Designation: B 231M – 95
METRIC

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

This standard is issued under the fixed designation B 231M; 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 (3/4 hard), 1350-H14 or -H24 (1/2 hard), and 1350-H142 or -H242 (1/2 hard), bare concentric-lay-stranded conductors made with a straight round central wire surrounded by one or more layers of helically layed wires. The conductors are for general use for electrical purposes (Explanatory Notes 1 and 2).

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

NOTE 2—The aluminum and temper designations conform to ANSI H35.1(M). Aluminum 1350 corresponds to Unified Numbering System A91350 in accordance with Practice E 257.

NOTE 3—This specification is the metric companion of Specification B 231.

NOTE 4—Sealed conductors that are intended to prevent longitudinal water propagation and are further covered/insulated are also permitted within the guidelines of this specification.

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:

2.1.1 *ASTM Standards:*

B 193 Test Method for Resistivity of Electrical Conductor Materials[2]

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

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

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

B 609M Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes [Metric][2]

B 682 Specification for Standard Metric Sizes of Electrical Conductors[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]

2.1.2 *Other Documents:*

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

NBS Handbook 100—Copper Wire Tables[6]

3. Classification

3.1 For the purpose of this specification, conductors are classified as follows (Explanatory Notes 1 and 2):

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 intended 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 7.4).

3.1.3 *Class B*—For conductors to be insulated with various materials, such as elastomers, etc., and for the conductors indicated under Class A where greater flexibility is required.

3.1.4 *Classes C and D*—For conductors where greater flexibility is required than is provided by Class B conductors.

4. Ordering Information

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

4.1.1 Quantity of each size, stranding, and class,

4.1.2 Conductor size, square millimetres, if cross-sectional area is specified as a requirement (Section 8, Tables 1 and 2), or

4.1.2.1 Conductor size, number and diameter of wires for Class B, C, or D conductors, if cross-sectional area is not specified as a requirement (see 8.2).

4.1.3 Temper (see 5.1),

4.1.4 Details of special-purpose lays, when required (see 7.2, 7.3, 7.4, and 7.5),

4.1.5 Special tension test, if required (see 14.1.1 and 14.2.1),

4.1.6 Place of inspection (Section 16),

4.1.7 Package size and type (see 17.1 and Table 1),

4.1.8 Heavy wood lagging, if required (see 17.3),

4.1.9 Special package marking, if required (see 17.4), and

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[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, 13th Floor, New York, NY 10036.

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

4.1.10 Method of cross-sectional area determination if not optional (see 12.1).

4.2 Supplementary Requirements shall apply only when specified by the purchaser in the inquiry, contract, or purchase order for direct procurement by agencies of the U.S. Government (S1, S2, and S3).

5. Requirements for Wires

5.1 Aluminum wire employed in Classes AA and A conductors shall be 1350-H19, unless otherwise specified. The purchaser shall designate the temper of conductors of Classes B, C, and D.

5.1.1 For conductor tempers other than 1350-H19, when temper designations are not more specific in the inquiry and purchase order, the manufacturer shall have the following options on manufacturing method:

5.1.1.1 Strand the conductor from wires drawn to final temper;

5.1.1.2 Strand the conductor from wires drawn to H19 temper and annealed to final temper prior to stranding;

5.1.1.3 Strand the conductor from 1350-H19 wires and anneal the stranded conductor to final temper.

5.2 Before stranding, the aluminum wire shall meet the requirements of Specification B 230M or Specification B 609M, whichever is applicable.

5.3 All wires in the conductor shall be of the same temper.

6. Joints

6.1 Only cold-pressure welds or electric-butt, cold-upset welds may be made in the six outer wires of (*1*) Class AA finished conductors composed of seven wires or (*2*) Class A finished conductors composed of seven wires used in overhead lines. In other conductors, electric-butt welds, cold-pressure welds, or electric-butt, cold-upset welds may be made in the finished wires composing conductors, but such welds shall be not closer than prescribed in Table 3 (Explanatory Note 3).

7. Lay

7.1 For Class AA conductors composed of seven wires or more the preferred lay of a layer of wires is 13.5 times the outside diameter of that layer, but the lay shall be not less than 10 nor more than 16 times this diameter.

7.2 For all other classes the lay of a layer of wires shall be not less than 8 nor more than 16 times the outside diameter of that layer, except that for conductors composed of 37 wires or more, this requirement shall apply only to the two outermost layers. The lay of the layers other than the two outermost layers shall be at the option of the manufacturer, unless otherwise agreed upon.

7.2.1 For conductors to be used in covered or insulated wires or cables, the lay length of the wires shall be not less than 8 nor more than 16 times the outer diameter of the finished conductor. For conductors of 37 wires or more, this requirement shall apply to the wires in the outer two layers. The lay of the layers other than the two outer layers shall be at the option of the manufacturer, unless otherwise agreed upon.

7.3 Other lays for special purposes shall be furnished by special agreement between the manufacturer and the purchaser at the time of placing the order (Explanatory Note 4).

7.4 The direction of lay of the outer layer of aluminum wires shall be right-hand for Classes AA and A and left-hand for other classes, unless the direction of lay is specified otherwise by the purchaser.

