Designation: B549 – 13

# Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced for Use in Overhead Electrical Conductors[1]

This standard is issued under the fixed designation B549; 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 concentric-lay-stranded conductors made from round aluminum 1350-H19 (extra hard) aluminum wires and round aluminum-clad steel core wires for use as overhead electrical conductors (Explanatory Note 1 and Note 2).

1.2 The SI values of density and resistivity are to be regarded as standard. For all other properties the inch-pound units are regarded as standard and the SI units may be approximate.

## 2. Referenced Documents

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

2.2 *ASTM Standards:*[2]

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

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

B354 Terminology Relating to Uninsulated Metallic 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

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

2.3 *ANSI Standards:*[3]

ANSI C 42.100 Dictionary of Electrical and Electronics Terms

ANSI H 35.1 American National Standard Alloy and Temper Designation Systems for Aluminum

2.4 *Other Standard:*

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

## 3. Terminology

3.1 *Description of Terms Specific to This Standard*

3.1.1 ACSR covered by this specification has one type of steel core wire which is designated by the following abbreviation (Explanatory Note 2):

3.1.1.1 *ACSR/AW*—ACSR using aluminum-clad steel wire (Explanatory Note 2).

## 4. Classification

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

4.1.1 *Class AA*—For bare conductors usually used in overhead lines. These conductors are used as follows:

4.1.1.1 Conductors used for regular overhead line construction and

4.1.1.2 Conductors having a high ratio of mechanical strength to current-carrying capacity used for overhead ground wires and for extra-long span construction.

4.1.2 *Class A*—For conductors to be covered with weather-resistant (weatherproof) materials.

## 5. Ordering Information

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

5.1.1 Quantity of each size, stranding, and class,

5.1.2 Conductor size: circular mil area or AWG of aluminum wires (Section 9 and Table 1),

[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 1, 2013. Published May 2013. Originally approved in 1971. Last previous edition approved in 2010 as B549 – 10. DOI: 10.1520/B0549-13.

[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), 5301 Shawnee Rd., Alexandria, VA 22312, http://www.ntis.gov.

