



UL 1581

STANDARD FOR SAFETY

Reference Standard for Electrical
Wires, Cables, and Flexible Cords

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UL Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581
Fourth Edition, Dated October 31, 2001

Summary of Topics:

This revision to ANSI/UL 1581 dated November 29, 2023 includes revision to update outside references; [10.2](#), [10.3](#), [Table 10.1](#), [Table 50.133](#), [Table 50.135](#), [Table 50.136](#), [480.9](#), and [1090.1](#).

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated August 25, 2023.

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UL 1581

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Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 This standard contains specific details of the conductors, of the insulation, of the jackets and other coverings, and of the methods of sample preparation, of specimen selection and conditioning, and of measurement and calculation that are required in wire and cable standards.

1.2 The requirements for the particular materials, construction, performance, and marking of an individual type of wire, cable, or flexible cord are stated in the standard covering the finished type. They are not part of this reference standard.

1.3 In each case in which an element of this standard does not apply, the standard covering the finished type so states and specifies what does apply.

2 Units of Measurement

2.1 In addition to being stated in the inch/pound units that are customary in the USA, each numerical requirement in this standard is also stated in units that make the requirement conveniently usable in countries employing the metric system. Equivalent – although not exactly identical – results are to be expected from applying a requirement in inch/pound or metric units. Equipment calibrated in metric units is to be used when a requirement is stated in metric terms.

3 References and Terms

3.1 The term "wire standard" as used in this standard means any standard that covers finished electrical wires, cables, or flexible cords and in which reference is made to this reference standard (UL 1581).

4 thru 9 *Reserved for Future Use*

CONDUCTORS

10 Requirements for Aluminum Conductors of an 8000 Series Alloy

10.1 These requirements cover aluminum wire in annealed and intermediate tempers using 8000 series electrical-conductor-grade aluminum alloys. These alloys are for use in solid conductors in the 6 – 4/0 AWG sizes and in round-strand and compressed- and compact-stranded conductors in the 12 AWG – 2000 kcmil sizes.

10.2 The wire shall be of a registered 8000 series electrical-conductor-grade aluminum alloy complying with ASTM B 800. The conductor diameter and cross-sectional area shall comply with Conductor Diameter and Cross-Sectional Area, Section [20](#). The d-c resistance of the conductors shall comply with D-C Conductor Resistance, Section [30](#).

10.3 The temper of the wire of the finished conductor shall be annealed (-0) or intermediate (-H1X) or (-H2X). The tensile strength and elongation (see note b to [Table 10.1](#)) of the finished stranded conductor tested as a unit or of the individual strands removed from the finished conductor or of the finished solid conductor shall comply with [Table 10.1](#) when specimens are tested at a speed of 1 in/min or 25 mm/min using the equipment and procedure described in ASTM B 557.

Table 10.1
Mechanical properties^a of solid and stranded conductors of an 8000 series aluminum alloy

Temper	Tensile strength	Elongation ^b in 10 inches or 250 mm
Annealed (-0)	All specimens: 11,250 ±2,750 lbf/in ² or 78 ±19 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum
Semi-annealed: (-H1X) and (-H2X)	Wires (strands) removed from the finished stranded conductor: 18,675 ±4,425 lbf/in ² or 129 ±30 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum
	All other specimens: 18,500 ±3,500 lbf/in ² or 128 ±24 MPa	Solid conductor: 10.0 percent minimum Stranded conductor: 10.0 percent minimum

^a For the purpose of determining compliance with the tabulated limits, test results are to be rounded as follows after specimens are tested at a speed of 1 in/min or 25 mm/min using the equipment and procedure described in ASTM B 557:

- 1) Each calculated value of tensile strength is to be rounded to the nearest 100 lbf/in² or 1 MPa.
- 2) Each value of elongation is to be rounded to the nearest 0.5 percent as described in the rounding method in ASTM E 29.

^b Compliance with the elongation requirement for stranded conductors is to be determined on wires taken prior to stranding into conductors, on wires taken from a stranded conductor, or on the stranded conductor as a whole.

