	7	0.1111	856	18.2	19.9	21.9	22.9	17.5	18.2	0.91
664.8	16	Oswego/ACSS/TW	556.5	26/7	20	2	7	0.1244	913	21.7	23.4	26.0	27.2	20.9	21.3	0.93
768.2	13	Maumee/ACSS/TW	636.0	24/7	20	2	7	0.1195	987	21.0	23.0	25.3	26.5	20.2	21.0	0.98
762.8	16	Wabash/ACSS/TW	636.0	26/7	20	2	7	0.1331	1047	24.9	26.8	29.7	31.2	23.4	24.4	0.99
957.2	7	Kettle/ACSS/TW	795.0	45/7	32	3	7	0.0973	1078	16.8	18.1	19.7	20.4	16.3	16.8	1.06
946.7	10	Fraser/ACSS/TW	795.0	22/7	35	3	7	0.1154	1140	21.1	22.9	25.1	26.2	20.3	21.1	1.08
966.2	13	Columbia/ACSS/TW	795.0	54/7	21	2	7	0.1338	1240	26.4	28.3	31.3	32.8	24.9	25.9	1.09
959.6	16	Suwannee/ACSS/TW	795.0	26/7	22	2	7	0.1493	1317	30.7	33.1	36.8	38.6	28.2	30.0	1.11
1080.0	7	. . .	900.0	45/7	20	2	7	0.1033	1211	18.9	20.4	22.2	23.1	18.4	18.9	1.13
1168.1	5	Cheyenne/ACSS/TW	954.0	42/7	30	3	7	0.0926	1259	17.2	18.3	19.7	20.4	16.7	17.1	1.16
1158.0	7	Genesee/ACSS/TW	954.0	45/7	33	3	7	0.1078	1307	20.5	22.1	24.0	25.0	19.9	20.5	1.17
1158.4	13	Hudson/ACSS/TW	954.0	54/7	25	2	7	0.1467	1488	31.1	33.5	37.0	38.8	28.7	30.5	1.20
1272.0	5	Catawba/ACSS/TW	1033.5	42/7	30	3	7	0.0967	1371	18.7	20.0	21.5	22.3	18.2	18.7	1.20
1257.1	7	Nelson/ACSS/TW	1033.5	45/7	35	3	7	0.1115	1416	22.1	23.8	25.8	26.9	21.4	22.1	1.21
1233.6	13	Yukon/ACSS/TW	1033.5	54/7	38	3	19	0.0910	1584	33.2	36.3	40.0	41.9	32.0	33.2	1.25
1372.5	5	Truckee/ACSS/TW	1113.0	42/7	30	3	7	0.1004	1479	20.2	21.5	23.2	24.0	19.6	20.2	1.25
1359.7	7	Mackenzie/ACSS/TW	1113.0	45/7	36	3	7	0.1159	1531	23.9	25.7	27.9	29.0	23.1	23.8	1.26
1334.6	13	Thames/ACSS/TW	1113.0	54/19	39	3	19	0.0944	1711	35.8	39.1	43.1	45.1	34.5	35.8	1.29
1467.8	5	St. Croix/ACSS/TW	1192.5	42/7	33	3	7	0.1041	1583	21.6	23.1	24.9	25.8	21.0	21.6	1.29
1455.3	7	Miramichi/ACSS/TW	1192.5	45/7	36	3	7	0.1200	1639	25.6	27.1	29.5	30.7	24.8	25.2	1.30
1433.6	13	Merrimack/ACSS/TW	1192.5	54/19	39	3	19	0.0978	1838	38.4	42.0	46.3	48.4	37.0	38.4	1.34
1569.0	5	Platte/ACSS/TW	1272.0	42/7	33	3	7	0.1074	1691	23.1	24.6	26.5	27.5	22.4	23.1	1.33
1557.4	7	Potomac/ACSS/TW	1272.0	45/7	36	3	7	0.1241	1754	27.3	29.0	31.6	32.8	26.5	26.9	1.35
1533.3	13	Rio Grande/ACSS/TW	1272.0	54/19	39	3	19	0.1012	1966	41.2	45.0	49.6	51.9	39.6	41.2	1.38
1657.4	7	Schuylkill/ACSS/TW	1351.5	45/7	36	3	7	0.1280	1866	29.1	30.9	33.6	34.9	28.2	28.6	1.39
1622.0	13	Pecos/ACSS/TW	1351.5	54/19	39	3	19	0.1064	2105	45.0	49.3	54.3	56.9	43.3	45.0	1.42
1758.6	7	Pee Dee/ACSS/TW	1431.0	45/7	37	3	7	0.1319	1980	30.9	32.8	35.7	37.1	29.4	30.4	1.43
1730.6	13	James/ACSS/TW	1431.0	54/19	39	3	19	0.1075	2219	46.4	50.8	55.9	58.5	44.7	46.4	1.47
1949.6	7	Athabaska/ACSS/TW	1590.0	45/7	42	3	7	0.1392	2197	34.3	36.5	39.3	40.8	31.7	33.5	1.50
1926.9	13	Cumberland/ACSS/TW	1590.0	54/19	42	3	19	0.1133	2469	51.6	56.4	62.2	65.0	49.7	51.6	1.55
2153.8	8	Powder/ACSS/TW	1780.0	84/19	64	4	19	0.0961	2510	42.1	45.5	49.6	51.7	40.7	42.1	1.60
2627.3	8	Santee/ACSS/TW	2156.0	84/19	64	4	19	0.1062	3063	51.3	55.6	60.6	63.1	49.7	51.3	1.76