**TABLE 1 Construction Requirements of Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced[A]**

| | Conductor Size | | | | | Stranding | | | | | | Conductor Rated Strength | | Conductor Mass per Unit Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cross-sectional Area Using Only Aluminum Strand Wires | | Approximate Cross-sectional Area Including Nominal Aluminum Area in AW Strand Wires[D] | | | Aluminum | | | Aluminum-Clad Steel | | | | | | |
| | | | | | | Number of Wires | Nominal Diameter | | Number of Wires | Nominal Diameter | | | | | |
| Code Name[B] | cmil | $mm^2$ | cmil | $mm^2$ | Class[C] | | in. | mm | | in. | mm | (1000 lbf) | kN | lb/1000 ft | kg/km |
| Thrasher/AW | 2312000 | 1171 | 2324300 | 1178 | AA | 76 | 0.1744 | 4.43 | 19 | 0.0814 | 2.07 | 55.3 | 246 | 2472 | 3679 |
| Kiwi/AW | 2167000 | 1098 | 2176100 | 1103 | AA | 72 | 0.1735 | 4.41 | 7 | 0.1157 | 2.94 | 49.1 | 218 | 2262 | 3366 |
| Bluebird/AW | 2156000 | 1092 | 2173100 | 1101 | AA | 84 | 0.1602 | 4.07 | 19 | 0.0961 | 2.44 | 59.0 | 262 | 2437 | 3627 |
| Chukar/AW | 1780000 | 902 | 1795200 | 910 | AA | 84 | 0.1456 | 3.70 | 19 | 0.0874 | 2.22 | 49.4 | 220 | 2013 | 2996 |
| Falcon/AW | 1590000 | 806 | 1609800 | 816 | AA | 54 | 0.1716 | 4.36 | 19 | 0.1030 | 2.62 | 53.0 | 236 | 1960 | 2917 |
| Lapwing/AW | 1590000 | 806 | 1601200 | 811 | AA | 45 | 0.1880 | 4.78 | 7 | 0.1253 | 3.18 | 41.8 | 186 | 1746 | 2598 |
| Parrot/AW | 1510500 | 765 | 1528200 | 774 | AA | 54 | 0.1672 | 4.25 | 19 | 0.1003 | 2.55 | 50.3 | 224 | 1860 | 2768 |
| Nuthatch/AW | 1510500 | 765 | 1520500 | 770 | AA | 45 | 0.1832 | 4.65 | 7 | 0.1221 | 3.10 | 39.7 | 177 | 1658 | 2467 |
| Plover/AW | 1431000 | 725 | 1448900 | 734 | AA | 54 | 0.1628 | 4.14 | 19 | 0.0977 | 2.48 | 47.7 | 212 | 1764 | 2625 |
| Bobolink/AW | 1431000 | 725 | 1440200 | 730 | AA | 45 | 0.1783 | 4.53 | 7 | 0.1189 | 3.02 | 37.6 | 167 | 1570 | 2336 |
| Martin/AW | 1351500 | 685 | 1367700 | 693 | AA | 54 | 0.1582 | 4.02 | 19 | 0.0949 | 2.41 | 45.1 | 201 | 1665 | 2478 |
| Dipper/AW | 1351500 | 685 | 1360100 | 689 | AA | 45 | 0.1733 | 4.40 | 7 | 0.1155 | 2.93 | 35.5 | 158 | 1483 | 2207 |
| Pheasant/AW | 1272000 | 645 | 1287700 | 652 | AA | 54 | 0.1535 | 3.90 | 19 | 0.0921 | 2.34 | 42.4 | 189 | 1568 | 2333 |
| Bittern/AW | 1272000 | 645 | 1280600 | 649 | AA | 45 | 0.1681 | 4.27 | 7 | 0.1121 | 2.85 | 33.4 | 149 | 1396 | 2078 |
| Skylark/AW | 1272000 | 645 | 1275400 | 646 | AA | 36 | 0.1880 | 4.78 | 1 | 0.1880 | 4.78 | 25.7 | 114 | 1272 | 1893 |
| Grackle/AW | 1192500 | 604 | 1206700 | 611 | AA | 54 | 0.1486 | 3.77 | 19 | 0.0892 | 2.27 | 40.2 | 179 | 1470 | 2188 |
| Bunting/AW | 1192500 | 604 | 1201000 | 609 | AA | 45 | 0.1628 | 4.14 | 7 | 0.1085 | 2.76 | 31.3 | 139 | 1309 | 1948 |
| Finch/AW | 1113000 | 564 | 1127800 | 571 | AA | 54 | 0.1436 | 3.65 | 19 | 0.0862 | 2.19 | 37.5 | 167 | 1373 | 2043 |
