Designation: B400/B400M – 14

Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors[1]

This standard is issued under the fixed designation B400/B400M; 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 aluminum 1350-H19 (extra hard), 1350-H16 or -H26 ([n]hard), 1350-H14 or -H24 (½ hard) and 1350-H142 or -H242 (½ hard) bare compact-round concentric-lay-stranded conductors made from round or shaped wires for use as uninsulated electrical conductors or in covered or insulated electrical conductors. These conductors shall be composed of a central core surrounded by one or more roller or die compacted layers of helically applied wires (Explanatory Note 1 and Note 2).

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.

NOTE 1—Prior to 1975, aluminum 1350 was designated as EC aluminum.

NOTE 2—The aluminum and temper designations conform to ANSI Standard H35.1. Aluminum 1350 corresponds to Unified Numbering System A91350 in accordance with Practice E527.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B230/B230M Specification for Aluminum 1350–H19 Wire for Electrical Purposes

B231/B231M Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors

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

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

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

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *Other Documents:*

ANSI H35.1/H35.1(M) Alloy and Temper Designation Systems for Aluminum[3]

NBS *Handbook 100-Copper Wire Tables, of the National Bureau of Standards*[4]

3. Classification

3.1 For the purpose of this specification, conductors are classified as follows:

3.1.1 *Class AA*—For bare conductors usually used in overhead lines.

3.1.2 *Class A*—For conductors to be covered with weather-resistant materials, and for bare conductors where greater flexibility than is afforded by Class AA is required. Conductors indicated for further fabrication into tree wire or to be insulated and laid helically with or around aluminum or ACSR messengers, shall be regarded as Class A conductors with respect to direction of lay only (see 6.3).

3.1.3 *Class B*—For conductors to be insulated with various materials such as rubber, paper, varnished cloth, and so forth, and for the conductors indicated under Class A where greater flexibility is required.

4. Ordering Information

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

4.1.1 Quantity of each size and class (Table 1),

4.1.2 Conductor size; circular-mil area or AWG (Section 7),

4.1.3 Class (Section 3),

4.1.4 Temper (Section 13),

[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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

TABLE 1 Construction of Compact-Round Concentric-Lay-Stranded, Aluminum Conductors

NOTE 1—Metric values listed below represent a soft conversion and as such they may not be the same as those metric values which are calculated from the basic metric density.