[A] Conversion factors:
1 cmil = 5.067E−04 mm ^{2} (0.0005067 mm^2)
1 in. = 2.54E+01 mm (25.4 mm)
1 lb/1000 ft = 1.488 kg/km
1 ft = 3.048E−01 m (0.3048 m)
1 lb = 4.536E−01 kg (0.4536 kg)
1 lbf = 4.448E−03 kN (0.004448 kN)

[B] 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.

[C] See Explanatory Note 4.

TABLE 3 Comparison of ACSS/TW With Equivalent Stranding of ACSR[A] and ACSS[B]

ACSS/TW Type Number[C]	Conventional ACSR and ACSS Stranding[D]
5	42/7
7	45/7
8	84/19
10	22/7
13	54/7
13	24/7
16	26/7
23	30/7
23	30/19

[A] The equivalent stranding is that stranding of conventional ACSR that has the same area of aluminum and steel as a given ACSS/TW type.
[B] The equivalent stranding is that stranding of conventional ACSS that has the same area of aluminum and steel as a given ACSS/TW type.
[C] ACSS/TW type number is the approximate ratio of the steel area to the aluminum area in percent.
[D] See Specifications B549 and B856.

Determine Conformance with Specifications
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.3 *Other Standards:*
NBS Handbook 100 — Copper Wire Tables of the National Bureau of Standards[3]
Aluminum Association Publication 50 Code Words for Overhead Aluminum Electrical Conductors[4]

3. Terminology

3.1 *Definitions*—For definitions of terms relating to conductors, also refer to definitions found in Specification B354.

3.2 *Definitions of Terms Specific to This Standard:*
3.2.1 *aluminum-clad*—aluminum bonded.

3.2.2 *galvanized*—zinc coated.

3.2.3 *Zn-5A1-MM*—zinc-5 % aluminum-mischmetal alloy coated.

3.3 *Abbreviations:*
3.3.1 *ACSS/TW*—shaped wire aluminum conductor, steel supported.

3.3.2 *ACSS/TW/AW2*—supported with regular strength aluminum-clad core wires in accordance with Specification B502.

3.3.3 *ACSS/TW/AW3*—supported with high-strength aluminum-clad core wires in accordance with Specification B502.