| Bluejay/AW | 1113000 | 564 | 1120500 | 568 | AA | 45 | 0.1573 | 4.00 | 7 | 0.1049 | 2.66 | 29.3 | 130 | 1222 | 1819 |
| Curlew/AW | 1033500 | 524 | 1046100 | 530 | AA | 54 | 0.1383 | 3.51 | 7 | 0.1383 | 3.51 | 35.6 | 158 | 1274 | 1896 |
| Ortolan/AW | 1033500 | 524 | 1040000 | 527 | AA | 45 | 0.1515 | 3.85 | 7 | 0.1010 | 2.57 | 27.1 | 121 | 1134 | 1688 |
| Tanager/AW | 1033500 | 524 | 1035800 | 525 | AA | 36 | 0.1694 | 4.30 | 1 | 0.1694 | 4.30 | 21.1 | 94 | 1033 | 1537 |
| Cardinal/AW | 954000 | 483 | 966100 | 490 | AA | 54 | 0.1329 | 3.38 | 7 | 0.1329 | 3.38 | 32.9 | 146 | 1177 | 1752 |
| Rail/AW | 954000 | 483 | 960400 | 487 | AA | 45 | 0.1456 | 3.70 | 7 | 0.0971 | 2.47 | 25.4 | 113 | 1047 | 1558 |
| Catbrid/AW | 954000 | 483 | 956600 | 485 | AA | 36 | 0.1628 | 4.14 | 1 | 0.1628 | 4.14 | 19.5 | 87 | 954 | 1420 |
| Canary/AW | 900000 | 456 | 911400 | 462 | AA | 54 | 0.1291 | 3.28 | 7 | 0.1291 | 3.28 | 31.0 | 138 | 1111 | 1653 |
| Ruddy/AW | 900000 | 456 | 906100 | 459 | AA | 45 | 0.1414 | 3.59 | 7 | 0.0943 | 2.40 | 24.0 | 107 | 988 | 1470 |
| Mallary/AW | 795000 | 403 | 812700 | 412 | AA | 30 | 0.1628 | 4.14 | 19 | 0.0977 | 2.48 | 37.1 | 165 | 1160 | 1726 |
| Condor/AW | 795000 | 403 | 805000 | 408 | AA | 54 | 0.1213 | 3.08 | 7 | 0.1213 | 3.08 | 27.8 | 124 | 980 | 1458 |
| Tern/AW | 795000 | 403 | 800400 | 406 | AA | 45 | 0.1329 | 3.38 | 7 | 0.0886 | 2.25 | 21.5 | 96 | 872 | 1298 |
| Drake/AW | 795000 | 403 | 807600 | 409 | AA | 26 | 0.1749 | 4.44 | 7 | 0.1360 | 3.45 | 30.5 | 136 | 1041 | 1549 |
| Cuckoo/AW | 795000 | 403 | 805000 | 408 | AA | 24 | 0.1820 | 4.62 | 7 | 0.1213 | 3.08 | 27.5 | 122 | 981 | 1460 |
| Coot/AW | 795000 | 403 | 797200 | 404 | AA | 36 | 0.1486 | 3.77 | 1 | 0.1486 | 3.77 | 16.6 | 74 | 795 | 1183 |
| Redwing/AW | 715500 | 363 | 730900 | 370 | AA | 30 | 0.1544 | 3.92 | 19 | 0.0926 | 2.35 | 33.4 | 149 | 1043 | 1552 |
| Starling/AW | 715500 | 363 | 727400 | 369 | AA | 26 | 0.1659 | 4.21 | 7 | 0.1290 | 3.28 | 27.5 | 122 | 936 | 1393 |
| Stilt/AW | 715500 | 363 | 725000 | 367 | AA | 24 | 0.1727 | 4.39 | 7 | 0.1151 | 2.92 | 24.8 | 110 | 883 | 1314 |
| Gannet/AW | 666600 | 338 | 676600 | 343 | AA | 26 | 0.1601 | 4.07 | 7 | 0.1245 | 3.16 | 26.0 | 116 | 872 | 1298 |
| Flamingo/AW | 666600 | 338 | 675400 | 342 | AA | 24 | 0.1667 | 4.23 | 7 | 0.1111 | 2.82 | 23.1 | 103 | 823 | 1225 |
| Egret/AW | 636000 | 322 | 650200 | 329 | AA | 30 | 0.1456 | 3.70 | 19 | 0.0874 | 2.22 | 29.9 | 133 | 928 | 1381 |
| Sooter/AW | 636000 | 322 | 650500 | 330 | AA | 30 | 0.1456 | 3.70 | 7 | 0.1456 | 3.70 | 29.3 | 130 | 935 | 1391 |
| Grosbeak/AW | 636000 | 322 | 646100 | 327 | AA | 26 | 0.1564 | 3.97 | 7 | 0.1216 | 3.09 | 24.8 | 110 | 832 | 1238 |
| Rook/AW | 636000 | 322 | 644000 | 326 | AA | 24 | 0.1628 | 4.14 | 7 | 0.1085 | 2.76 | 22.0 | 98 | 785 | 1168 |

