Designation: B173 – 17

Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors[1]

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 U.S. Department of Defense.

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.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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 Terms[3]

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 mm^2) to 5 000 000 cmil (2534 mm^2). (Typical use is for rubber-sheathed conductor, apparatus conductor, portable conductor, and similar applications.)

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 mm^2) to 5 000 000 cmil (2534 mm^2).

[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.04 on Conductors of Copper and Copper Alloys.

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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.

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 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 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 than 100 wires shall be tested for the purpose of final determination for conformance to 8.4.

8.6 Elongation tests to determine compliance shall not be made on the conductor as a unit.

8.7 If a tinning, lead-coating, or lead-alloy-coating test is required, it shall be made on the wires prior to stranding.

9. Density

9.1 For the purpose of calculating mass, cross sections, etc., the density of copper shall be taken as 8.89 g/cm^3 (0.32117 lb/in.^{3}) at 20°C (Explanatory Note 5).

10. Mass and Resistance

10.1 The mass and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The

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 AWG	Number of Wires	Diameter of Wires		Number of Wires in Each Member	Completed Conductor[B]				Uncoated Copper				Tinned Copper			
							Nominal Diameter		Nominal Mass		Nominal DC Resistance @20C		Maximum DC Resistance @20C		Nominal DC Resistance @20C		Maximum DC Resistance @20C	
cmil	mm^2			in.	mm		in.	mm	lb/1000 ft	kg/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km
5 000 000	2534	...	1159	0.0657	1.67	19	2.957	75.1	16 052	23 888	0.00220	0.00721	0.00224	0.00735	0.00229	0.00750	0.00234	0.00765
4 500 000	2280	...	1159	0.0623	1.58	19	2.804	71.2	14 433	21 479	0.00244	0.00801	0.00249	0.00817	0.00254	0.00833	0.00259	0.00850
4 000 000	2027	...	1159	0.0587	1.49	19	2.642	67.1	12 814	19 069	0.00275	0.00902	0.00281	0.00920	0.00286	0.00938	0.00292	0.00957
3 500 000	1773	...	1159	0.0550	1.40	19	2.475	62.9	11 249	16 741	0.00314	0.0103	0.00320	0.0105	0.00327	0.0107	0.00334	0.0109
3 000 000	1520	...	1159	0.0509	1.29	19	2.291	58.2	9635	14 338	0.00366	0.0120	0.00373	0.0122	0.00381	0.0125	0.00389	0.0128
2 500 000	1267	...	703	0.0596	1.51	19	2.086	53.0	8012	11 924	0.00440	0.0144	0.00449	0.0147	0.00457	0.0150	0.00466	0.0153
2 000 000	1013	...	703	0.0533	1.35	19	1.866	47.4	6408	9536	0.00550	0.0180	0.00561	0.0184	0.00572	0.0188	0.00583	0.0192
1 900 000	963	...	703	0.0520	1.32	19	1.820	46.2	6099	9077	0.00579	0.0190	0.00591	0.0194	0.00602	0.0197	0.00614	0.0201
1 800 000	912	...	703	0.0506	1.29	19	1.771	45.0	5775	8594	0.00611	0.0200	0.00623	0.0204	0.00635	0.0208	0.00648	0.0212
1 750 000	887	...	703	0.0499	1.27	19	1.747	44.4	5617	8358	0.00628	0.0206	0.00641	0.0210	0.00653	0.0214	0.00666	0.0218
1 700 000	861	...	703	0.0492	1.25	19	1.722	43.7	5460	8125	0.00647	0.0212	0.00660	0.0216	0.00672	0.0221	0.00685	0.0225
1 600 000	811	...	703	0.0477	1.21	19	1.670	42.4	5132	7638	0.00687	0.0225	0.00701	0.0230	0.00715	0.0234	0.00729	0.0239
1 500 000	760	...	427	0.0593	1.51	7	1.601	40.7	4772	7102	0.00726	0.0238	0.00741	0.0243	0.00755	0.0248	0.00770	0.0253