3.3.4 *ACSS/TW/GA2*—ACSS using Class A zinc-coated regular strength steel core wires in accordance with Specification B498/B498M.

3.3.5 *ACSS/TW/GA3*—ACSS using Class A zinc-coated high-strength steel core wires in accordance with Specification B606.

3.3.6 *ACSS/TW/GA4*—ACSS using Class A zinc-coated extra-high-strength steel core wires in accordance with Specification B957.

3.3.7 *ACSS/TW/GA5*—ACSS using Class A zinc-coated ultra-high-strength steel core wires in accordance with Specification B957.

3.3.8 *ACSS/TW/GC2*—ACSS using Class C zinc-coated regular strength steel core wires in accordance with Specification B498/B498M.

3.3.9 *ACSS/TW/MA2*—ACSS using Class A Zn-5A1-MM coated regular strength steel core wires in accordance with Specification B802/B802M.

3.3.10 *ACSS/TW/MA3*—ACSS using Class A Zn-5A1-MM coated high strength steel core wires in accordance with Specification B803.

3.3.11 *ACSS/TW/MA4*—ACSS using Class A Zn-5A1-MM coated extra-high-strength steel core wires in accordance with Specification B958.

3.3.12 *ACSS/TW/MA5*—ACSS using Class A Zn-5A1-MM coated ultra-high-strength steel core wires in accordance with Specification B958.

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, (Table 1 and Table 2),
4.1.4 Type of steel core wire and class (if applicable) of coating (see 5.2),
4.1.5 Direction of lay of outer layer of aluminum wires if other than right-hand (see 7.7),
4.1.6 Special tension test, if desired (see 14.3),
4.1.7 Package size and type (see 16.1),
4.1.8 Special package markings, if required (see 16.4),
4.1.9 Heavy wood lagging, if required (see 16.3), and
4.1.10 Place of inspection (see Section 15).

5. Requirement for Wires

5.1 After stranding, the trapezoidal aluminum wires (see Definitions B354) shall conform to the requirements of O Temper in accordance with Specification B609/B609M except for shape and diameter tolerance requirements. The tensile strength and elongation requirements of trapezoidal wires shall be the same as for round wires of equal area. The area tolerances for trapezoidal wires shall be such that the finished conductor conforms to Section 13. The elongation shall not be less than 20 % after stranding.

5.2 Before stranding, the steel core wire shall meet the requirements of Specifications B498/B498M, B502, B606, B802/B802M, B803, B957, or B958 whichever is applicable.

5.3 The stranded steel core shall meet the requirements of Specification B500/B500M or B549, as applicable.

[3] Available from National Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, http://www.ntis.gov.
[4] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, http://www.aluminum.org.

6. Joints

6.1 Electric-butt welds, cold-pressure welds, and electric-butt, cold upset welds in the finished individual aluminum wires composing the conductor may be made during the stranding process. No weld shall occur within 50 ft (15 m) of a weld in the same wire or in any other wire of the completed conductor (see Explanatory Note 2).

6.2 There shall be no joints of any kind made in the finished coated steel wires.

7. Lay

7.1 The preferred lay of the outside layer of aluminum wires of shaped wire compact aluminum conductors, steel supported, having a stranded steel core 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 (see Explanatory Note 3).

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 neither less than 10 nor more than 16 times that diameter.

7.3 The lay of the inner layers of aluminum wires shall be neither less than 10 nor more than 17 times the outside diameter of such layer.

7.4 The lay length of the 6-wire layer of a 7, 19, or 37 wire stranded core shall be neither less than 16 nor more than 26 times the outside diameter of the 6-wire layer. (Outside diameter is three times normal core wire diameter.)

7.5 The lay length of the 12-wire layer of a 19 or 37 wire stranded core shall be neither less than 14 nor more than 22 times the outside diameter of the 12-wire layer. (Outside diameter is five times normal core wire diameter.)