11 Requirements for Copper-Clad Aluminum Conductors

11.1 The requirements in this section (11.1) cover copper-clad aluminum conductors. Copper-clad aluminum conductors shall be drawn from copper-clad aluminum rod. The copper shall be metallurgically bonded to the aluminum core, shall occupy 10 percent or more of the cross section of a solid conductor and of each wire (strand) of a stranded conductor, and shall be concentric with the aluminum. The thickness of the copper shall not be less than 2.56 percent of the diameter of the solid conductor or wire (strand) as determined by microscopic examination of a polished right cross section of the round strand or round solid conductor. The tensile strength of a finished copper-clad aluminum conductor tested as a unit or of the wires (strands) from a finished stranded copper-clad aluminum conductor and of a finished solid copper-clad aluminum conductor shall not exceed 20,000 lbf/in² or 138 MPa when specimens are tested at the speed and using the equipment and procedure indicated in ASTM B 566. The elongation of the same specimens shall not be less than 15 percent in 10 inches or 250 mm.

12 Requirements for Copper-Clad Aluminum Conductors Used in Building Wire

12.1 General

12.1.1 The requirements in this section cover finished, copper-clad aluminum conductors and the individual strands of a finished copper-clad aluminum conductor. Copper-clad aluminum conductors shall be drawn from copper-clad aluminum rod. Copper-clad aluminum strands shall be limited to sizes 0.02257 – 0.2043 in diameter (23 – 4 AWG).

12.1.2 The aluminum core shall be an AA8000 series alloy as described in Section 10. The elemental analysis of the aluminum core shall be determined in accordance with ASTM E227. The results of the

elemental analysis on the aluminum core used shall meet the requirements for an AA 8000 series alloy as described in UL 44, Chemical composition of ACM, AA 8000 series aluminum alloy conductor materials.

12.1.3 The copper shall be high-conductivity, oxygen-free copper with an oxygen content not to exceed 0.001% meeting the requirements of ASTM B152. The copper shall be metallurgically bonded to the aluminum core as determined by the methods in [12.6](#) and [12.7](#). The copper shall occupy 10 percent or more by volume of the cross section of a solid conductor and of each wire (strand) of a stranded conductor as determined by the methods in [12.8](#). The thickness of the copper shall not be less than 4.0 percent of the radius of the solid conductor or wire (strand).

12.2 Tensile strength and elongation test

12.2.1 The tensile strength of a finished copper-clad aluminum conductor or of the wires (strands) from a finished stranded copper-clad aluminum conductor and of a finished solid copper-clad aluminum conductor shall not exceed 20,000 lbf/in² or 138 MPa. The elongation of the same specimens shall not be less than 15 percent. The tensile and elongation of a finished conductor or an individual strand shall be tested in accordance with the test, Physical properties of conductors (tensile strength, elongation at break, and ultimate strength) as described in UL 2556. The test shall be conducted at a speed of 12 in/min (305 mm/min), with 10 inches (254 mm) between the benchmarks.

12.3 DC resistance test

12.3.1 The DC resistance of the finished copper-clad aluminum conductor shall not exceed 0.026813 $\Omega \cdot \text{mm}^2/\text{m}$ when tested in accordance with the method, DC Resistance as described in UL 2556.

12.4 Density test

12.4.1 The density of the copper-clad aluminum shall be 3.32 g/cm³ (0.1200 lb/in³) nominal when the conductor material is tested using the method described in Annex B of UL 2556.

12.5 Diameter measurement

12.5.1 The diameter of the solid conductor or any individual strands from a stranded conductor shall meet the requirements in [Table 20.1](#) when measured in accordance with the test Conductor Diameter as described in UL 2556.

12.6 Adhesion test

12.6.1 A specimen of finished copper-clad aluminum conductor shall be fixed in a vice or other securement means. The free end of the conductor shall be flexed back and forth thru 180 degrees using any suitable means until the conductor breaks. The fractured area (not including the clamped area) shall be examined for delamination using magnification of 10X. There shall be no delamination between the copper and the aluminum.

12.7 Cohesion test

12.7.1 A specimen of a single strand of finished copper-clad aluminum conductor shall be selected. The minimum length of the specimen shall be 15 times the diameter of wire under test, plus the length required to secure both ends of the specimen. For example, a 12 AWG solid conductor has a diameter of 0.0808 inches. This would require a length of 1.212 inches (15 X 0.080) between the securement means. The specimen shall be fixed in a clamp or other securement means twisted three complete turns in one direction, untwisted to the original position, twisted three turns in the opposite direction and finally returned to the original position.