**TABLE 1** *Continued*

| Code Name[B] | Conductor Size | | | | Class[C] | Stranding | | | | | | Conductor Rated Strength | | Conductor Mass per Unit Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cross-sectional Area Using Only Aluminum Strand Wires | | Approximate Cross-sectional Area Including Nominal Aluminum Area in AW Strand Wires[D] | | | Aluminum | | | Aluminum-Clad Steel | | | | | | |
| | | | | | | Number of Wires | Nominal Diameter | | Number of Wires | Nominal Diameter | | | | | |
| | cmil | $mm^2$ | cmil | $mm^2$ | | | in. | mm | | in. | mm | (1000 lbf) | kN | lb/1000 ft | kg/km |
| Swift/AW | 636000 | 322 | 637700 | 323 | AA | 36 | 0.1329 | 3.38 | 1 | 0.1329 | 3.38 | 13.6 | 61 | 636 | 946 |
| Kingbird/AW | 636000 | 322 | 639400 | 324 | AA | 18 | 0.1880 | 4.78 | 1 | 0.1880 | 4.78 | 15.0 | 67 | 676 | 1006 |
| Teal/AW | 605000 | 307 | 618400 | 313 | AA | 30 | 0.1420 | 3.61 | 19 | 0.0852 | 2.16 | 28.5 | 127 | 883 | 1314 |
| Wood Duck/AW | 605000 | 307 | 618800 | 314 | AA | 30 | 0.1420 | 3.61 | 7 | 0.1420 | 3.61 | 28.4 | 126 | 889 | 1323 |
| Squab/AW | 605000 | 307 | 614600 | 311 | AA | 26 | 0.1525 | 3.87 | 7 | 0.1186 | 3.01 | 23.6 | 105 | 791 | 1177 |
| Peacock/AW | 605000 | 307 | 612700 | 310 | AA | 24 | 0.1588 | 4.03 | 7 | 0.1059 | 2.69 | 21.0 | 93 | 747 | 1112 |
| Eagle/AW | 556500 | 282 | 569700 | 289 | AA | 30 | 0.1362 | 3.46 | 7 | 0.1362 | 3.46 | 26.8 | 119 | 818 | 1217 |
| Dove/AW | 556500 | 282 | 564800 | 286 | AA | 26 | 0.1463 | 3.72 | 7 | 0.1138 | 2.89 | 21.9 | 97 | 728 | 1083 |
| Parakeet/AW | 556500 | 282 | 564000 | 286 | AA | 24 | 0.1523 | 3.87 | 7 | 0.1015 | 2.58 | 19.3 | 86 | 687 | 1022 |
| Ospray/AW | 556500 | 282 | 559000 | 283 | AA | 18 | 0.1758 | 4.47 | 1 | 0.1758 | 4.47 | 13.2 | 59 | 591 | 880 |
| Hen/AW | 477000 | 242 | 487900 | 247 | AA | 30 | 0.1261 | 3.20 | 7 | 0.1261 | 3.20 | 23.4 | 104 | 701 | 1043 |
| Hawk/AW | 477000 | 242 | 484600 | 246 | AA | 26 | 0.1354 | 3.44 | 7 | 0.1053 | 2.68 | 18.9 | 84 | 624 | 929 |
| Flicker/AW | 477000 | 242 | 483000 | 245 | AA | 24 | 0.1410 | 3.58 | 7 | 0.0940 | 2.39 | 16.7 | 74 | 589 | 877 |
| Pelican/AW | 477000 | 242 | 479600 | 243 | AA | 18 | 0.1628 | 4.14 | 1 | 0.1628 | 4.14 | 11.5 | 51 | 507 | 755 |
| Lark/AW | 397500 | 201 | 406000 | 206 | AA | 30 | 0.1151 | 2.92 | 7 | 0.1151 | 2.92 | 19.6 | 87 | 584 | 869 |
| Ibis/AW | 397500 | 201 | 403300 | 204 | AA | 26 | 0.1236 | 3.14 | 7 | 0.0961 | 2.44 | 15.8 | 70 | 520 | 774 |
| Brant/AW | 397500 | 201 | 403000 | 204 | AA | 24 | 0.1287 | 3.27 | 7 | 0.0858 | 2.18 | 14.1 | 63 | 491 | 731 |
| Chickadee/AW | 397500 | 201 | 399200 | 202 | AA | 18 | 0.1486 | 3.77 | 1 | 0.1486 | 3.77 | 9.8 | 44 | 422 | 628 |
| Oriole/AW | 336400 | 170 | 343700 | 174 | AA | 30 | 0.1059 | 2.69 | 7 | 0.1059 | 2.69 | 16.7 | 74 | 495 | 737 |
| Linnet/AW | 336400 | 170 | 341300 | 173 | AA | 26 | 0.1137 | 2.89 | 7 | 0.0884 | 2.25 | 13.5 | 60 | 440 | 655 |
| Merlin/AW | 336400 | 170 | 337800 | 171 | AA | 18 | 0.1367 | 3.47 | 1 | 0.1367 | 3.47 | 8.5 | 38 | 357 | 531 |
| Ostrich/AW | 300000 | 152 | 304800 | 154 | AA | 26 | 0.1074 | 2.73 | 7 | 0.0835 | 2.12 | 12.1 | 54 | 392 | 583 |
| Partridge/AW | 266800 | 135 | 271200 | 137 | AA | 26 | 0.1013 | 2.57 | 7 | 0.0788 | 2.00 | 10.8 | 48 | 349 | 519 |
| Waxwing/AW | 266800 | 135 | 268400 | 136 | AA | 18 | 0.1217 | 3.09 | 1 | 0.1217 | 3.09 | 6.8 | 30 | 283 | 421 |
| #4/0 Penguin/AW | 211600 | 107 | 215400 | 109 | AA,A | 6 | 0.1878 | 4.77 | 1 | 0.1878 | 4.77 | 7.7 | 34 | 277 | 412 |
| Cochin/AW | 211300 | 107 | 223000 | 113 | AA(+) | 12 | 0.1327 | 3.37 | 7 | 0.1327 | 3.37 | 19.8 | 88 | 477 | 710 |
| Brahma/AW | 203200 | 103 | 220700 | 112 | AA(+) | 16 | 0.1127 | 2.86 | 19 | 0.0977 | 2.48 | 27.1 | 121 | 601 | 894 |
| Dorking/AW | 190800 | 96.7 | 201900 | 102 | AA(+) | 12 | 0.1261 | 3.20 | 7 | 0.1261 | 3.20 | 18.3 | 81 | 431 | 641 |
| Dotterel/AW | 176900 | 89.6 | 187100 | 95 | AA(+) | 12 | 0.1214 | 3.08 | 7 | 0.1214 | 3.08 | 16.9 | 75 | 399 | 594 |
| #3/0 Pigeon/AW | 167800 | 85.0 | 170700 | 86.5 | AA,A | 6 | 0.1672 | 4.25 | 1 | 0.1672 | 4.25 | 6.3 | 28 | 219 | 326 |
| Guinea/AW | 159000 | 80.6 | 168000 | 85.1 | AA(+) | 12 | 0.1151 | 2.92 | 7 | 0.1151 | 2.92 | 15.3 | 68 | 359 | 534 |
| #3/0 (5/2) AWAC* | 152500 | 77.3 | 159000 | 80.6 | AA(+) | 5 | 0.1747 | 4.44 | 2 | 0.1747 | 4.44 | 9.7 | 43 | 281 | 418 |
| #3/0 (12/7) AWAC* | 141300 | 71.6 | 151300 | 76.7 | AA(+) | 4 | 0.1880 | 4.78 | 3 | 0.1880 | 4.78 | 14.2 | 63 | 373 | 555 |
| Leghorn/AW | 134600 | 68.2 | 142700 | 72.3 | AA(+) | 12 | 0.1059 | 2.69 | 7 | 0.1059 | 2.69 | 13.0 | 58 | 304 | 452 |
| #2/0 Quail/AW | 133100 | 67.4 | 135200 | 68.5 | AA,A | 6 | 0.1489 | 3.78 | 1 | 0.1489 | 3.78 | 5.1 | 23 | 174 | 259 |
| #2/0 (5/2) AWAC* | 121000 | 61.3 | 125700 | 63.7 | AA(+) | 5 | 0.1556 | 3.95 | 2 | 0.1556 | 3.95 | 8.0 | 36 | 223 | 332 |
| #2/0 (4/3) AWAC* | 112100 | 56.8 | 120200 | 60.9 | AA(+) | 4 | 0.1674 | 4.25 | 3 | 0.1674 | 4.25 | 11.9 | 53 | 296 | 441 |
| Minorca/AW | 110800 | 56.1 | 117300 | 59.4 | AA(+) | 12 | 0.0961 | 2.44 | 7 | 0.0961 | 2.44 | 10.8 | 48 | 250 | 372 |
| #1/0 Raven/AW | 105600 | 53.5 | 107700 | 54.6 | AA,A | 6 | 0.1327 | 3.37 | 1 | 0.1327 | 3.37 | 4.3 | 19 | 138 | 205 |
| Petrel/AW | 101800 | 51.6 | 107800 | 54.6 | AA(+) | 12 | 0.0921 | 2.34 | 7 | 0.0921 | 2.34 | 9.9 | 44 | 230 | 342 |