Conductor Size			Class	Number of Wires	Nominal Compact Conductor Diameter		Nominal Mass per 1000 ft, lb	Nominal Mass per Kilometer, kg[A]	Nominal DC Resistance at 20°C	
Circular Mils	AWG	mm^2			in.	mm			Ω/1000 ft	Ω/km
1 500 000		760	B	91[B,C]	1.299	33.0	1406	2092	0.0116	0.0380
1 250 000		633	B	91[B,C]	1.184	30.1	1172	1744	0.0138	0.0453
1 100 000		557	B	91[B,C]	1.112	28.2	1031	1534	0.0158	0.0518
1 000 000		507	B	61[D]	1.060	26.9	937	1394	0.0173	0.0563
900 000		456	B	61[D]	0.999	25.4	844	1257	0.0193	0.0632
800 000		405	B	61[D]	0.938	23.8	750	1116	0.0217	0.0712
750 000		380	B	61[D]	0.908	23.1	703	1046	0.0231	0.0759
700 000		355	B	61[D]	0.877	22.3	656	976	0.0248	0.0813
650 000		329	B	61[D]	0.845	21.5	609	906	0.0267	0.0875
600 000		304	B	61[D]	0.813	20.7	563	838	0.0289	0.0948
556 500		282	AA	19[E]	0.780	19.8	521	775	0.0312	0.102
550 000		279	B	61[D]	0.775	19.7	516	768	0.0315	0.103
500 000		253	B	37[F]	0.736	18.7	468	696	0.0347	0.114
500 000		253	AA	19[E]	0.736	18.7	468	696	0.0347	0.114
477 000		242	AA	19[E]	0.722	18.3	447	665	0.0364	0.119
450 000		228	B	37[F]	0.700	17.8	422	628	0.0385	0.126
400 000		203	B	37[F]	0.659	16.7	375	558	0.0434	0.142
397 500		201	AA, A	19[E]	0.659	16.7	372	554	0.0436	0.143
350 000		177	B	37[F]	0.616	15.6	328	488	0.0495	0.162
350 000		177	A	19[E]	0.616	15.6	328	488	0.0495	0.162
336 400		170	A	19[E]	0.603	15.3	315	469	0.0516	0.169
336 400		170	AA	7	0.603	15.3	315	469	0.0516	0.169
300 000		152	B	37[F]	0.570	14.5	281	418	0.0578	0.190
300 000		152	A	19[E]	0.570	14.5	281	418	0.0578	0.190
300 000		152	AA	7	0.570	14.5	281	418	0.0578	0.190
266 800		135	A	19[E]	0.537	13.6	250	372	0.0650	0.213
266 800		135	AA	7	0.537	13.6	250	372	0.0650	0.213
250 000		127	B	37[F]	0.520	13.2	234	348	0.0694	0.228
250 000		127	A	19[E]	0.520	13.2	234	348	0.0694	0.228
250 000		127	AA	7	0.520	13.2	234	348	0.0694	0.228
211 600	0000	107	B	19[E]	0.475	12.1	198	295	0.0820	0.269
211 600	0000	107	AA, A	7	0.475	12.1	198	295	0.0820	0.269
167 800	000	85.0	B	19[E]	0.423	10.7	157	234	0.103	0.338
167 800	000	85.0	AA, A	7	0.423	10.7	157	234	0.103	0.338
133 100	00	67.4	B	19[E]	0.376	9.55	125	186	0.130	0.428
133 100	00	67.4	AA, A	7	0.376	9.55	125	186	0.130	0.428
105 600	0	53.5	B	19[E]	0.336	8.53	98.9	147	0.164	0.539
105 600	0	53.5	AA, A	7	0.336	8.53	98.9	147	0.164	0.539
83 690	1	42.4	B	19[E]	0.299	7.59	78.4	117	0.207	0.680
83 690	1	42.4	AA, A	7	0.299	7.59	78.4	117	0.207	0.680
66 360	2	33.6	AA, A, B	7	0.268	6.81	62.2	92.6	0.261	0.857
52 620	3	26.7	A, B	7	0.238	6.05	49.3	73.3	0.330	1.08
41 740	4	21.2	A, B	7	0.213	5.41	39.1	58.2	0.416	1.36
26 240	6	13.3	A, B	7	0.169	4.29	24.6	36.6	0.661	2.17
16 510	8	8.37	A, B	7	0.134	3.40	15.5	23.1	1.05	3.44

[A] 1 lb/1000 ft = 1.488 kg/km.
[B] 85 wires minimum.
[C] As agreed upon between the manufacturer and the customer, these sizes may be produced with a 61 to 58 wire construction of the appropriate wire size.
[D] 58 wires minimum.
[E] 18 wires minimum.
[F] 35 wires minimum.

4.1.5 Lay direction if nonstandard (see 6.3 and 6.4), reversed or unidirectional (see 6.4) or special (see 6.5),

4.1.6 Special tension test, if required (see 17.2),

4.1.7 Place of inspection (Section 18), and

4.1.8 Packaging and Package Marking (Section 19).

5. Joints

5.1 *1350-H19 Conductors for Use in Bare Overhead Lines:*

5.1.1 Joints may be made in the six outer wires of seven-strand conductors by cold-pressure welding or by electric-butt, cold-upset welding, but not by electric-butt welding. Joints are not permitted in the finished center wire of seven-stranded conductors.

5.1.2 Joints may be made in any of the wires in conductors of 18 or more wires by electric-butt welding, cold-pressure welding, or electric butt, cold-upset welding.

5.1.3 The minimum distance between a wire joint and another joint either in the same wire or in other wires of the completed conductor shall be 50 ft [15 m].

5.2 *Conductors of All Tempers to Be Insulated or Covered:*

5.2.1 Joints may be made in any of the wires of any stranding by electric-butt welding, cold-pressure welding, or electric-butt, cold-upset welding.

5.2.2 Joints in the individual wires in a finished conductor shall be not closer together than 1 ft [0.3 m] for conductors of 19 wires or less, or closer than 1 ft in a layer for conductors of more than 19 wires.