7.5 The direction of lay for conductors having a nominal cross-sectional area larger than 8 mm^2 shall be reversed in successive layers, unless otherwise specified by the purchaser.

7.5.1 For conductors to be used in covered or insulated wires or cables, the direction of lay of the outer layer shall be left hand and may be reversed or unidirectional/unilay in successive layers, unless otherwise agreed upon with the purchaser.

8. Construction

8.1 The number, diameter, and area of cross section of wires in the various classes of concentric-lay-stranded conductors shall conform to the requirements prescribed in Table 1 or, if applicable, Table 2.

8.2 When cross-sectional area is not specified as a requirement, the sizes of conductors, number of wires, and diameters for Classes B, C, and D are subject to agreement between the purchaser and the manufacturer. When conductor cross-sectional area is specified as a requirement of conductors, a representative number of conductor sizes is shown in Table 3 where the diameter of wires is nominal. Where "combination strand" (wires in the outer layer having a larger diameter than those in the inner layers) is required in order to insulate the conductor properly or for other purposes, the individual wire diameters shall be subject to a tolerance of ±5 %, provided that the area of cross section after stranding, if applicable, is in accordance with Section 12.

8.3 Where compressed stranding is required in order to cover the conductor properly or for other purposes, one or more layers of any stranded conductor consisting of seven wires or more may be slightly compressed, thereby reducing the outside diameter of the conductor to the nominal values shown in Table 2, provided that the area of cross section after compressing, if applicable, is in accordance with Section 12.

8.3.1 The average diameter of the conductor in 8.3 shall vary by not more than +1 or −2 % from the diameter specified in Table 2.

9. Rated Strength of Conductor

9.1 The rated strength of 1350-H19 conductors shall be taken as the percentage, indicated in Table 4, of the sum of the strengths of the component wires, calculated on the basis of the nominal wire diameter given in Table 1 or, if applicable, Table 2 and the specified minimum average tensile strength given in Specification B 230M. In the case of compressed conductors, the nominal wire diameter should be that of the corresponding non-compressed construction as listed in Tables 1 and 2. Rated strengths for 1350-H19 Classes AA and A conductors are given in Table 1.

9.2 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 given in Table 1 or, if applicable, Table 2 and the specified maximum and minimum tensile strengths for the appropriate temper of the respective component wires given in Specification B 609M. The minimum

TABLE 1 Construction Requirements, Linear Density, Rated Strengths, and Recommended Reel Sizes and Shipping Lengths of Conductors, Classes AA and A

NOTE—Sizes selected from Specification B 682.

Conductor Size, mm²	Class	Stranding		Mass, kg/km	Rated Strength 1350-H19, kN	Recommended Package Sizes[A]		
		Number of Wires	Diameter, mm			Reel Designation[B]	Nominal Length of Each Piece, m	Nominal Mass of Each Length, kg
2000	A	127	4.48	5 632	294	RMT 90.45	770	4325
1600	A	127	4.01	4 512	236	RMT 90.45	960	4325
1250	A	91	4.18	3 479	183	RMT 90.45	1185	4130
1120	A	91	3.96	3 123	165	RMT 90.45	1320	4130
1000	A	91	3.74	2 785	151	RMT 90.45	1495	4130
900	AA	61	4.33	2 478	133	RMT 90.45	1785	4425
800	AA, A	61	4.09	2 211	119	RMT 90.45	2000	4425
						RM 68.38	1000	2215
710	AA, A	61	3.85	1 959	105	RMT 90.45	2260	4425
						RM 68.38	1130	2215
630	AA, A	61	3.63	1 742	96.6	RMT 90.45	2540	4425
						RM 68.38	1270	2215
560	AA, A	61	3.42	1 546	85.7	RMT 90.45	2860	4425
						RM 68.38	1430	2215
500	AA	37	4.15	1 381	75.1	RMT 84.45	2430	3355
						RM 66.32	1215	1680
						NR 48.28	610	840
500	A	61	3.23	1 379	76.5	RMT 90.45	3210	4425
						RM 68.38	1605	2215
450	AA	37	3 94	1 245	67.7	RMT 84.45	2695	3355
						RM 66.32	1350	1680
						NR 48.28	675	840
450	A	61	3.06	1 238	68.6	RMT 90.45	3575	4425
						RM 68.38	1790	2215
400	AA	37	3.71	1 104	61.9	RMT 84.45	3040	3355
						RM 66.32	1520	1680
						NR 48.28	760	840
400	A	61	2.89	1 104	63.0	RMT 90.45	4010	4425
						RM 68.38	2005	2215
355	AA	37	3.50	982	55.1	RMT 84.45	3415	3355
						RM 66.32	1710	1680
						NR 48.28	855	840
355	A	61	2.72	978	57.4	RMT 90.45	4525	4425
						RM 68.38	2265	2215
315	AA, A	37	3.29	868	48.7	RMT 84.45	3865	3355
						RM 66.32	1935	1680
						NR 48.28	970	840
280	AA	19	4 33	772	42.9	RM 66.32	2235	1725
						NR 48.28	1115	860
						NR 42.28	745	575
280	A	37	3.10	771	43.2	RMT 84.45	4350	3355
						RM 66.32	2180	1680
						NR 48.28	1090	840
250	AA	19	4.09	689	38.3	RM 66.32	2505	1725
						NR 48.28	1250	860
						NR 42.28	835	575
250	A	37	2.93	688	39.7	RMT 84.45	875	3355
						RM 66.32	2440	1680
						NR 48.28	1220	840
224	AA	19	3.87	617	34.3	RM 66.32	2795	1725
						NR 48.28	1395	860
						NR 42.28	930	575
200	AA, A	19	3.66	552	31.6	RM 66.32	3125	1725
						NR 48.28	1560	860
						NR 42.28	1040	575
180	A	19	3.47	496	28.4	RM 66.32	3480	1725
						NR 48.28	1730	860
						NR 42.28	1160	575
160	A	19	3.27	440	25.2	RM 66.32	3920	1725
						NR 48.28	1955	860
						NR 42.28	1305	575
140	AA	7	5.05	387.0	22.2	NR 42.28	1640	635
						NR 36.22	830	320
140	A	19	3.06	386	22.1	RM 66.32	4470	1725
						NR 48.28	2230	860
						NR 42.28	1490	575
125	AA	7	4.77	345	19.8	NR 42.28	1840	635
						NR 36.22	930	320