**TABLE 1** *Continued*

| Code Name[B] | Conductor Size: Cross-sectional Area Using Only Aluminum Strand Wires, cmil | Conductor Size: Cross-sectional Area Using Only Aluminum Strand Wires, mm² | Conductor Size: Approximate Cross-sectional Area Including Nominal Aluminum Area in AW Strand Wires[D], cmil | Conductor Size: Approximate Cross-sectional Area Including Nominal Aluminum Area in AW Strand Wires[D], mm² | Class[C] | Stranding: Aluminum: Number of Wires | Stranding: Aluminum: Nominal Diameter, in. | Stranding: Aluminum: Nominal Diameter, mm | Stranding: Aluminum-Clad Steel: Number of Wires | Stranding: Aluminum-Clad Steel: Nominal Diameter, in. | Stranding: Aluminum-Clad Steel: Nominal Diameter, mm | Conductor Rated Strength, (1000 lbf) | Conductor Rated Strength, kN | Conductor Mass per Unit Length, lb/1000 ft | Conductor Mass per Unit Length, kg/km |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #2/0 (3/4) AWAC* | 99830 | 50.6 | 113000 | 57.3 | AA(+) | 3 | 0.1824 | 4.63 | 4 | 0.1824 | 4.63 | 16.4 | 73 | 395 | 588 |
| #1/0 (5/2) AWAC* | 95910 | 48.6 | 99700 | 50.5 | AA(+) | 5 | 0.1385 | 3.52 | 2 | 0.1385 | 3.52 | 6.6 | 29 | 177 | 263 |
| #1/0 (4/3) AWAC* | 88800 | 45.0 | 95500 | 48.4 | AA(+) | 4 | 0.1490 | 3.79 | 3 | 0.1490 | 3.79 | 9.7 | 43 | 234 | 348 |
| #1 Robin/AW | 83690 | 42.4 | 85400 | 43.3 | AA,A | 6 | 0.1181 | 3.00 | 1 | 0.1181 | 3.00 | 3.5 | 15 | 109 | 162 |
| Grouse/AW | 80000 | 40.5 | 82700 | 41.9 | AA(+) | 8 | 0.1000 | 2.54 | 1 | 0.1670 | 4.24 | 4.9 | 22 | 138 | 205 |
| #1/0 (3/4) AWAC* | 79130 | 40.1 | 89300 | 45.2 | AA(+) | 3 | 0.1624 | 4.13 | 4 | 0.1624 | 4.13 | 13.8 | 61 | 313 | 466 |
| #1 (5/2) AWAC* | 76080 | 38.6 | 79000 | 40.0 | AA(+) | 5 | 0.1234 | 3.13 | 2 | 0.1234 | 3.13 | 5.5 | 24 | 140 | 208 |
| #1 (4/3) AWAC* | 70480 | 35.7 | 75200 | 38.1 | AA(+) | 4 | 0.1327 | 3.37 | 3 | 0.1327 | 3.37 | 8.1 | 36 | 186 | 277 |
| #2 Sparate/AW | 66360 | 33.6 | 67600 | 34.3 | AA,A | 7 | 0.0974 | 2.47 | 1 | 0.1299 | 3.30 | 3.5 | 16 | 100 | 149 |
| #2 Sparrow/AW | 66360 | 33.6 | 67100 | 34.0 | AA,A | 6 | 0.1052 | 2.67 | 1 | 0.1052 | 2.67 | 2.8 | 12 | 87 | 129 |
| #1/0 (2/5) AWAC* | 64920 | 32.9 | 80800 | 40.9 | AA(+) | 2 | 0.1802 | 4.58 | 5 | 0.1802 | 4.58 | 19.5 | 87 | 430 | 640 |
| #1 (3/4) AWAC* | 62770 | 31.8 | 71200 | 36.1 | AA(+) | 3 | 0.1446 | 3.67 | 4 | 0.1446 | 3.67 | 11.2 | 50 | 248 | 369 |
| #2 (5/2) AWAC* | 60340 | 30.6 | 62400 | 31.6 | AA(+) | 5 | 0.1099 | 2.79 | 2 | 0.1099 | 2.79 | 4.4 | 19 | 111 | 165 |
| #2 (4/3) AWAC* | 55890 | 28.3 | 60100 | 30.5 | AA(+) | 4 | 0.1182 | 3.00 | 3 | 0.1182 | 3.00 | 6.6 | 29 | 147 | 219 |
| #3 Swallow/AW | 52620 | 26.7 | 53900 | 27.3 | A | 6 | 0.0937 | 2.38 | 1 | 0.0937 | 2.38 | 2.2 | 10 | 69 | 103 |
| #1 (2/5) AWAC* | 51500 | 26.1 | 64600 | 32.7 | AA(+) | 2 | 0.1605 | 4.08 | 5 | 0.1605 | 4.08 | 16.5 | 73 | 341 | 507 |
| #2 (3/4) AWAC* | 49780 | 25.2 | 56500 | 28.6 | AA(+) | 3 | 0.1288 | 3.27 | 4 | 0.1288 | 3.27 | 9.7 | 43 | 197 | 293 |
| #3 (5/2) AWAC* | 47850 | 24.3 | 49900 | 25.3 | AA(+) | 5 | 0.0978 | 2.48 | 2 | 0.0978 | 2.48 | 3.5 | 16 | 88 | 131 |
| #3 (4/3) AWAC* | 44320 | 22.5 | 47200 | 23.9 | AA(+) | 4 | 0.1053 | 2.68 | 3 | 0.1053 | 2.68 | 5.3 | 23 | 117 | 174 |
| #4 Swanate/AW | 41740 | 21.2 | 43000 | 21.8 | AA,A | 7 | 0.0772 | 1.96 | 1 | 0.1029 | 2.61 | 2.3 | 10 | 62.7 | 93 |
| #4 Swan/AW | 41740 | 21.2 | 42700 | 21.6 | AA,A | 6 | 0.0834 | 2.12 | 1 | 0.0834 | 2.12 | 1.8 | 8 | 54.5 | 81 |
| #2 (2/5) AWAC* | 40840 | 20.7 | 51000 | 25.8 | AA(+) | 2 | 0.1429 | 3.63 | 5 | 0.1429 | 3.63 | 13.5 | 60 | 270 | 402 |
| #3 (3/4) AWAC* | 39470 | 20.0 | 44100 | 22.3 | AA(+) | 3 | 0.1147 | 2.91 | 4 | 0.1147 | 2.91 | 7.7 | 34 | 156 | 232 |
| #4 (5/2) AWAC* | 37950 | 19.2 | 39500 | 20.0 | AA(+) | 5 | 0.0871 | 2.21 | 2 | 0.0871 | 2.21 | 2.8 | 12 | 69.8 | 104 |
| #4 (4/3) AWAC* | 35150 | 17.8 | 37600 | 19.1 | AA(+) | 4 | 0.0937 | 2.38 | 3 | 0.0937 | 2.38 | 4.2 | 19 | 92.6 | 138 |
| #3 (2/5) AWAC* | 32390 | 16.4 | 39900 | 20.2 | AA(+) | 2 | 0.1273 | 3.23 | 5 | 0.1273 | 3.23 | 11.3 | 50 | 215 | 320 |
| #4 (3/4) AWAC* | 31300 | 15.9 | 35100 | 17.8 | AA(+) | 3 | 0.1022 | 2.60 | 4 | 0.1022 | 2.60 | 6.1 | 27 | 124 | 185 |
| #4 (2/5) AWAC* | 25690 | 13.0 | 32300 | 16.4 | AA(+) | 2 | 0.1133 | 2.88 | 5 | 0.1133 | 2.88 | 9.0 | 40 | 170 | 253 |