5.3 No joint or splice shall be made in a stranded conductor as a whole.

6. Lay

6.1 The length of lay or each layer for Classes AA and A shall be not less than 11 nor more than 17.5 times the outside diameter of that layer.

6.2 The length of lay of the outer layer for Class B shall be not less than 8 nor more than 16 times the outside diameter of the completed conductor, except that for sizes No. 2 AWG [33.6 mm^2] and smaller, the maximum length of lay shall be not more than 17.5 times the outside diameter of the completed conductor.

6.3 The direction of lay of the outer layer shall be right-hand for Classes AA and A, and it shall be reversed in successive layers. For Class A stranding where the conductors are to be insulated and laid helically with or around aluminum or ACSR messengers, the stranding lay direction may be unidirectional or unilay in successive layers.

6.4 The direction of lay of the outer layer shall be left-hand for Class B, and it shall be reversed in successive layers, unidirectional, or unilay.

6.5 Other lay requirements may be furnished by special agreement between the manufacturer and the purchaser.

7. Construction

7.1 The construction of the conductors shall be as shown in Table 1 as to number of wires and cross-sectional area of the completed conductor, and the lay shall be in accordance with Section 6.

7.2 Wire used in the fabrication of conductor shall be of such dimensions as to produce a finished conductor having a nominal cross-sectional area and diameter as prescribed in Table 1.

8. Rated Strength of Conductor

8.1 The rated strength of 1350-H19 conductors shall be taken as the percentage, indicated in Table 2, of the sum of the strengths of the component wires, calculated on the basis of the nominal wire diameter for the corresponding noncompacted construction given in Specification B231/B231M and the specified minimum average tensile strength given in Specification B230/B230M for 1350-H19 wire (Explanatory Note 6).

8.2 Calculations for rated strengths of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors shall be made on the basis of the strengths of the component wires using the nominal wire diameter for the noncompacted construction given in Specification B231/B231M and the specified maximum and minimum tensile strengths for the appropriate temper of the respective component wires given in Specification B609/B609M. The minimum rated strengths of the conductors shall be taken as the sum of the calculated minimum strengths of the component wires multiplied by the rating factor given in Table 2. The maximum rated strength of the conductors shall be taken as the sum of the calculated maximum strengths of the component wires (Explanatory Note 6).

TABLE 2 Rating Factors

Stranding		
Number of Wires in Conductor	Number of Layers	Rating Factor, %
7	1	96
19[A]	2	93
37[B]	3	91
61[C]	4	90
91[D]	5	90

[A] 18 wires minimum.
[B] 35 wires minimum.
[C] 58 wires minimum.
[D] 85 wires minimum.

8.3 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.

8.4 Rated strengths of conductors are given in Table 3.

9. Density

9.1 For the purpose of calculating mass, linear density, cross sections, and so forth, the density of aluminum 1350 shall be taken as 2705 kg/m^3 (0.0975 $lb/in.^3$) at 20°C.

10. Mass and Electrical Resistance

10.1 The mass and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The approximate mass and electrical resistance may be determined using an increment of 2 %. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 1).

10.2 The maximum electrical resistance of a unit length of stranded conductor shall not exceed the nominal dc resistance (Table 1) +2 % (Explanatory Note 1).

10.2.1 When the dc resistance is measured at other than 20°C, it is to corrected by using the multiplying factor given in Table 4.

10.3 For conductors to be used in covered or insulated wires or cables, direct current (DC) resistance measurement may be used instead of the method outlined in Section 14 to determine compliance with this specification.

11. Mechanical and Electrical Tests of Conductors Fabricated from Wires other than 1350-H26, -H24, or -H242 and Annealed after Stranding to Meet 1350-H26, -H24, or -H242 Requirements

11.1 The completed conductor shall be tested as a unit. The minimum breaking strength of bare conductors shall be not less than minimum 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 minimum rated strength if