1 400 000	709	...	427	0.0573	1.46	7	1.547	39.3	4456	6631	0.00778	0.0255	0.00794	0.0260	0.00809	0.0265	0.00825	0.0270
1 300 000	659	...	427	0.0552	1.40	7	1.490	37.8	4135	6154	0.00838	0.0275	0.00855	0.0281	0.00871	0.0286	0.00888	0.0292
1 250 000	633	...	427	0.0541	1.37	7	1.461	37.1	3972	5911	0.00871	0.0286	0.00888	0.0292	0.00906	0.0297	0.00924	0.0303
1 200 000	608	...	427	0.0530	1.35	7	1.431	36.3	3812	5673	0.00907	0.0298	0.00925	0.0304	0.00944	0.0310	0.00963	0.0316
1 100 000	557	...	427	0.0508	1.29	7	1.372	34.8	3502	5212	0.00990	0.0325	0.0101	0.0332	0.0103	0.0338	0.0105	0.0345
1 000 000	507	...	427	0.0484	1.23	7	1.307	33.2	3179	4731	0.01090	0.0357	0.0111	0.0364	0.0113	0.0372	0.0115	0.0379
900 000	456	...	427	0.0459	1.17	7	1.239	31.5	2859	4255	0.0121	0.0397	0.0123	0.0405	0.0126	0.0413	0.0129	0.0421
800 000	405	...	427	0.0433	1.10	7	1.169	29.7	2544	3787	0.0136	0.0447	0.0139	0.0456	0.0142	0.0464	0.0145	0.0473
750 000	380	...	427	0.0419	1.06	7	1.131	28.7	2383	3546	0.0145	0.0476	0.0148	0.0486	0.0151	0.0495	0.0154	0.0505
700 000	355	...	427	0.0405	1.03	7	1.094	27.8	2226	3313	0.0156	0.0510	0.0159	0.0520	0.0162	0.0531	0.0165	0.0542
650 000	329	...	427	0.0390	0.99	7	1.053	26.7	2064	3072	0.0168	0.0550	0.0171	0.0561	0.0174	0.0572	0.0177	0.0583
600 000	304	...	427	0.0375	0.95	7	1.013	25.7	1908	2840	0.0181	0.0595	0.0185	0.0607	0.0189	0.0619	0.0193	0.0631
550 000	279	...	427	0.0359	0.91	7	0.969	24.6	1749	2603	0.0198	0.0650	0.0202	0.0663	0.0206	0.0676	0.0210	0.0690
500 000	253	...	259	0.0439	1.12	7	0.922	23.4	1579	2350	0.0217	0.0711	0.0221	0.0725	0.0225	0.0740	0.0230	0.0755
450 000	228	...	259	0.0417	1.06	7	0.876	22.3	1425	2120	0.0241	0.0790	0.0246	0.0806	0.0251	0.0822	0.0255	0.0838
400 000	203	...	259	0.0393	1.00	7	0.825	21.0	1265	1883	0.0271	0.0889	0.0276	0.0907	0.0282	0.0924	0.0288	0.0942
350 000	177	...	259	0.0368	0.93	7	0.773	19.6	1109	1651	0.0310	0.102	0.0316	0.104	0.0322	0.106	0.0328	0.108
300 000	152	...	259	0.0340	0.86	7	0.714	18.1	947	1409	0.0361	0.119	0.0368	0.121	0.0376	0.123	0.0384	0.125
250 000	127	...	259	0.0311	0.79	7	0.653	16.6	792	1179	0.0434	0.142	0.0443	0.145	0.0451	0.148	0.0460	0.151
211 600	107	0000	133	0.0399	1.01	7	0.599	15.2	667	992	0.0510	0.167	0.0520	0.170	0.0530	0.174	0.0541	0.177
167 800	85.0	000	133	0.0355	0.90	7	0.533	13.5	528	785	0.0643	0.211	0.0656	0.215	0.0668	0.219	0.0681	0.223
133 100	67.4	00	133	0.0316	0.80	7	0.474	12.0	418	622	0.0810	0.266	0.0826	0.271	0.0843	0.276	0.0860	0.282
105 600	53.5	0	133	0.0282	0.72	7	0.423	10.7	333	495	0.102	0.335	0.104	0.342	0.106	0.348	0.108	0.355
83 690	42.4	1	133	0.0251	0.64	7	0.377	9.6	264	393	0.129	0.423	0.132	0.431	0.134	0.440	0.137	0.449
66 360	33.6	2	49	0.0368	0.93	7	0.331	8.4	207	308	0.161	0.528	0.164	0.539	0.167	0.549	0.170	0.560
52 620	26.7	3	49	0.0328	0.83	7	0.295	7.5	164	245	0.203	0.666	0.207	0.679	0.211	0.693	0.215	0.707
41 740	21.1	4	49	0.0292	0.74	7	0.263	6.7	130	194	0.256	0.840	0.261	0.857	0.266	0.873	0.271	0.890
33 090	16.8	5	49	0.0260	0.66	7	0.234	5.9	103	154	0.323	1.06	0.329	1.08	0.336	1.10	0.343	1.12
26 240	13.3	6	49	0.0231	0.59	7	0.208	5.3	81.5	121	0.407	1.34	0.415	1.37	0.423	1.39	0.431	1.42
20 820	10.5	7	49	0.0206	0.52	7	0.185	4.7	64.8	96.5	0.513	1.68	0.523	1.71	0.534	1.75	0.545	1.79
16 510	8.37	8	49	0.0184	0.47	7	0.166	4.2	51.7	77.0	0.647	2.12	0.660	2.16	0.687	2.25	0.701	2.30
13 090	6.63	9	49	0.0163	0.41	7	0.148	3.8	40.6	60.4	0.816	2.68	0.832	2.73	0.867	2.84	0.884	2.90
10 380	5.26	10	49	0.0146	0.37	7	0.131	3.3	32.6	48.5	1.03	3.38	1.05	3.45	1.09	3.59	1.11	3.66