If a longer length is needed to facilitate the testing, the number of twists for a given length of wire shall be calculated from the formula:

$$\text{Number of twists} = \frac{\text{Length of wire between securement means, in inches}}{5 \times \text{OD of wire, in inches}}$$

In no case shall the number of twists be less than three.

12.7.2 After completion of the twists, the specimen shall be examined for seams or splits in the copper using 10X magnification in the area between the securement means. There shall be no seams or splits in the copper.

12.8 Copper construction

12.8.1 The surface of wire shall be free from pits, slivers, exposed aluminum, or other imperfections when examined under normal vision.

12.8.2 Three specimens of copper-clad aluminum, each specimen located at least 10 feet from the previous specimen, shall be mounted (in a suitable material if needed) so that a polished, right cross section of the conductor can be obtained. The minimum thickness at any point (MinAAP) shall be located and measured. The diameter of the overall conductor (D_c) and the diameter of the aluminum core (D_a) shall be each be measured at three locations and averaged. The three measurement locations shall be at the maximum diameter, the minimum diameter and at a location bisecting the maximum and minimum diameters. The measurements shall be made using a micrometer microscope with a resolution and accuracy of 0.001 mm (0.0001 in).

12.8.3 The ratio of copper with respect to the overall radius, R_{ca} , shall not be less than 4% of the radius of the overall conductor, where

$$R_{ca} = 100 \times \left(\frac{\text{MinAAP}}{D_c / 2} \right)$$

Where:

MinAAP is the minimum thickness of copper at any point when measured as described in [12.8.2](#)

D_c is the average diameter of the overall conductor

12.8.4 The percent copper volume, $\%C_v$ shall be calculated using

$$\%C_v = 100 \times \left(\frac{D_c^2 - D_a^2}{D_c^2} \right)$$

Where:

D_c is the average diameter of the overall conductor

D_a is the average diameter of the aluminum core

The copper shall be 10 percent or more by volume of the cross section.

13 thru 19 *Reserved for Future Use*

20 **Conductor Diameter and Cross-Sectional Area**

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**Table 20.1
Conductor dimensions**

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		Minimum			
			mils (0.98 x nominal)		mils (1.01 x nominal)		mils (0.99 x nominal)				0.98 × Nominal ^a		0.97 × Nominal ^b	
	mils	mm	mm	mm	mm	mm	mm	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
AWG														
56	0.49	0.0124	0.48	0.0122	0.495	0.0126	0.485	0.0123	0.240	0.000122	0.235	0.000119	–	–
55	0.55	0.0140	0.54	0.0137	0.556	0.0141	0.545	0.0138	0.302	0.000153	0.296	0.000150	–	–
54	0.62	0.0157	0.61	0.0154	0.63	0.0159	0.614	0.0156	0.384	0.000195	0.376	0.000191	–	–
53	0.70	0.0178	0.69	0.0174	0.71	0.0180	0.69	0.0176	0.490	0.000248	0.480	0.000243	–	–
52	0.78	0.0198	0.76	0.0194	0.79	0.0200	0.77	0.0196	0.608	0.000308	0.596	0.000302	–	–
51	0.88	0.0224	0.86	0.0219	0.89	0.0226	0.87	0.0221	0.774	0.000392	0.759	0.000384	–	–
50	0.99	0.0251	0.97	0.0246	1.00	0.0254	0.98	0.0249	0.980	0.000497	0.960	0.000487	–	–
49	1.11	0.0282	1.09	0.0276	1.12	0.0285	1.10	0.0279	1.23	0.000624	1.21	0.000611	–	–
48	1.24	0.0315	1.22	0.0309	1.25	0.0318	1.23	0.0312	1.54	0.000779	1.51	0.000765	–	–
47	1.40	0.0356	1.37	0.0348	1.41	0.0359	1.39	0.0352	1.96	0.000993	1.92	0.000973	–	–
46	1.57	0.0399	1.54	0.0391	1.59	0.0403	1.55	0.0395	2.46	0.00125	2.41	0.00122	–	–
45	1.76	0.0447	1.73	0.0438	1.78	0.0452	1.74	0.0443	3.10	0.00157	3.04	0.00154	–	–
44	2.0	0.051	1.96	0.050	2.02	0.0513	1.98	0.050	4.00	0.00203	3.92	0.00199	–	–
43	2.2	0.056	2.16	0.055	2.22	0.0564	2.18	0.055	4.84	0.00245	4.74	0.00240	–	–
42	2.5	0.064	2.45	0.062	2.53	0.0641	2.48	0.063	6.25	0.00317	6.13	0.00310	–	–
AWG														
41	2.8	0.071	2.7	0.070	2.83	0.072	2.77	0.070	7.84	0.00397	7.68	0.00389	–	–