TABLE 3 Conductor Rated Strengths

Conductor Size			Number of Wires	1350-H19		1350-H16, -H26[A]				1350-H14, -H24[A]			
						1350-H142, -H242[A]							
						Min		Max		Min		Max	
cmil	AWG	mm^2		kips	kN	kips	kN	kips	kN	kips	kN	kips	kN
1 500 000		760	91[B]	25.4	113	18.0	80.1	25.9	115	15.9	70.7	23.5	105
1 250 000		633	91[B]	21.6	96.3	15.0	66.7	21.6	96.1	13.3	59.2	19.6	87.3
1 100 000		557	91[B]	19.4	86.4	13.2	58.8	19.0	84.6	11.7	52.0	17.3	75.2
1 000 000		507	61[C]	17.7	78.6	12.0	53.4	17.3	76.8	10.60	47.1	15.7	69.8
900 000		456	61[C]	15.9	70.8	10.8	48.1	15.6	69.2	9.55	42.5	14.1	62.9
800 000		405	61[C]	14.4	64.1	9.61	42.7	13.8	61.5	8.48	37.7	12.6	55.9
750 000		380	61[C]	13.5	60.2	9.02	40.1	13.0	57.7	7.95	35.4	11.8	52.4
700 000		355	61[C]	12.9	57.2	8.41	37.4	12.1	53.8	7.42	33.0	11.0	48.9
650 000		329	61[C]	11.9	53.1	7.81	34.7	11.2	49.9	6.89	30.6	10.2	45.4
600 000		304	61[C]	11.50	51.0	7.21	32.1	10.4	46.1	6.36	28.3	9.43	41.9
556 500		282	19[D]	9.75	43.4	6.91	30.7	9.61	42.8	6.09	27.1	8.74	38.9
550 000		279	61[C]	10.50	46.7	6.62	29.4	9.51	42.3	5.84	26.0	8.65	38.5
500 000		253	37[E]	9.11	40.5	6.07	27.0	8.63	38.4	5.36	23.8	7.85	34.9
500 000		253	19[D]	8.76	39.0	6.21	27.6	8.64	38.4	5.48	24.4	7.85	34.9
477 000		242	19[D]	8.36	37.2	5.92	26.3	8.24	36.6	5.22	23.2	7.49	33.3
450 000		228	37[E]	8.20	36.5	5.47	24.3	7.78	34.6	4.83	21.5	7.07	31.5
400 000		203	37[E]	7.44	33.1	4.86	21.6	6.91	30.8	4.29	19.1	6.29	28.0
397 500		201	19[D]	7.11	31.6	4.93	21.9	6.86	30.5	4.35	19.4	6.24	27.8
350 000		177	37[E]	6.76	30.1	4.26	18.9	6.05	26.9	3.76	16.7	5.50	24.5
350 000		177	19[D]	6.39	28.4	4.34	19.3	6.05	26.9	3.83	17.1	5.50	24.4
336 400		170	19[D]	6.15	27.3	4.18	18.6	5.82	25.9	3.69	16.4	5.29	23.5
336 400		170	7	5.96	26.5	4.31	19.2	5.81	25.9	3.80	16.9	5.28	23.5
300 000		152	37[E]	5.89	26.2	3.64	16.2	5.18	23.0	3.21	14.3	4.71	20.9
300 000		152	19[D]	5.48	24.4	3.73	16.6	5.19	23.1	3.29	14.6	4.72	21.0
300 000		152	7	5.43	24.1	3.84	17.1	5.18	23.1	3.39	15.1	4.71	21.0
266 800		135	19[D]	4.97	22.1	3.31	14.7	4.61	20.5	2.92	13.0	4.19	18.6
266 800		135	7	4.83	21.5	3.42	15.2	4.61	20.5	3.02	13.4	4.19	18.6
250 000		127	37[E]	4.91	21.9	3.04	13.5	4.32	19.2	2.68	11.9	3.93	17.5
250 000		127	19[D]	4.66	20.7	3.10	13.8	4.32	19.2	2.74	12.2	3.93	17.5
250 000		127	7	4.52	20.1	3.21	14.3	4.32	19.2	2.83	12.6	3.93	17.5
211 600	0000	107	19[D]	4.02	17.9	2.63	11.7	3.65	16.3	2.32	10.3	3.32	14.8
211 600	0000	107	7	3.83	17.0	2.71	12.1	3.66	16.3	2.39	10.6	3.33	14.8
167 800	000	85.0	19[D]	3.31	14.7	2.08	9.27	2.90	12.9	1.84	8.18	2.64	11.7
167 800	000	85.0	7	3.04	13.5	2.15	9.56	2.90	12.9	1.90	8.44	2.63	11.7
133 100	00	67.4	19[D]	2.67	11.9	1.65	7.35	2.30	10.2	1.46	6.49	2.09	9.30
133 100	00	67.4	7	2.51	11.2	1.71	7.59	2.30	10.2	1.51	6.70	2.09	9.30
105 600	0	53.5	19[D]	2.16	9.62	1.31	5.84	1.83	8.13	1.16	5.15	1.66	7.39
105 600	0	53.5	7	1.99	8.85	1.35	6.02	1.82	8.11	1.19	5.31	1.66	7.38
83 690	1	42.4	19[D]	1.74	7.76	1.04	4.63	1.45	6.44	0.918	4.08	1.32	5.85
83 690	1	42.4	7	1.64	7.29	1.07	4.77	1.44	6.43	0.946	4.21	1.31	5.84
66 360	2	33.6	7	1.35	6.01	0.851	3.79	1.15	5.10	0.751	3.34	1.04	4.64
52 620	3	26.7	7	1.09	4.85	0.674	3.00	0.909	4.04	0.595	2.65	0.827	3.68
41 740	4	21.1	7	0.881	3.92	0.535	2.38	0.721	3.21	0.472	2.10	0.655	2.92
26 240	6	13.3	7	0.563	2.51	0.336	1.49	0.453	2.02	0.297	1.32	0.412	1.83
16 510	8	8.37	7	0.312	1.39	0.212	0.943	0.286	1.27	0.187	0.832	0.260	1.16