7.6 The lay length of the 18-wire layer of a 37-wire stranded core shall be not less than 14 or more than 20 times the outside diameter of the 18-wire layer. (Outside diameter is seven times nominal wire diameter.)

7.7 The direction of lay of the outside layer of aluminum wires shall be right hand unless otherwise specified in the purchase order.

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

7.9 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, the rated strength, and the outside diameter of the shaped wire compact concentric-lay-stranded aluminum conductors, steel supported, shall be as shown in Table 1 and Table 2.

8.2 *ACSS/TW* may be constructed using steel core wire with a number of different types. The acceptable core wires are, but not limited to:

8.2.1 Regular strength galvanized steel core wires, with coating Classes A or C (designated GA2 and GC2) in accordance with Specification B498/B498M (see Explanatory Note 8);

8.2.2 High-strength galvanized steel core wire, coating Class A (designated GA3) in accordance with Specification B606 (see Explanatory Note 8);

8.2.3 Regular strength Zn-5A1-MM coated steel core wire, coating Class A (designated MA2), in accordance with Specification B802/B802M;

8.2.4 High-strength Zn-5A1-MM coated steel core wire, coating Class A (designated MA3) in accordance with Specification B803;

8.2.5 Extra-high-strength galvanized steel core wire coating Class A (designated GA4) in accordance with Specification B957 (see Explanatory Note 8);

8.2.6 Extra-high-strength Zn-5Al-MM coated steel core wire, coating Class A (designated MA4) in accordance with Specification B958;

8.2.7 Ultra-high-strength galvanized steel core wire coating Class A (designated GA5) in accordance with Specification B957 (see Explanatory Note 8);

8.2.8 Ultra-high-strength Zn-5Al-MM coated steel core wire, coating Class A (designated MA5) in accordance with Specification B958;

8.2.9 Regular strength Aluminum Clad steel (designated AW2) in accordance with Specification B502.

8.2.10 High-strength Aluminum Clad steel (designated AW3) in accordance with Specification B502.

9. Rated Strength of Conductor (see Explanatory Note 5)

9.1 The rated strength of ACSS/TW conductors, as shown in Table 1 and Table 2, shall be taken as the aggregate strength of the aluminum and steel components calculated as follows: The strength contribution of the aluminum 1350-0 wires shall be taken as the percentage, indicated in Table 4 in accordance with the number of aluminum layers, of the sum 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 B609/B609M. The strength of the steel core wires shall be taken as the percentage, indicated in Table 4, of the sum of the strengths of the component steel wires, calculated from their specified nominal wire diameter and the appropriate minimum ultimate

TABLE 4 Strength De-Rating Factors

Number of Layers		Number of Steel Wires	Strength De-Rating Factor, %	
Aluminum	Steel			
Trapezoidal	Round		Aluminum	Steel
2	1	7	96	100
2	2	19	96	100
2	3	37	96	100
3	1	7	96	100
3	2	19	96	100
3	3	37	96	100
4	2	19	96	100
4	3	37	96	100

tensile strength given in Specifications B498/B498M, B502, B606, B802/B802M, B803, B957, or B958, whichever is applicable.

9.2 Rated strength and breaking strength values shall be rounded to three significant figures in the final value only, in accordance with the rounding method of Practice E29.

9.3 The rated strengths of conductors calculated in accordance with 9.1 and 9.2 are listed in Table 1 and Table 2.

9.4 Tests to confirm that the rated strength of the conductor is met are not required by this specification but shall be made 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. (25 mm) of the end of either gripping device.

10. Density

10.1 For the purpose of calculating mass, cross sections, and the like, the density of Aluminum 1350 shall be taken as 0.0975 lb/in.^{3} (2705 kg/m^3) at 20°C.

10.2 For the purpose of calculating mass, cross sections, and the like, the density of galvanized, or Zn-5A1-MM alloy-coated steel wire shall be taken as 0.281 lb/in.^{3} (7780 kg/m^3) at 20°C.