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		Minimum			
			mils (0.98 x nominal)		mils (1.01 x nominal)		mils (0.99 x nominal)				0.98 x Nominal ^a		0.97 x Nominal ^b	
	mils	mm	mils	mm	mils	mm	mils	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
40	3.1	0.079	3.0	0.077	3.13	0.080	3.07	0.078	9.61	0.00487	9.42	0.00477	–	–
39	3.5	0.089	3.4	0.087	3.54	0.090	3.47	0.088	12.2	0.00621	12.0	0.00606	–	–
38	4.0	0.102	3.9	0.100	4.04	0.103	3.96	0.101	16.0	0.00811	15.7	0.00795	–	–
37	4.5	0.144	4.4	0.112	4.55	0.115	4.46	0.113	20.2	0.0103	19.8	0.0100	–	–
36	5.0	0.127	4.9	0.125	5.05	0.128	4.95	0.126	25.0	0.0127	24.5	0.0124	–	–
35	5.6	0.142	5.5	0.139	5.7	0.144	5.5	0.141	31.4	0.0159	30.8	0.0156	–	–
34	6.3	0.160	6.2	0.157	6.4	0.162	6.2	0.158	39.7	0.0201	38.9	0.0197	–	–
33	7.1	0.180	7.0	0.177	7.2	0.182	7.0	0.179	50.4	0.0255	49.4	0.0250	–	–
32	8.0	0.203	7.8	0.199	8.1	0.205	7.9	0.201	64.0	0.0324	62.7	0.0318	–	–
31	8.9	0.226	8.7	0.222	9.0	0.228	8.8	0.224	79.2	0.0401	77.6	0.0393	–	–
30	10.0	0.254	9.8	0.249	10.1	0.257	9.9	0.251	100	0.0507	98	0.0497	–	–
29	11.3	0.287	11.1	0.282	11.4	0.290	11.2	0.284	128	0.0647	125	0.0633	–	–
28	12.6	0.320	12.3	0.312	12.7	0.323	12.5	0.318	159	0.0804	156	0.0790	–	–
27	14.2	0.361	13.9	0.353	14.3	0.363	14.1	0.358	202	0.102	198	0.100	–	–
26	15.9	0.404	15.6	0.396	16.1	0.409	15.7	0.399	253	0.128	248	0.126	–	–
25	17.9	0.455	17.5	0.444	18.1	0.460	17.7	0.450	320	0.162	314	0.159	–	–
24	20.1	0.511	19.7	0.500	20.3	0.516	19.9	0.506	404	0.205	396	0.201	392	0.199
23	22.6	0.574	22.1	0.561	22.8	0.579	22.4	0.568	511	0.259	501	0.254	496	0.251