[A] The minimum rated strength for a 1350 H142 or a 1350 H242 temper is based on the minimum tensile strength of the 1350 H14 or 1350 H24 temper. The maximum rated strength for a 1350 H142 or a 1350 H242 temper is based on the maximum tnesile strength of the 1350 H16 H24 temper.
[B] 85 wires minimum.
[C] 58 wires minimum.
[D] 18 wires minimum.
[E] 35 wires minimum.

failure occurs inside, or within 1 in. of the end of either gripping device. The maximum breaking strength of 1350-H26, -H24, or -H242 conductors shall be not greater than their maximum rated strengths. The free length between grips of the test specimen shall be not less than 24 in. [600 mm], and care shall be taken to ensure that the wires in the conductor are evenly gripped during the test (Section 8 and Explanatory Note 3).

12. Workmanship, Finish, and Appearance

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

13. Requirements of Wires

13.1 Before stranding and compacting, the round wire used shall meet the requirements of Specifications B230/B230M or B609/B609M, whichever is applicable.

13.2 Wire shaped before stranding shall meet the requirements of the appropriate specification listed in 13.1 except for tensile and elongation requirements and diameter tolerance. For 1350-H19 temper, the minimum tensile and elongation requirements shall be 96 % of those for round wire of the same nominal area, provided the completed conductor is capable of meeting the requirements of Sections 8 and 17. For 1350-H16

TABLE 4 Temperature Correction Factors for Conductor Resistance

Temperature,°C	Multiplying Factor for Conversion to 20°C
0	1.088
5	1.064
10	1.042
15	1.020
20	1.000
25	0.980
30	0.961
35	0.943
40	0.925
45	0.908
50	0.892
55	0.876
60	0.861
65	0.846
70	0.832
75	0.818
80	0.805
85	0.792
90	0.780

or -H26, 1350-H14 or -H24, and 1350-H142 or -H242, the tensile requirements shall be the same as those for round wires of equal nominal area. The area tolerances for shaped wire of all tempers shall be such that the finished conductor conforms to Section 14.

14. Variation in Area

14.1 The cross-sectional area of the conductor shall be not less than 98 % of the cross-sectional area as specified in Column 1 of Table 1.

14.2 The manufacturer shall determine the cross-sectional area by Test Method B263. In applying this method, the increment in weight resulting from stranding may be the applicable value specified in 10.1 or it may be calculated from the measured dimensions of the sample under test. In case of question regarding area compliance, the actual mass increment due to stranding shall be calculated.

15. Variation in Diameter

15.1 The average diameter of the conductor shall vary by not more than +1–2 % from the diameter specified in Table 1 except that sizes 0 [53.5 mm^2] through 0000 [107 mm^2] shall vary by not more than +1½ –2½ % from the average diameter specified in Table 1.