TABLE 1 *Continued*

Area of Cross Section		Size AWG	Number of Wires	Diameter of Wires		Number of Wires in Each Member	Completed Conductor[B]				Uncoated Copper				Tinned Copper			
							Nominal Diameter		Nominal Mass		Nominal DC Resistance @20C		Maximum DC Resistance @20C		Nominal DC Resistance @20C		Maximum DC Resistance @20C	
cmil	mm^2			in.	mm		in.	mm	lb/1000 ft	kg/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km	ohm/1000 ft	ohm/km
6530	3.31	12	49	0.0115	0.29	7	0.104	2.6	20.2	30.1	1.64	5.37	1.67	5.48	1.74	5.70	1.77	5.81
4110	2.08	14	49	0.0092	0.23	7	0.083	2.1	12.9	19.2	2.60	8.53	2.65	8.70	2.79	9.15	2.85	9.33

[A] The constructions shown in this table are typical of those used in the industry. It is not intended that this table preclude other constructions that may be desirable for specific applications. The constructions shown provide for a finished, non-covered, stranded conductor approximately of the area indicated. When specified by the purchaser, the number or size of wires may be increased to provide additional area to compensate for draw-down during subsequent processing.

[B] Values for the nominal diameter and mass of the completed conductor are approximate. The mass values are based upon the standard stranding increments listed in Explanatory Note 6.

TABLE 2 Constructional and DC Resistance Requirements of Rope-Lay Stranded Copper Conductors Having Concentric-Stranded Members—Class H[A]