TABLE 1 *Continued*

Conductor Size, mm²	Class	Stranding		Mass, kg/km	Rated Strength 1350-H19, kN	Recommended Package Sizes[A]		
		Number of Wires	Diameter, mm			Reel Designation[B]	Nominal Length of Each Piece, m	Nominal Mass of Each Length, kg
125	A	19	2.89	343.9	20.3	RM 66.32	5015	1725
						NR 48.28	2500	860
						NR 42.28	1670	575
100	AA, A	7	4.26	275.3	15.8	NR 42.28	2305	635
						NR 36.22	1160	320
80.0	AA, A	7	3.81	220.2	12.6	NR 42.28	2885	635
						NR 36.22	1455	320
63.0	AA, A	7	3.39	174.3	10.3	NR 42.28	3645	635
						NR 36.22	1835	320
50.0	AA, A	7	3.02	138.3	8.18	NR 42.28	4590	635
						NR 36.22	2315	320
40.0	AA, A	7	2.70	110.6	6.93	NR 42.28	5741	635
						NR 36.22	2895	320
31.5	AA, A	7	2.39	86.6	5.58	NR 42.28	7335	635
						NR 36.22	3695	320
25.0	A	7	2.13	68.8	4.55	NR 42.28	9230	635
						NR 36.22	4650	320
20.0	A	7	1.91	55.3	3.75	NR 42.28	11485	635
						NR 36.22	5785	320
16.0	A	7	1.71	44.4	3.01	NR 42.28	14300	635
						NR 36.22	7205	320
12.5	A	7	1.51	34.6	2.35	NR 42.28	18355	635
						NR 36.22	9250	320

[A] For information only.
[B] See Table 6 for dimensions of standard reels.

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 4. The maximum rated strength of the conductors shall be taken as the sum of the calculated maximum strengths of the component wires.

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

10. Density

10.1 For the purpose of calculating mass, cross sections, etc., the density of aluminum 1350 shall be taken as 2705 kg/m³ 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 mass 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 (Explanatory Note 5).

11.2 The maximum electrical resistance of a unit length of stranded conductor shall not exceed 2 % over the nominal D-C resistance shown in Table 2 (Explanatory Note 8). When the D-C resistance is measured at other than 20°C, it is to be corrected by using the multiplying factor given in Table 7.

11.3 Direct current (D-C) resistance measurement may be used to determine compliance with this specification; however, the referee method shall be that outlined in Section 12.

12. Variation in Area

12.1 The area of cross section of the conductor shall be not less than 98 % of the area of cross section for the conductor size listed in Column 1 of Table 1 or, if applicable, Table 2. Unless otherwise specified by the purchaser, the manufacturer may have the option of determining the cross sectional area by either of the following methods except that in case of question regarding area compliance, the method of 12.1.2 shall be used.

12.1.1 The area of cross section of a conductor may be determined by calculations from diameter measurements, expressed to two decimal places, of its component wires at any point when measured perpendicularly to their axes.

12.1.2 The area of cross section of the wires of a conductor may be determined by Test Method B 263. In applying this method, the increment in mass resulting from stranding may be the applicable value specified in 11.1 or may be calculated from the measured component dimensions of the sample under test. In case of question regarding area compliance, the actual mass increment due to stranding shall be calculated.

13. Finish

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

14. Mechanical and Electrical Tests

14.1 *Conductors NOT Annealed After Stranding:*

14.1.1 Wires composing the conductors shall be tested prior to stranding in accordance with the applicable specification (see 5.2), and tests on the conductor are not required. However, when requested by the purchaser and agreed to by the manufacturer at the time of ordering, the tension tests of wires before stranding may be waived and the conductor tested in accordance with 14.1.2 or wires removed from the conductor tested in accordance with 14.1.3.

14.1.2 When the conductor is tested as a unit, the