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Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors¹

This standard is issued under the fixed designation B173; 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.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1}Note—Table 1 was editorially corrected in March 2007.

1. Scope

1.1 This specification covers bare rope-lay-stranded conductors having concentric-stranded members made from round copper wires, either uncoated or coated with tin, lead, or lead-alloy for use as electrical conductors (Explanatory Note 1 and Note 2).

1.2 Coated wires shall include only those wires with finished diameters and densities substantially equal to the respective diameters and densities of uncoated wires.

1.3 The values stated in inch-pound or SI units are to be regarded separately as standard. Each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. For conductor sizes designated by AWG or kcmil, the requirements in SI units have been numerically converted from corresponding values, stated or derived, in inch-pound units. For conductor sizes designated by SI units only, the requirements are stated or derived in SI units.

1.3.1 For density, resistivity, and temperature, the values stated in SI units are to be regarded as standard.

2. Referenced Documents

2.1 The following documents of the issue in effect at the time of reference form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards*:²

B3 Specification for Soft or Annealed Copper Wire

B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B33 Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

B172 Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

B189 Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes

B193 Test Method for Resistivity of Electrical Conductor Materials

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

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

2.3 *American National Standard*:

ANSI C42.35 Definitions of Electrical Terms³

3. Classification

3.1 For the purpose of this specification rope-lay-stranded conductors having concentric-stranded members are classified as follows:

3.1.1 *Class G*—Conductors consisting of 7 to 61 rope-lay-stranded members, each of which consists of 7 to 19 concentric-stranded wires, with total conductor sizes ranging from No. 14 AWG (2.08 mm²) to 5 000 000 cmil (2534 mm²). (Typical use is for rubber-sheathed conductor, apparatus conductor, portable conductor, and similar applications.)

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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>.

3.1.2 *Class H*—Conductors consisting of 19 to 91 rope-lay-stranded members, each of which consists of 7 to 19 concentric-stranded wires, with total conductor sizes ranging from No. 9 AWG (6.63 mm²) to 5 000 000 cmil (2534 mm²). Class K construction produces a conductor with greater flexibility than class G. (Typical use is for rubber-sheathed cord and applications where flexibility is required such as on take-up reels over sheaves and extra-flexible apparatus conductor.)

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;
- 4.1.2 Conductor size: circular-mil area or AWG (Section 7);
- 4.1.3 Class (Section 3 and ~~Table 1~~ Tables 1 and 2);
- 4.1.4 Whether coated or uncoated; if coated, designate type of coating (see 11.1);
- 4.1.5 Details of special-purpose lays, if required (see 6.2 and 6.3) and (Explanatory Note 3);
- 4.1.6 Package size (see 14.1);
- 4.1.7 Special package marking, if required (Section 15);
- 4.1.8 Lagging, if required (see 14.2); and
- 4.1.9 Place of inspection (Section 13).

5. Joints

5.1 Necessary joints in wires or in groups of wires shall be made in accordance with accepted commercial practice, taking into account the size of the wire or group of wires as related to the size of the entire conductor.

5.2 Concentric-stranded members forming the completed conductor may be joined as a unit by soldering, brazing, or welding.

5.3 Joints shall be so constructed and so disposed throughout the conductor that the diameter or configuration of the completed conductor is not substantially affected, and so that the flexibility of the completed conductor is not adversely affected.

6. Lay (Explanatory Note 3)

6.1 Conductors of the same size and description furnished on one order shall have the same lay.

6.2 The length of lay of the outer layer of the rope-lay stranded conductor shall be not less than 8 nor more than 16 times the outside diameter of the completed conductor. The length of lay of the other layers shall be at the option of the manufacturer unless specifically agreed upon. The direction of lay of the outer layer shall be left-hand, unless the direction of lay is specified otherwise by the purchaser. The direction of lay of the other layers shall be reversed in successive layers, unless otherwise agreed upon between the manufacturer and the purchaser.

6.3 The length of lay of the individual wires composing the stranded members shall be not less than 8 nor more than 16 times the outside diameter of that layer. Unless otherwise specified, the direction of lay of the outer layer of wires shall be at the option of the manufacturer. The direction of lay shall be reversed in successive layers, unless otherwise agreed upon between the manufacturer and the purchaser.

7. Construction

7.1 The area of cross section and the number and diameter of wires for a variety of strand constructions in general use are shown in ~~Table 1~~ Tables 1 and 2.

8. Physical and Electrical Tests

8.1 Tests for the electrical properties of wires composing conductors made from soft or annealed copper wire, bare or coated, shall be made before stranding.