Area of Cross Section		Size AWG	Number of Wires	Diameter of Wires		Number of Wires in Each Member	Completed Conductor[B]				Uncoated Copper				Tinned Copper			
							Nominal Diameter		Nominal Mass		Nominal DC Resistance @20C		Maximum DC Resistance @20C		Nominal DC Resistance @20C		Maximum DC Resistance @20C	
cmil	mm²			in.	mm		in.	mm	lb/ 1000 ft	kg/km	ohm/ 1000 ft	ohm/km	ohm/ 1000 ft	ohm/km	ohm/ 1000 ft	ohm/km	ohm/ 1000 ft	ohm/km
5 000 000	2534	. . .	1729	0.0538	1.37	19	2.959	75.2	16 057	23 896	0.00220	0.00721	0.00224	0.00735	0.00229	0.00750	0.00234	0.00765
4 500 000	2280	. . .	1729	0.0510	1.30	19	2.805	71.2	14 429	21 473	0.00244	0.00801	0.00249	0.00817	0.00254	0.00833	0.00259	0.00850
4 000 000	2027	. . .	1729	0.0481	1.22	19	2.646	67.2	12 835	19 101	0.00275	0.00902	0.00281	0.00920	0.00286	0.00938	0.00292	0.00957
3 500 000	1773	. . .	1729	0.0450	1.14	19	2.475	62.9	11 234	16 718	0.00314	0.0103	0.00320	0.0105	0.00327	0.0107	0.00334	0.0109
3 000 000	1520	. . .	1729	0.0417	1.06	19	2.294	58.3	9647	14 356	0.00366	0.0120	0.00373	0.0122	0.00381	0.0125	0.00389	0.0128
2 500 000	1267	. . .	1159	0.0464	1.18	19	2.088	53.0	8006	11 915	0.00440	0.0144	0.00449	0.0147	0.00457	0.0150	0.00466	0.0153
2 000 000	1013	. . .	1159	0.0415	1.05	19	1.868	47.4	6405	9531	0.00550	0.0180	0.00561	0.0184	0.00572	0.0188	0.00583	0.0192
1 900 000	963	. . .	1159	0.0405	1.03	19	1.823	46.3	6100	9077	0.00579	0.0190	0.00591	0.0194	0.00602	0.0197	0.00614	0.0201
1 800 000	912	. . .	1159	0.0394	1.00	19	1.773	45.0	5773	8591	0.00611	0.0200	0.00623	0.0204	0.00635	0.0208	0.00648	0.0212
1 750 000	887	. . .	1159	0.0389	0.99	19	1.751	44.5	5627	8374	0.00628	0.0206	0.00641	0.0210	0.00653	0.0214	0.00666	0.0218
1 700 000	861	. . .	1159	0.0383	0.97	19	1.724	43.8	5455	8118	0.00647	0.0212	0.00660	0.0216	0.00672	0.0221	0.00685	0.0225
1 600 000	811	. . .	1159	0.0372	0.94	19	1.674	42.5	5146	7658	0.00687	0.0225	0.00701	0.0230	0.00715	0.0234	0.00729	0.0239
1 500 000	760	. . .	703	0.0462	1.17	19	1.617	41.1	4815	7165	0.00733	0.0240	0.00748	0.0245	0.00762	0.0250	0.00777	0.0255
1 400 000	709	. . .	703	0.0446	1.13	19	1.561	39.6	4487	6677	0.00785	0.0258	0.00801	0.0263	0.00817	0.0268	0.00833	0.0273
1 300 000	659	. . .	703	0.0430	1.09	19	1.505	38.2	4171	6207	0.00846	0.0277	0.00863	0.0283	0.00879	0.0289	0.00897	0.0295
1 250 000	633	. . .	703	0.0422	1.07	19	1.477	37.5	4017	5978	0.00879	0.0289	0.00897	0.0295	0.00915	0.0300	0.00933	0.0306
1 200 000	608	. . .	703	0.0413	1.05	19	1.446	36.7	3847	5726	0.00916	0.0301	0.00934	0.0307	0.00953	0.0313	0.00972	0.0319
1 100 000	557	. . .	703	0.0396	1.01	19	1.386	35.2	3537	5264	0.00999	0.0328	0.0102	0.0335	0.0104	0.0341	0.0106	0.0348
1 000 000	507	. . .	703	0.0377	0.96	19	1.320	33.5	3206	4771	0.0110	0.0361	0.0112	0.0368	0.0114	0.0375	0.0116	0.0383