[A] Metric Conversion Factors—the following conversion factors were used in building the table:
1 cmil = 5.067 E-04 $mm^2$
1 in. = 25.4 mm
1 lb/1000 ft = 1.488 kg/km
1 kip (1000 lbf) = 4.448 kN

[B] The Code Name denoted with the letters "AWAC" represents a product made with strand wires comprised of aluminum and aluminum clad steel wires. The numbers in the parenthesis in front of the "AWAC" letters represent the number of aluminum and aluminum clad steel wires in the construction. The first number in the sequence is the approximate AWG size for the total aluminum cross-sectional area present in the conductor. "AWAC" is a registered trade name of US Alumoweld Corporation.

[C] The "+" marking beside the stranding class indicates a conductor with a high strength to current capacity ratio.

[D] The cmil area of the aluminum in the aluminum clad steel wire is calculated based on the requirement that the minimum thickness of aluminum is 10 % of the nominal wire radius (as per Specification B502 requirements for the aluminum clad steel wire component). The approximate total cross-sectional area for both the aluminum strands and the aluminum in the aluminum clad steel strands is provided for information purposes only.

5.1.3 Number of wires, aluminum, and aluminum-clad steel (Table 1),

5.1.4 Direction of lay of outer layer of aluminum wires if other than right-hand (see 8.2),

5.1.5 Special tests, if required (see 15.3 and 15.5),

5.1.6 Package size (see 17.1 and Explanatory Note 5),

5.1.7 Special package marking, if required (Section 17),

5.1.8 Lagging, if required (see 17.3), and

5.1.9 Place of inspection (Section 16).

## 6. Requirement for Wires

6.1 Before stranding, the aluminum wires used shall meet all the requirements of Specification B230/B230M.

6.2 Before stranding, the aluminum-clad steel core wires used shall meet all the requirements of Specification B502.

## 7. Joints

7.1 Electric-butt welds, cold-pressure welds, or 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 (Explanatory Note 1).

7.2 There shall be no joints of any kind made in the finished aluminum-clad steel wires.

## 8. Lay

8.1 The length of lay of the various layers of aluminum wires in a conductor shall conform to Table 2 (Explanatory Note 5). The length of lay of the various layers of aluminum-clad steel wires shall conform to Specification B500/B500M. The length of lay of the varous layers of mixed aluminum and aluminum-clad steel wires (AWAC) shall conform to Table 2.

8.2 The direction of lay of the outside layer of wires shall be right hand unless otherwise specified in the purchase order. The direction of lay of the aluminum and aluminum-clad steel wires shall be reversed in successive layers.

## 9. Construction

9.1 The number and diameter of aluminum and steel wires and the areas of cross section of aluminum wires shall conform to the requirements prescribed in Table 1 and Fig. 1.

9.2 Where compressed stranding is required in order to insulate the conductor properly, one or more aluminum layers of any stranded conductor consisting of 7 wires or more may be slightly compressed, thereby reducing the outside diameter of the conductor by not more than 3 %, provided that the area of cross section after compressing is in accordance with Section 13.

## 10. Rated Strength of Conductor

10.1 The rated strength of a completed conductor shall be taken as the aggregate strength of the aluminum and aluminum-clad steel components, calculated as follows. The strength contribution of the aluminum wires shall be taken as the percentage, according to the number of layers of aluminum wires, indicated in Table 3, of the sum of the strengths of the 1350-H19 wires, calculated from their specified nominal wire diameter and the appropriate specified minimum average tensile strength given in Specification B230/B230M. The strength contribution of the aluminum-clad steel core wires shall be taken as the percentage according to the number of layers of aluminum-clad steel wires, indicated in Table 3, of the sum of the strengths of the aluminum-clad steel wires, calculated from their specified nominal wire diameter and the appropriate specified minimum stress at 1 % extension given in Specification B502.

10.2 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.

## 11. Density

11.1 For the purpose of calculating mass, cross sections, etc., the density of aluminum 1350 shall be taken as 2705 kg/m$^3$ (0.0975 lb/in.$^3$) at 20°C (68°F) (Explanatory Note 6).

**TABLE 2 Lay Factors for Aluminum Conductors, Aluminum-Clad Steel Reinforced, Concentric-Lay-Stranded**

| Stranding Class | Stranding | Aluminum Wire Layers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | First (outside) | | Second | | Third | | Fourth (inside) | |
| | | min | max | min | max | min | max | min | max |
| A | 6/1, 7/1 | 8 | 16 | ... | ... | ... | ... | ... | ... |
| AA | 76/19, 84/19 | 10 | 13 | 10 | 16 | 10 | 17 | 10 | 17 |
| | 72/7 | 10 | 13 | 10 | 16 | 10 | 17 | 10 | 17 |
| | 54/19 | 10 | 13 | 10 | 16 | 10 | 17 | ... | ... |
| | 54/7, 48/7, 45/7, 42/7 | 10 | 13 | 10 | 16 | 10 | 17 | ... | ... |
| | 36/1 | 10 | 13 | 10 | 16 | 10 | 17 | ... | ... |
| | 30/19 | 10 | 13 | 10 | 16 | ... | ... | ... | ... |
| | 30/7, 26/7, 24/7 | 10 | 13 | 10 | 16 | ... | ... | ... | ... |
| | 18/1 | 10 | 13 | 10 | 16 | ... | ... | ... | ... |
| | 16/19 | 10 | 14.5 | ... | ... | ... | ... | ... | ... |
| | 12/7 | 10 | 14.5 | ... | ... | ... | ... | ... | ... |
| | 6/1, 7/1, 8/1 | 12 | 16 | ... | ... | ... | ... | ... | ... |
| | 5/2, 4/3, 3/4, 2/5 | 12[A] | 16[A] | 12[A] | 16[A] | ... | ... | ... | ... |