8.2 Tests for the physical properties of soft or annealed copper wire, bare or coated, may be made upon the wires before stranding or upon wires removed from the completed stranded conductors, but need not be made upon both. Care shall be taken to avoid mechanical injury and stretching when removing wires from the conductor for the purpose of testing.

8.3 The physical properties of wire when tested before stranding shall conform to the applicable requirements of 11.1.

8.4 The physical properties of wires removed from the completed stranded conductor shall be permitted to vary from the applicable requirements of 11.1 by the following amounts: (Explanatory Note 4):

8.4.1 *Average of Results Obtained on All Wires Tested*—The percent minimum elongation may be reduced by the value of 5 % from the values required for unstranded wires as specified by Specifications B3, B33, or B189, as applicable. For example, where the unstranded wire specification requires minimum elongation of 30 %, wire of that material removed from Specification B173 stranded conductor shall meet a minimum elongation value of 25 %, a value 5 % reduction.

8.4.2 *Results Obtained on Individual Wires*—The percent minimum elongation may be reduced by the value of 15 % from the values required for unstranded wires as specified by Specifications B3, B33, or B189, as applicable. For example, where the unstranded wire specification requires minimum elongation of 30 %, wire of that material removed from Specification B173 stranded conductor shall meet a minimum elongation value of 15 %. If the reduction results in minimum elongation of less than 5 %, a minimum of 5 % shall apply.

8.5 In the event that the requirements prescribed in 8.4.2 are met, but those prescribed in 8.4.1 are not met, a retest shall be permitted wherein all wires of a conductor of 100 wires or less, or 100 wires selected at random throughout a conductor of more

TABLE 1 Constructional and DC Resistance Requirements of Rope-Lay Stranded Copper Conductors Having Concentric-Stranded Members—Class G^A