16. Sampling

16.1 The aluminum cross-sectional area (Section 14) and the diameter (Section 15) shall be measured on a sample of completed conductor. At least one sample shall be tested on each size of conductor on each order of quantities from 5000 to 100 000 ft [1500 to 30 000 m], and one additional sample tested from each 100 000 ft thereafter.

17. Mechanical and Electrical Tests of Conductors with 1350-H19 Wire and Conductors Fabricated from 1350-H16 or -H26, 1350-H14 or -H24, or 1350-H142 or -H242 Wire and Not Annealed After Stranding

17.1 Tests for the mechanical and electrical properties of wire composing the conductor shall be made before, but not after stranding, unless otherwise agreed by the manufacturer and the purchaser as provided in 17.2 (Explanatory Note 2).

17.2 At the option of the purchaser, at the time of placing the order, tension and elongation tests of wire before stranding may be waived, and the completed conductor may be tested as a unit. The minimum breaking strength of conductors so tested shall be not less than the rated strength of 1350-H19 conductors or the minimum rated strength of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors 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 or minimum rated strength if failure occurs inside, or within 1 in. of the end of either gripping device. The maximum breaking strength of 1350-H16, -H26, -H14, -H24, -H142, and -H242 conductors shall be not greater than their maximum rated strengths. The free length between grips of the test specimen shall be not less than 24 in. [600 mm] and care shall be taken to ensure that the wires in the conductor are evenly gripped during the test (Section 8 and Explanatory Note 3).

18. Inspection

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

18.2 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.

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

19. Packaging and Package Marking

19.1 Package sizes for conductors shall be agreed upon by the manufacturer and the purchaser in the placing of individual orders.

19.2 The conductors shall be protected against damage in ordinary handling and shipping.

19.3 There shall be only one length of conductor on a reel unless otherwise agreed upon by the manufacturer and purchaser at time of placing order.

19.4 The net mass, length (and number of lengths, if more than one length is included in the package), size, kind of conductor, purchase order number, and any other marks required by the purchase order shall be marked on a tag attached to the end of the conductor inside of the package. The same information, together with the manufacturer's serial number (if any) and all shipping marks required by the purchaser, shall appear on the outside of each package.

20. Keywords

20.1 aluminum conductors; aluminum electrical conductor; compact round stranded conductors; concentric-lay-stranded conductors; electrical conductor; electrical conductor-aluminum; stranded conductors

EXPLANATORY NOTES

NOTE 1—In this specification only compact round concentric-lay-stranded conductor constructions are specifically designated. Constructions not included in this specification should be specifically agreed upon by the manufacturer and the purchaser when placing the order.

NOTE 2—For definitions of terms relating to conductors, reference should be made to Terminology B354.

NOTE 3—The increment of mass or electrical resistance of a completed concentric-lay-stranded conductor (k) in percent is as follows:

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

where m is the stranding factor, and is also the ratio of the mass of linear density 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 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 =

$$\frac{\textit{length of lay}}{\textit{diameter of helical path of the wire}}$$

The derivation of the above as given in *NBS Handbook 100* is based on round wire constructions which are applicable to compacted wire constructions.

NOTE 4—Individual wires should not be unlaid from compact round conductors for testing purposes. Some physical properties of the individual compacted wires may be altered by the deformation brought about by compacting, unlaying, and straightening for test.

NOTE 5—To test stranded conductors for breaking strength successfully as a unit requires adequate means of gripping the ends of the test specimen without causing damage that may result in a failure below the actual strength of the conductor. Various means are available, such as compression sleeves, split sleeves, and preformed grips, but ordinary jaws or clamping devices usually are not suitable.

NOTE 6—The calculation of a nominal strand wire diameter (in.) is =

$$\sqrt{\left(\frac{\textit{nominal circular mil area of conductor}}{\textit{number of strand wires}}\right)} \times 0.001$$

The calculation of a nominal strand wire diameter (mm) is =

$$\sqrt{\left(\frac{\textit{nominal mm}^2\ \textit{area of conductor}}{\textit{number of strand wires}} \times \frac{4}{\pi}\right)}$$

Where the *number of strand wires* is the numeric value of the number of strand wires as shown in Table 1.