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		Minimum			
			mils (0.98 x nominal)		mils (1.01 x nominal)		mils (0.99 x nominal)				0.98 × Nominal ^a		0.97 × Nominal ^b	
	mils	mm	mils	mm	mils	mm	mils	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
22	25.3	0.643	24.8	0.630	25.6	0.650	25.0	0.635	640	0.324	627	0.318	621	0.314
21	28.5	0.724	27.9	0.709	28.8	0.732	28.2	0.717	812	0.412	796	0.404	788	0.400
20	32.0	0.813	31.4	0.798	32.3	0.820	31.7	0.805	1020	0.519	1000	0.509	989	0.503
19	35.9	0.912	35.2	0.894	36.3	0.922	35.5	0.902	1290	0.653	1264	0.641	1251	0.633
18	40.3	1.02	39.5	1.00	40.7	1.03	39.9	1.01	1620	0.823	1588	0.807	1571	0.798
17	45.3	1.15	44.4	1.13	45.8	1.16	44.8	1.14	2050	1.04	2009	1.02	1989	1.01
16	50.8	1.29	49.8	1.26	51.3	1.30	50.3	1.28	2580	1.31	2528	1.28	2503	1.27
15	57.1	1.45	56.0	1.42	57.7	1.47	56.5	1.44	3260	1.65	3195	1.62	3162	1.60
14	64.1	1.63	62.8	1.60	64.7	1.64	63.5	1.61	4110	2.08	4028	2.04	3987	2.02
13	72.0	1.83	70.6	1.79	72.7	1.85	71.3	1.81	5180	2.63	5076	2.58	5025	2.55
12	80.8	2.05	79.2	2.01	81.6	2.07	80.0	2.03	6530	3.31	6399	3.24	6334	3.21
11	90.7	2.30	88.9	2.26	91.6	2.33	89.8	2.28	8230	4.17	8065	4.09	7983	4.04
AWG														
10	101.9	2.588	99.9	2.537	102.9	2.614	100.9	2.563	10380	5.261	10172	5.16	10069	5.103
9	114.4	2.906	112.1	2.847	115.5	2.934	113.3	2.878	13090	6.631	12828	6.50	–	–
8	128.5	3.264	125.9	3.198	129.8	3.297	127.2	3.231	16510	8.367	16180	8.20	–	–
7	144.3	3.665	141.4	3.592	145.7	3.701	142.9	3.630	20820	10.55	20404	10.34	–	–
6	162.0	4.115	158.8	4.034	163.6	4.155	160.4	4.074	26240	13.30	25715	13.03	–	–

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor					
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		Minimum			
			mils (0.98 x nominal)		mils (1.01 x nominal)		mils (0.99 x nominal)				0.98 × Nominal ^a		0.97 × Nominal ^b	
	mils	mm	mils	mm	mils	mm	mils	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
5	181.9	4.620	178.3	4.529	183.7	4.666	180.1	4.575	33090	16.77	32428	16.43	–	–
4	204.3	5.189	200.2	5.085	206.3	5.240	202.3	5.138	41740	21.15	40905	20.73	–	–
3	229.4	5.827	224.8	5.710	231.7	5.885	227.1	5.768	52620	26.67	51568	26.14	–	–
2	257.6	6.543	252.4	6.411	260.2	6.609	255.0	6.477	66360	33.62	65033	32.95	–	–
1	289.3	7.348	283.5	7.201	292.2	7.422	286.4	7.275	83690	42.41	82016	41.56	–	–
1/0	324.9	8.252	318.4	8.087	328.1	8.334	321.7	8.171	105600	53.49	103488	52.42	–	–
2/0	364.8	9.266	357.5	9.080	368.4	9.357	361.2	9.174	133100	67.43	130438	66.08	–	–
3/0	409.6	10.40	401.4	10.20	413.7	10.51	405.5	10.30	167800	85.01	164444	83.31	–	–
4/0	460.0	11.68	450.8	11.45	464.6	11.80	455.4	11.57	211600	107.2	207368	105.1	–	–
kcmil									kcmil		kcmil			
250	–	–	–	–	–	–	–	–	250	127	245	124.1	–	–
300	–	–	–	–	–	–	–	–	300	152	294	149.0	–	–
350	–	–	–	–	–	–	–	–	350	177	343	173.8	–	–
400	–	–	–	–	–	–	–	–	400	203	392	198.6	–	–
450	–	–	–	–	–	–	–	–	450	228	441	223.5	–	–
500	–	–	–	–	–	–	–	–	500	253	490	248.3	–	–
550	–	–	–	–	–	–	–	–	550	279	539	273.1	–	–
600	–	–	–	–	–	–	–	–	600	304	588	297.9	–	–
650	–	–	–	–	–	–	–	–	650	329	637	322.8	–	–