Area of Cross Section		Size		Glass G		Glass H		Number of Wires		Diameter of Wires		Number of Wires in Each Member		Number of Wires in Each Member Completed		Completed Conductor ^B		Number of Wires		Diameter of Wires		Mass											
mm ²	cmil	mm ²	cmil	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.								
																										Nominal Diameter	Nominal Mass	Nominal DC Resistance @20C	Maximum DC Resistance @20C	Nominal DC Resistance @20C	Maximum DC Resistance @20C	Nominal Diameter	Nominal DC Resistance @20C
5-000-000	2594	5-000-000	2594	19	0.667	1.67	2.957	49	1.67	16-052	23-888	47-29	0.00220	0.00224	1-97	1-97	49	1.97	2-959	75-2	16-057	23-896	47-29	0.00224	0.00224	1-97	1-97	49	1.97	2-959	75-2	16-057	23-896
5-000-000	2534	5-000-000	2534	19	0.657	1.67	2.957	19	0.657	16-052	23-888	47-29	0.00220	0.00224	1-97	1-97	49	1.97	2-959	75-2	16-057	23-896	47-29	0.00224	0.00224	1-97	1-97	49	1.97	2-959	75-2	16-057	23-896
4-500-000	2280	4-500-000	2280	19	0.623	1.58	2.804	19	0.623	14-433	21-479	0.00244	0.00244	0.00244	0.00249	0.00817	0.00817	19	0.817	2-804	71-2	14-433	21-479	0.00244	0.00244	0.00817	0.00817	19	0.817	2-804	71-2	14-433	21-479
4-000-000	2027	4-000-000	2027	19	0.587	1.49	2.642	19	0.587	12-814	19-069	0.00275	0.00275	0.00281	0.00286	0.00920	0.00920	19	0.920	2-642	67-2	12-814	19-069	0.00275	0.00281	0.00920	0.00920	19	0.920	2-642	67-2	12-814	19-069
3-500-000	1773	3-500-000	1773	19	0.550	1.40	2.475	19	0.550	11-249	16-741	0.00314	0.00314	0.00320	0.00327	0.0105	0.0105	19	0.105	2-475	62-9	11-249	16-741	0.00314	0.00320	0.0105	0.0105	19	0.105	2-475	62-9	11-249	16-741
3-000-000	1520	3-000-000	1520	19	0.509	1.29	2.291	19	0.509	9-635	14-388	0.00366	0.00366	0.00373	0.00381	0.0122	0.0122	19	0.122	2-291	58-3	9-635	14-388	0.00366	0.00373	0.0122	0.0122	19	0.122	2-291	58-3	9-635	14-388
2-500-000	1267	2-500-000	1267	19	0.456	1.15	2.086	19	0.456	8-012	11-924	0.00440	0.00440	0.00449	0.00457	0.0147	0.0147	19	0.147	2-086	53-0	8-012	11-924	0.00440	0.00449	0.0147	0.0147	19	0.147	2-086	53-0	8-012	11-924
2-000-000	1013	2-000-000	1013	19	0.413	1.04	1.866	19	0.413	6-408	9-536	0.00550	0.00550	0.00561	0.00572	0.0184	0.0184	19	0.184	1-866	47-4	6-408	9-536	0.00550	0.00561	0.0184	0.0184	19	0.184	1-866	47-4	6-408	9-536
1-900-000	963	1-900-000	963	19	0.352	0.89	1.620	19	0.352	5-099	7-077	0.0079	0.0079	0.0079	0.00823	0.0204	0.0204	19	0.204	1-620	45-0	5-099	7-077	0.0079	0.00823	0.0204	0.0204	19	0.204	1-620	45-0	5-099	7-077
1-800-000	912	1-800-000	912	19	0.336	0.84	1.571	19	0.336	4-575	6-594	0.00611	0.00611	0.00623	0.00635	0.0208	0.0208	19	0.208	1-571	44-5	4-575	6-594	0.00611	0.00623	0.0208	0.0208	19	0.208	1-571	44-5	4-575	6-594
1-750-000	887	1-750-000	887	19	0.329	0.82	1.547	19	0.329	4-444	6-358	0.00628	0.00628	0.00641	0.00653	0.0214	0.0214	19	0.214	1-547	44-5	4-444	6-358	0.00628	0.00641	0.0214	0.0214	19	0.214	1-547	44-5	4-444	6-358
1-700-000	861	1-700-000	861	19	0.312	0.78	1.460	19	0.312	4-332	6-252	0.00647	0.00647	0.00660	0.00672	0.0221	0.0221	19	0.221	1-460	43-8	4-332	6-252	0.00647	0.00660	0.0221	0.0221	19	0.221	1-460	43-8	4-332	6-252
1-600-000	811	1-600-000	811	19	0.277	0.70	1.321	19	0.277	4-249	5-911	0.00687	0.00687	0.00701	0.00715	0.0234	0.0234	19	0.234	1-321	42-5	4-249	5-911	0.00687	0.00701	0.0234	0.0234	19	0.234	1-321	42-5	4-249	5-911
1-500-000	760	1-500-000	760	19	0.259	0.66	1.247	19	0.259	4-132	5-742	0.00726	0.00726	0.00741	0.00755	0.0248	0.0248	19	0.248	1-247	41-1	4-132	5-742	0.00726	0.00741	0.0248	0.0248	19	0.248	1-247	41-1	4-132	5-742
1-400-000	709	1-400-000	709	19	0.242	0.61	1.167	19	0.242	4-056	5-664	0.00778	0.00778	0.00794	0.00809	0.0265	0.0265	19	0.265	1-167	39-6	4-056	5-664	0.00778	0.00794	0.0265	0.0265	19	0.265	1-167	39-6	4-056	5-664
1-300-000	659	1-300-000	659	19	0.217	0.54	1.061	19	0.217	3-935	5-456	0.00838	0.00838	0.00855	0.00871	0.0286	0.0286	19	0.286	1-061	38-2	3-935	5-456	0.00838	0.00855	0.0286	0.0286	19	0.286	1-061	38-2	3-935	5-456
1-250-000	633	1-250-000	633	19	0.201	0.51	1.014	19	0.201	3-812	5-312	0.00871	0.00871	0.00888	0.00906	0.0297	0.0297	19	0.297	1-014	37-5	3-812	5-312	0.00871	0.00888	0.0297	0.0297	19	0.297	1-014	37-5	3-812	5-312
1-200-000	608	1-200-000	608	19	0.185	0.47	0.931	19	0.185	3-692	5-212	0.00907	0.00907	0.00925	0.00944	0.0304	0.0304	19	0.304	0-931	36-7	3-692	5-212	0.00907	0.00925	0.0304	0.0304	19	0.304	0-931	36-7	3-692	5-212
1-100-000	557	1-100-000	557	19	0.158	0.40	0.812	19	0.158	3-502	5-122	0.00990	0.00990	0.0101	0.0103	0.0332	0.0332	19	0.332	0-812	35-2	3-502	5-122	0.00990	0.0101	0.0332	0.0332	19	0.332	0-812	35-2	3-502	5-122