900 000	456	. . .	703	0.0358	0.91	19	1.253	31.8	2891	4302	0.0122	0.0401	0.0124	0.0409	0.0127	0.0417	0.0130	0.0425
800 000	405	. . .	703	0.0337	0.86	19	1.180	30.0	2562	3812	0.0137	0.0451	0.0140	0.0460	0.0143	0.0469	0.0146	0.0478
750 000	380	. . .	703	0.0327	0.83	19	1.145	29.1	2412	3589	0.0147	0.0481	0.0150	0.0491	0.0152	0.0500	0.0155	0.0510
700 000	355	. . .	703	0.0316	0.80	19	1.106	28.1	2252	3352	0.0157	0.0515	0.0160	0.0525	0.0163	0.0536	0.0166	0.0547
650 000	329	. . .	703	0.0304	0.77	19	1.064	27.0	2085	3102	0.0169	0.0555	0.0172	0.0566	0.0176	0.0577	0.0180	0.0589
600 000	304	. . .	703	0.0292	0.74	19	1.022	26.0	1923	2862	0.0183	0.0601	0.0187	0.0613	0.0191	0.0625	0.0195	0.0638
550 000	279	. . .	703	0.0280	0.71	19	0.980	24.9	1768	2632	0.0200	0.0656	0.0204	0.0669	0.0208	0.0682	0.0212	0.0696
500 000	253	. . .	427	0.0342	0.87	7	0.923	23.4	1587	2362	0.0218	0.0715	0.0222	0.0729	0.0226	0.0743	0.0231	0.0758
450 000	228	. . .	427	0.0325	0.83	7	0.878	22.3	1433	2133	0.0242	0.0794	0.0247	0.0810	0.0252	0.0826	0.0257	0.0843
400 000	203	. . .	427	0.0306	0.78	7	0.826	21.0	1271	1891	0.0272	0.0893	0.0277	0.0911	0.0283	0.0929	0.0289	0.0948
350 000	177	. . .	427	0.0286	0.73	7	0.772	19.6	1110	1652	0.0311	0.102	0.0317	0.104	0.0324	0.106	0.0330	0.108
300 000	152	. . .	427	0.0265	0.67	7	0.716	18.2	953	1418	0.0363	0.119	0.0370	0.121	0.0377	0.124	0.0385	0.126
250 000	127	. . .	427	0.0242	0.61	7	0.653	16.6	795	1183	0.0436	0.143	0.0445	0.146	0.0453	0.149	0.0462	0.152
211 600	107	0000	259	0.0286	0.73	7	0.601	15.3	670	997	0.0512	0.168	0.0522	0.171	0.0533	0.175	0.0544	0.178
167 800	85	000	259	0.0255	0.65	7	0.536	13.6	533	793	0.0646	0.212	0.0659	0.216	0.0672	0.220	0.0685	0.225
133 100	67.4	00	259	0.0227	0.58	7	0.477	12.1	422	628	0.0814	0.267	0.0830	0.272	0.0847	0.278	0.0864	0.283
105 600	53.5	0	259	0.0202	0.51	7	0.424	10.8	334	497	0.103	0.337	0.105	0.344	0.107	0.350	0.109	0.357
83 690	42.2	1	259	0.0180	0.46	7	0.378	9.6	265	395	0.129	0.425	0.132	0.434	0.138	0.451	0.141	0.460
66 360	33.6	2	259	0.0160	0.41	7	0.335	8.5	210	312	0.163	0.536	0.167	0.547	0.173	0.569	0.176	0.580
52 620	26.7	3	133	0.0199	0.51	7	0.299	7.6	166	247	0.205	0.672	0.209	0.685	0.218	0.714	0.222	0.729
41 740	21.1	4	133	0.0177	0.45	7	0.266	6.8	131	195	0.258	0.848	0.264	0.865	0.274	0.900	0.279	0.918
33 090	16.8	5	133	0.0158	0.40	7	0.237	6.0	105	156	0.326	1.07	0.332	1.09	0.346	1.14	0.353	1.16
26 240	13.3	6	133	0.0140	0.36	7	0.210	5.3	82.1	122	0.411	1.35	0.419	1.38	0.437	1.43	0.446	1.46
20 820	10.5	7	133	0.0125	0.32	7	0.188	4.8	65.4	97.4	0.518	1.70	0.528	1.73	0.550	1.81	0.561	1.85
16 510	8.37	8	133	0.0111	0.28	7	0.167	4.2	51.6	76.8	0.653	2.14	0.666	2.18	0.694	2.28	0.708	2.33
13 090	6.63	9	133	0.0099	0.25	7	0.149	3.8	41.0	61.1	0.824	2.70	0.840	2.75	0.885	2.90	0.903	2.96