10.3 For the purposes of calculating mass, 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 and Electrical Resistance

11.1 The mass and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The approximate weight and electrical resistance may be determined using the standard increments shown in Table 5. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (see Explanatory Note 6).

TABLE 5 Standard Increments Due to Stranding

NOTE 1—For constructions that utilize a 37 wire steel core, consult the conductor manufacturer.

		Increment (Increase), %	
	Stranding of ACSS/TW Mass and Electrical Resistance		
Type Number	Number of Steel Wires	Aluminum	Steel
	Two-Layer Designs		
5	7	2.0	0.4
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
23	7	2.75	0.4
23	19	2.75	0.6
	Three-Layer Designs		
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

11.2 In the calculation of the electrical resistance of a conductor, the zinc-coated, or Zn-5A1-MM-coated, steel core wires shall be taken as 0.19157 Ω·mm^2/m at 20°C and the resistivity of aluminum-clad steel core wires shall be taken as 0.0848 Ω·mm^2/m at 20°C. These are typical values and are not guaranteed. The electrical resistance of the aluminum wires shall be taken as 0.0279 Ω·mm^2/m at 20°C.

12. Workmanship, Finish, and Appearance

12.1 The conductor shall be clean and free of all imperfections not consistent with good commercial practice.

13. Variation in Area and Diameter

13.1 The area of cross section of the aluminum wires of a conductor shall be not less than 98 % nor more than 102 % of the area specified in Column 1 of Table 1 and Table 2. The total area of the aluminum wires in the conductor shall be determined by Test Method B263. In applying this method, the increment in mass resulting from stranding may be the applicable value specified in Table 5, or it may be calculated from the measured dimensions of the sample under test. In case of questions regarding area compliance, the actual mass increment due to stranding shall be calculated.

13.2 The diameter of the finished conductor shall be neither less than 99 % nor more than 101 % of that shown in Table 1 or Table 2 when measured under tension with a diameter tape between the closing die(s) and the capstan of the strander.

14. Mechanical and Electrical Tests

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

14.2 The electrical resistivity shall meet the minimum resistivity specified for the wire after stranding. The frequency of these tests shall be agreed upon between the purchaser and the manufacturer.

14.3 Tests for demonstration of rated strength of the completed conductor are not required by this specification but may be made if agreed upon between the manufacturer and the purchaser at the time of placing an order. If tested, the breaking strength of the completed 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. (25 mm) of the end of, either gripping device (see Explanatory Note 5).

14.4 Tests for all properties of zinc-coated, Zn-5A1-MM–coated, or aluminum-clad steel wires shall be made before stranding (see 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 upon 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 manufacture'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 purchase order.

16.4 The net mass, length, size, kind of conductors, conductor type, stranding, type of coating, class of coating and any other necessary identification shall be marked on a tag attached to the end of 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.

17. Keywords

17.1 aluminum conductors; concentric-lay stranded aluminum conductors; electrical conductors; electrical conductors, aluminum; steel-reinforced conductors; steel-supported aluminum conductors; stranded aluminum conductors

EXPLANATORY NOTES

NOTE 1—In this specification only shaped wire compact concentric-lay-stranded aluminum conductors, steel supported, 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—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 performance to that of a cold-pressure weld or an electric-butt, cold-upset weld in stranded conductors.

NOTE 3—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 4—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 Table 1 and Table 2, and also in dimensions of the individual wires.

NOTE 5—To obtain the actual breaking strength of ACSS/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 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 assumed to be the inside diameter + 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) that is on a diameter slightly larger than the average layer diameter used in the preceding 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 preceding is given in *NBS Handbook 100*.[3] The factors (k) and (m) for composite conductors are to be determined separately for each different material involved (see Section 7).

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.

NOTE 8—Industry practice has limited the use of ACSS conductors built with zinc galvanized steel core material to an operational conductor temperature limit of 200°C.