1-000-000	-507	0-0484	1-23	7	1-307	33-2	-0179	-4791	0-01090	-703	0-0377	0-06	49	1-320	33-5	3206	4771
1 000 000	507	0 0484	1 23	7	1 307	33 2	3 179	47 91	0 01090	0 0357	0 0111	0 0364	49	0 0372	33 5	0 0115	0 0379
900-000	-456	0-0459	1-17	7	1-239	31-5	-2859	42-55	0-0121	-703	0-0358	0-01	49	1-253	31-8	2891	4302
900 000	456	0 0459	1 17	7	1 239	31 5	28 59	42 55	0 0121	0 0397	0 0123	0 0405	49	1 0413	31 8	0 0129	0 0421
800-000	-405	0-0433	1-10	7	1-169	29-7	-2544	-37-87	0-0136	-703	0-0337	0-06	49	1-180	30-0	2562	3812
800 000	405	0 0433	1 10	7	1 169	29 7	25 44	37 87	0 0136	0 0447	0 0139	0 0456	49	1 0464	30 0	0 0145	0 0473
750-000	-380	0-0419	1-06	7	1-131	28-7	-2388	-35-46	0-0145	-703	0-0327	0-08	49	1-145	29-1	2412	3589
750 000	380	0 0419	1 06	7	1 131	28 7	23 88	35 46	0 0145	0 0476	0 0148	0 0486	49	1 0495	29 1	0 0154	0 0505
700-000	-355	0-0405	1-03	7	1-094	27-8	-2226	-33-13	0-0156	-703	0-0316	0-09	49	1-106	28-1	2252	3352
700 000	355	0 0405	1 03	7	1 094	27 8	22 26	33 13	0 0156	0 0510	0 0159	0 0520	49	1 0531	28 1	0 0165	0 0542
650-000	-329	0-0390	0-99	7	1-058	26-7	-2064	-30-72	0-0168	-703	0-0304	0-10	49	1-064	27-0	2085	3102
650 000	329	0 0390	0 99	7	1 053	26 7	20 64	30 72	0 0168	0 0550	0 0171	0 0561	49	1 0672	27 0	0 0177	0 0583
600-000	-304	0-0375	0-95	7	1-015	25-7	-1908	-28-40	0-0181	-703	0-0292	0-11	49	1-022	26-0	1923	2862
600 000	304	0 0375	0 95	7	1 013	25 7	19 08	28 40	0 0181	0 0595	0 0185	0 0607	49	1 0619	26 0	0 0193	0 0631
550-000	-279	0-0359	0-91	7	0-969	24-6	-1749	-26-03	0-0198	-703	0-0280	0-12	49	0-980	24-9	1768	2632
550 000	279	0 0359	0 91	7	0 969	24 6	17 49	26 03	0 0198	0 0202	0 0663	0 0676	49	0 923	24 9	0 0210	0 0690
500-000	-253	0-0343	0-86	7	0-922	23-4	-1579	-23-60	0-0217	-427	0-0342	0-13	7	0-923	23-4	1587	2362
500 000	253	0 0343	0 86	7	0 922	23 4	15 79	23 60	0 0217	0 0711	0 0725	0 0740	7	0 772	23 4	0 0230	0 0755
450-000	-228	0-0327	0-80	7	0-876	22-3	-1425	-21-20	0-0241	-427	0-0325	0-14	7	0-878	22-3	1433	2133
450 000	228	0 0327	0 80	7	0 876	22 3	14 25	21 20	0 0241	0 0790	0 0806	0 0822	7	0 826	22 3	0 0255	0 0838
400-000	-203	0-0311	0-79	7	0-825	21-0	-1265	-18-83	0-0271	-427	0-0306	0-15	7	0-826	21-0	1271	1891
400 000	203	0 0311	0 79	7	0 825	21 0	12 65	18 83	0 0271	0 0889	0 0907	0 0924	7	0 826	21 0	0 0288	0 0942
350-000	-177	0-0296	0-73	7	0-773	19-6	-1109	-16-81	0-0310	-427	0-0296	0-16	7	0-772	19-6	1110	1652
350 000	177	0 0296	0 73	7	0 773	19 6	11 09	16 81	0 0310	0 102	0 104	0 106	7	0 772	19 6	0 0328	0 108
300-000	-152	0-0280	0-66	7	0-714	18-1	-947	-14-09	0-0340	-427	0-0285	0-17	7	0-716	18-1	953	14
300 000	152	0 0280	0 66	7	0 714	18 1	9 47	14 09	0 0340	0 0265	0 0368	0 0384	7	0 716	18 1	0 0384	0 125
250-000	-127	0-0264	0-60	7	0-653	16-6	-792	-11-79	0-0434	-427	0-0242	0-18	7	0-653	16-6	795	103