[A] The constructions shown in this table are typical of those used in the industry. It is not intended that this table preclude other constructions that may be desirable for specific applications. The constructions shown provide for a finished, non-covered, stranded conductor approximately of the area indicated. When specified by the purchaser, the number or size of wires may be increased to provide additional area to compensate for draw-down during subsequent processing.

[B] Values for the nominal diameter and mass of the completed conductor are approximate. The mass values are based upon the standard stranding increments listed in Explanatory Note 6.

approximate mass and electrical resistance may be determined using the standard increments shown in Explanatory Note 6. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 7).

10.2 The maximum electrical resistance of a unit of stranded conductor shall not exceed 2 % over the nominal DC resistance shown in Table 1 and Table 2. When the DC resistance is measured at other than 20°C, it is to be corrected by using the multiplying factor given in Table 3.

10.3 For conductors to be used in covered or insulated wires or cables, direct current (DC) resistance measurements shall be used instead of the method outlined in Section 12 to determine compliance with this specification.

11. Requirements for Wires

11.1 The purchaser shall designate the type of wire and type of coating, if any, to be used in the conductor.

11.1.1 Before stranding, uncoated wire shall meet the requirements of Specification B3.

11.1.2 Before stranding, tinned wire shall meet the requirements of Specification B33.

11.1.3 Before stranding, lead coated and lead-alloy coated wire shall meet the requirements of Specification B189.

11.2 These requirements shall not prohibit the manufacture of conductors from uncoated hard-drawn wires which are annealed after stranding.

12. Variation in Area

12.1 The calculated area of cross section of a stranded conductor expressed in circular mils shall be the product of the square of the specified diameter in mils of the individual wires times the number of wires prescribed (Note 1).

NOTE 1—The calculated area of such cables as may incorporate more than one size of component wires should be the sum of the areas of the different sizes of wires.

12.2 The area of cross section of a completed stranded conductor designated as an AWG size shall be not less than 98 % of the area indicated in Column 1 of Tables 1 and 2 for sizes 211 600 cmil (107 mm^2) and smaller. The area of cross section of a completed stranded conductor not designated as an AWG size shall be not less than 98 % of a calculated value obtained as prescribed in 10.1.

12.3 The area of cross section of a conductor shall be determined by Test Method B263. In applying this method, the increment of linear density resulting from stranding may be the applicable value listed in Explanatory Note 6 or may be calculated from the measured component dimensions of the sample under test. In case of question regarding area compliance, the actual linear density increment due to stranding shall be calculated.

TABLE 3 Temperature Correction Factors for Conductor Resistance

Temperature, °C	Multiplying Factor for Conversion to 20°C
0	1.085
5	1.063
10	1.041
15	1.020
20	1.000
25	.981
30	.962
35	.944
40	.927
45	.911
50	.895
55	.879
60	.864
65	.850
70	.836
75	.822
80	.809
85	.797
90	.784

13. Inspection

13.1 All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon between the manufacturer and the purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

14. Packaging and Package Marking

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

14.2 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 purchase.

15. Marking

15.1 The net mass, length (or 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.

16. Keywords

16.1 copper electrical conductor; electrical conductor—copper; rope-lay-stranded copper conductors; stranded copper conductor

EXPLANATORY NOTES

NOTE 1—In this specification only rope-lay-stranded conductors constructed with concentric-stranded members are designated. Requirements for rope-lay-stranded conductors constructed with *bunch-stranded* members will be found in Specification B172. Requirements for concentric-lay-stranded conductors will be found in Specification B8.

NOTE 2—For definitions of terms relating to conductors, reference should be made to ANSI C42.35 and Terminology B354.

NOTE 3—Certain types of insulated conductors may require a shorter lay than other conductors. It is expected that departures from the provisions of this specification because of special requirements relative to length of lay, direction of lay, and direction of lay of successive layers will be agreed upon by the manufacturer and the purchaser.

NOTE 4—Wires removed from stranded conductors and straightened for tests will have altered physical properties due to cold working of the material. The reduced elongation requirement for wires removed from stranded conductors reflects this condition.

NOTE 5—The value of density of copper is in accordance with the International Annealed Copper Standard. The corresponding value at 0°C is 8.90 g/cm^3 (0.32150 lb/in.^{3}). Density calculations involving coated wire should consider the variation of coated wire density from the density of uncoated copper wire. The relative affect of the coating density on the overall wire density becomes greater as wire diameters decrease.

NOTE 6—The following values approximate the incremental increase in mass and resistance of rope-lay stranded conductor as a result of stranding. The values are sufficiently accurate for most purposes and may be used when more precise values are not available. They are as follows:

Construction	Increment of Linear Density and Resistance, %
Rope-lay-stranded conductors (Classes G and H):	
49 wires or less	3
133 wires	4
259 wires	4.5
427 wires	5
Over 427 wires	6

NOTE 7—Any calculation of the increment of mass or electrical resistance, k, of a rope-lay-stranded conductor involves two independent calculations:

(1) Determination of the increment due to stranding of the individual members, and

(2) Determination of the increment due to twisting these members to form the completed conductor.

In the case of a rope-lay-stranded conductor having concentric-stranded members, the increment k, in percent, may be expressed as:

$$k = k_m + k_a + k_m k_a/100$$

where:

k_m = is the increment of mass or electrical resistance, in percent, of an individual concentric-stranded member before twisting into the completed conductor, calculated as described in Specification B8, Note 9, and

k_a = is the increment of mass or electrical resistance, in percent, due to twisting the concentric-stranded members into the completed conductor, calculated as described in Specification B8, Note 9, with each member considered as an individual wire.