[A] Mixed aluminum and aluminum-clad steel (Fig. 1). Lay factors for aluminum-clad steel layers, see Specification B500/B500M.

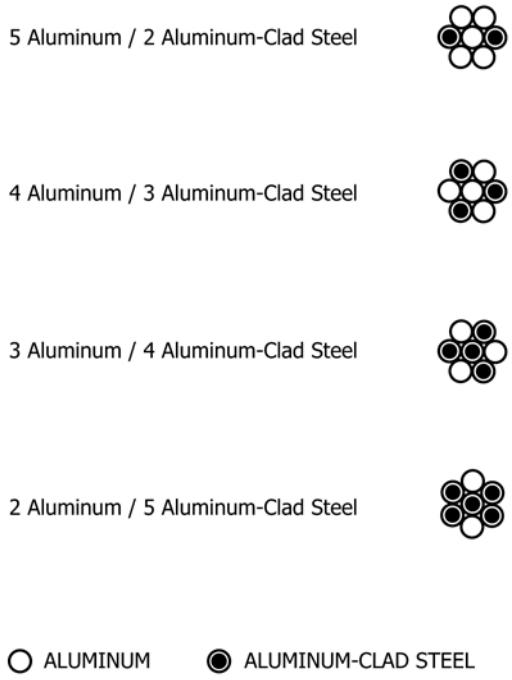


**FIG. 1 Suggested Configurations for Conductors with Mixed Wire Layers**

**TABLE 3 Rating Factors**

| Stranding | | | | Rating Factor, % | |
|---|---|---|---|---|---|
| Number of Wires | | Number of Layers[A] | | | |
| Aluminum | Aluminum-Clad Steel | Aluminum | Aluminum-Clad Steel | Aluminum | Aluminum-Clad Steel |
| 2 | 5 | 1 | 1 | 96 | 96 |
| 3 | 4 | 1 | 1 | 96 | 96 |
| 4 | 3 | 1 | 1 | 96 | 96 |
| 5 | 2 | 1 | 1 | 96 | 96 |
| 6 | 1 | 1 | center[B] | 96 | 96 |
| 7 | 1 | 1 | center[B] | 96 | 96 |
| 8 | 1 | 1 | center[B] | 96 | 96 |
| 18 | 1 | 2 | center[B] | 93 | 96 |
| 36 | 1 | 3 | center[B] | 91 | 96 |
| 12 | 7 | 1 | 1 | 96 | 96 |
| 24 | 7 | 2 | 1 | 93 | 96 |
| 26 | 7 | 2 | 1 | 93 | 96 |
| 30 | 7 | 2 | 1 | 93 | 96 |
| 42 | 7 | 3 | 1 | 91 | 96 |
| 45 | 7 | 3 | 1 | 91 | 96 |
| 48 | 7 | 3 | 1 | 91 | 96 |
| 54 | 7 | 3 | 1 | 91 | 96 |
| 72 | 7 | 4 | 1 | 90 | 96 |
| 16 | 19 | 1 | 2 | 96 | 93 |
| 30 | 19 | 2 | 2 | 93 | 93 |
| 54 | 19 | 3 | 2 | 91 | 93 |
| 76 | 19 | 4 | 2 | 90 | 93 |
| 84 | 19 | 4 | 2 | 90 | 93 |

[A] For purposes of determining strength rating factors, mixed layers are considered to be full layers for each material.
[B] Central aluminum-clad steel wire only; the 96 % rating factor is applied to the single aluminum-clad steelwire core as a factor of safety in the event the aluminum-clad steel wire contains a weld (made prior to drawing).

11.2 For the purpose of calculating mass, cross sections, etc., the density of aluminum-clad steel wire shall be taken as 6590 kg/m$^3$ (0.2381 lb/in.$^3$) at 20°C (68°F).

## 12. Mass and Electrical Resistance

12.1 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 4. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 7).

12.2 In the calculation of the electrical resistance of a completed conductor, the resistivity of the aluminum-clad steel core wire shall be taken as 0.08480 Ω·mm$^2$/m (51.01 Ω·cmil/ft) at 20°C (68°F).

## 13. Variation in Area

13.1 The area of cross section of the aluminum wires of a conductor shall be not less than 98 % of the area specified. 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 in 13.1.2 shall be used:

13.1.1 The area of cross section may be determined by calculations from diameter measurements, expressed to four decimal places, of the component aluminum wires at any point when measured perpendicularly to their axes.

13.1.2 The area of cross section of the aluminum wires of a conductor may be determined by Test Method B263. In applying that method the increment in mass resulting from stranding may be the applicable value specified in 12.1 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.