250 000	127	0 0264	0 60	7	0 653	16 6	7 92	11 79	0 0434	0 142	0 145	0 148	7	0 653	16 6	0 0460	0 153
200-000	-107	0-0249	0-54	7	0-599	15-2	-667	-9-92	0-0510	-259	0-0249	0-19	7	0-601	15-3	670	867
200 000	107	0 0249	0 54	7	0 599	15 2	6 67	9 92	0 0510	0 167	0 170	0 174	7	0 601	15 3	0 0541	0 177
167-000	-85-0	0-0235	0-50	7	0-533	13-5	-528	-7-85	0-0643	-259	0-0255	0-21	7	0-536	13-6	533	793
167 000	85 0	0 0235	0 50	7	0 533	13 5	5 28	7 85	0 0643	0 211	0 215	0 219	7	0 536	13 6	0 0681	0 235
133-000	-67-4	0-0219	0-48	7	0-474	12-0	-418	-6-22	0-0810	-259	0-0227	0-22	7	0-477	12-1	422	628
133 000	67 4	0 0219	0 48	7	0 474	12 0	4 18	6 22	0 0810	0 266	0 271	0 276	7	0 477	12 1	0 0860	0 282
105-000	-53-5	0-0202	0-42	7	0-423	10-7	-339	-4-95	0-102	-259	0-0202	0-23	7	0-424	10-8	334	597
105 000	53 5	0 0202	0 42	7	0 423	10 7	3 39	4 95	0 102	0 335	0 342	0 348	7	0 424	10 8	0 108	0 355
83-000	-42-4	0-0185	0-36	7	0-377	9-58	-264	-3-88	0-129	-259	0-0186	0-24	7	0-378	9-60	265	395
83 000	42 4	0 0185	0 36	7	0 377	9 6	2 64	3 88	0 129	0 423	0 431	0 440	7	0 378	9 60	0 137	0 449
66-000	-33-6	0-0169	0-30	7	0-331	8-4	-207	-3-08	0-161	-259	0-0160	0-25	7	0-385	8-51	210	312
66 000	33 6	0 0169	0 30	7	0 331	8 4	20 7	3 08	0 161	0 528	0 539	0 549	7	0 385	8 51	0 170	0 560
52-000	-26-7	0-0153	0-28	7	0-295	7-49	-164	-2-45	0-203	-133	0-0150	0-26	7	0-299	7-59	166	247
52 000	26 7	0 0153	0 28	7	0 295	7 5	1 64	2 45	0 203	0 666	0 679	0 693	7	0 299	7 59	0 215	0 707
41-740	-21-1	0-0138	0-23	7	0-263	6-68	-130	-1-94	0-256	-133	0-0137	0-27	7	0-266	6-76	131	195
41 740	21 1	0 0138	0 23	7	0 263	6 7	1 30	1 94	0 256	0 840	0 857	0 873	7	0 266	6 76	0 271	0 890
33-000	-16-8	0-0124	0-20	7	0-234	5-94	-103	-1-54	0-323	-133	0-0124	0-28	7	0-237	6-02	105	156
33 000	16 8	0 0124	0 20	7	0 234	5 9	1 03	1 54	0 323	1 06	1 08	1 10	7	0 237	6 02	0 343	1 12
26-240	-13-3	0-0108	0-15	7	0-208	5-28	-81-5	-1-21	0-407	-133	0-0108	0-29	7	0-210	5-33	82-1	122
26 240	13 3	0 0108	0 15	7	0 208	5 3	81 5	1 21	0 407	1 34	1 37	1 39	7	0 210	5 33	0 431	1 42
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20 820	10 5	0 0092	0 12	7	0 185	4 7	64 8	96 5	0 513	1 68	1 71	1 75	7	0 188	4 78	0 545	1 79
16-510	-8-37	0-0084	0-10	7	0-166	4-22	-51-7	-7-70	0-647	-133	0-0084	0-31	7	0-167	4-24	51-6	76-8
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13-000	-6-66	0-0069	0-07	7	0-148	3-76	-40-6	-6-04	0-816	-133	0-0069	0-32	7	0-149	3-78	41-0	61-1
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65-300	-3-31	0-0115	0-29	7	0-104	2-6	-20-2	-30-1	1-64	-133	0-0115	0-36	7	0-174	2-30	20-2	30-1
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4 110	2 08	0 0092	0 23	7	0 083	-2 11	12 9	19 2	1 64	5 37	1 67	5 48	7	0 570	1 11	1 77	5 81

corrected:
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