**TABLE 4 Standard Increments Due to Stranding**

| Stranding of ACSR/AW Number of Wires | | Increment (Increase), % Mass and Electrical Resistance | |
|---|---|---|---|
| Aluminum | Aluminum-Clad Steel | Aluminum | Aluminum-Clad Steel |
| 2 | 5 | 0.75 | 1.5 |
| 3 | 4 | 1.5 | 1.1 |
| 4 | 3 | 1.1 | 1.5 |
| 5 | 2 | 1.2 | 1.5 |
| 6 | 1 | 1.5 | 0 |
| 7 | 1 | 1.5 | 0 |
| 8 | 1 | 2.0 | 0 |
| 18 | 1 | 2.0 | 0 |
| 36 | 1 | 2.0 | 0 |
| 12 | 7 | 2.5 | 0.4 |
| 24 | 7 | 2.5 | 0.4 |
| 26 | 7 | 2.5 | 0.4 |
| 30 | 7 | 2.75 | 0.4 |
| 42 | 7 | 2.5 | 0.4 |
| 45 | 7 | 2.5 | 0.4 |
| 48 | 7 | 2.5 | 0.4 |
| 54 | 7 | 2.5 | 0.4 |
| 72 | 7 | 3.0 | 0.4 |
| 16 | 19 | 2.5 | 0.6 |
| 30 | 19 | 2.75 | 0.6 |
| 54 | 19 | 3.0 | 0.6 |
| 76 | 19 | 3.0 | 0.6 |
| 84 | 19 | 3.0 | 0.6 |

13.2 The approximate cross sectional area of the aluminum in the aluminum clad steel wire is calculated based on the requirement that the minimum thickness of aluminum is 10 % of the nominal wire radius (as per Specification B502). The minimum aluminum thickness value can also be expressed as 5 % of the nominal aluminum clad steel wire diameter.

## 14. Finish

14.1 The conductor shall be free of all imperfections not consistent with good commercial practice.

## 15. Mechanical and Electrical Tests

15.1 Tests for mechanical and electrical properties of aluminum wires shall be made before stranding (Explanatory Note 8).

15.2 All aluminum wires composing the conductors shall be capable of meeting the bending properties stated in Specification B230/B230M after stranding. Routine production testing after stranding is not required.

15.3 Routine production testing after stranding is not required. However, when such tests are requested by the purchaser and agreed upon by the manufacturer at the time of ordering (or made for other reasons) aluminum wires removed from the completed conductor shall have tensile strengths of not less than 95 % of the minimum tensile strength specified for the wire before stranding. The electrical resistivity shall meet the minimum resistivity specified for wire before stranding. Elongation tests may be made for information purposes only and no minimum values are assigned (Explanatory Note 8). The frequency of these tests shall be decided upon between the purchaser and the manufacturer.

15.4 Tests for all properties of aluminum-clad steel wires shall be made before stranding (Explanatory Note 8).

15.5 Tests for demonstration of rated strength of the completed conductor are not required by this specification but may be made if agreed upon by 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 (Explanatory Note 9).

## 16. Inspection

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

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

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

## 17. Packaging and Package Marking

17.1 Package sizes and kind of package, reels or coils, shall be agreed upon between the manufacturer and the purchaser (Explanatory Note 5).

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

17.3 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.

17.4 The net mass, length size, kind of conductors, stranding, type 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.

NOTE 1—Multiple lengths per package are allowable only when the bare conductor is intended for re-manufacture, such as adding a covering or insulation. In such cases the position of each end of a length shall be clearly marked and the length of each portion shall be shown on the tag attached to the end of the conductor.

## 18. Keywords

18.1 aluminum clad steel reinforced; aluminum conductor; aluminum conductor—steel-reinforced; electrical conductor; electrical conductor—aluminum; stranded aluminum conductor; stranded electrical conductor

## EXPLANATORY NOTES

NOTE 1—In this specification only concentrically-stranded aluminum conductors, aluminum-clad steel reinforced, are specifically designated. Conductor constructions not included in this specification shall be specifically agreed upon between the manufacturer and the purchaser when placing the order.

NOTE 2—For definitions of terms relating to conductors, reference should be made to ANSI C42.100 and ASTM Terminology B354.

NOTE 3—Owing to the variation in coil weights, and so forth, it is common practice to allow a permissible variation in length of ±10 %. It is also common practice to allow an amount not exceeding 10 % of the total weight of any one order to be shipped in random lengths with no piece shorter than 50 % of the standard length ordered.

NOTE 4—The behavior of properly spaced wire joints 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 5—The preferred ratio of the lay with respect to the outside diameter of a layer of wires varies for different layers and for different diameters of the conductor, being larger for the inside layers than for the outside layer, and larger for conductors of small diameter than for those of large diameter.

NOTE 6—This density is based upon aluminum of 99.50 % purity.

NOTE 7—The increment of mass or electrical resistance of a completed concentric-lay-stranded conductor, $k$, in percent is

$$k = 100\,(m - 1) \tag{1}$$

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

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

where:

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

The derivation of the above is given in *NBS Handbook 100*.[4]

The factors $k$ and $m$ for composite conductors are to be determined separately for each different material involved.

The helical path of the wire may be defined as the pitch diameter and may be calculated as:

$$\text{helical path of the wire} = \frac{(\text{diameter over the layer} + \text{diameter under the layer})}{2} \tag{3}$$

NOTE 8—Wires unlaid from conductors may have different physical properties from those of the wire when prepared for cabling, on account of the deformation brought about by stranding and again straightening for test. If tests of aluminum-clad steel wires are to be made after stranding, the purchaser and the manufacturer at the time of placing the order should agree on the properties to be met.

NOTE 9—To test ACSR/AW, for breaking strength successfully as a unit requires special devices for gripping the ends of the aluminum and aluminum-clad steel wires without causing damage that may result in failure below the actual strength of the conductor. Various special dead-end devices are available such as compression sleeves and split sleeves, but ordinary jaws or clamping devices usually are not suitable.