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor								Cross-sectional area of conductor							
	Nominal				Minimum ^c				Nominal		Minimum					
	mils		mm		mils (0.98 x nominal)		mm		mils (1.01 x nominal)		mm		mils (0.99 x nominal)		mm	
	Nominal		Minimum ^c		Maximum ^c		Minimum ^d		Nominal		0.98 × Nominal ^a		0.97 × Nominal ^b			
mils		mm		mils (0.98 x nominal)		mm		mils (1.01 x nominal)		mm		mils (0.99 x nominal)		mm		
cmil		mm ²		cmil		mm ²		cmil		mm ²		cmil		mm ²		
700	–	–	–	–	–	–	–	–	–	700	355	686	347.6	–	–	
750	–	–	–	–	–	–	–	–	–	750	380	735	372.4	–	–	
800	–	–	–	–	–	–	–	–	–	800	405	784	397.2	–	–	
900	–	–	–	–	–	–	–	–	–	900	456	882	446.9	–	–	
1000	–	–	–	–	–	–	–	–	–	1000	507	980	496.6	–	–	
1100	–	–	–	–	–	–	–	–	–	1100	557	1078	546.2	–	–	
1200	–	–	–	–	–	–	–	–	–	1200	608	1176	595.9	–	–	
kcmil										kcmil		kcmil				
1250	–	–	–	–	–	–	–	–	–	1250	633	1225	620.7	–	–	
1300	–	–	–	–	–	–	–	–	–	1300	659	1274	645.5	–	–	
1400	–	–	–	–	–	–	–	–	–	1400	709	1372	695.2	–	–	
1500	–	–	–	–	–	–	–	–	–	1500	760	1470	744.9	–	–	
1600	–	–	–	–	–	–	–	–	–	1600	811	1568	794.5	–	–	
1700	–	–	–	–	–	–	–	–	–	1700	861	1666	844.2	–	–	
1750	–	–	–	–	–	–	–	–	–	1750	887	1715	869.0	–	–	
1800	–	–	–	–	–	–	–	–	–	1800	912	1764	893.8	–	–	
1900	–	–	–	–	–	–	–	–	–	1900	963	1862	943.5	–	–	
2000	–	–	–	–	–	–	–	–	–	2000	1013	1960	993.1	–	–	

Table 20.1 Continued on Next Page

Table 20.1 Continued

Size of conductor	Diameter of solid conductor				Cross-sectional area of conductor									
					Nominal	Minimum								
	Nominal		Minimum ^c			0.98 × Nominal ^a		0.97 × Nominal ^b						
	mils	mm	mils (0.98 x nominal)	mm	mils (1.01 x nominal)	mm	mils (0.99 x nominal)	mm	cmil	mm ²	cmil	mm ²	cmil	mm ²
^a The minimums in this column apply to flexible cord and fixture wire conductors composed of 29 – 20 AWG strands. Except where specified otherwise in the wire standard, the minimums in this column also apply to solid and stranded wires and cables (regardless of strand size). ^b For conductors in flexible cords and fixture wires in which the conductors are composed of 36 – 30 AWG strands, the minimums in this column apply. ^c The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor. ^d The values in this column apply where the wire standard specifies only a minimum diameter for the conductor.														

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Table 20.2
Diameters over round compact-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
12 AWG	0.085	2.16	0.083	2.11	0.086	2.18
11	0.095	2.41	0.093	2.36	0.096	2.44
10	0.107	2.72	0.105	2.67	0.108	2.74
9	0.120	3.05	0.118	3.00	0.121	3.07
8	0.134	3.40	0.131	3.23	0.135	3.43
7	0.152	3.86	0.149	3.78	0.154	3.91
6	0.169	4.29	0.166	4.22	0.171	4.34
5	0.191	4.85	0.187	4.75	0.193	4.90
4	0.213	5.41	0.209	5.31	0.215	5.46
3 AWG	0.238	6.02	0.233	5.92	0.240	6.10
2	0.268	6.81	0.263	6.68	0.271	6.88
1	0.299	7.59	0.293	7.44	0.302	7.67
1/0	0.336	8.53	0.329	8.36	0.339	8.61
2/0	0.376	9.55	0.368	9.35	0.380	9.65
3/0	0.423	10.74	0.415	10.54	0.427	10.85
4/0	0.475	12.07	0.466	11.84	0.480	12.19
250 kcmil	0.520	13.21	0.510	12.95	0.525	13.34
300	0.570	14.48	0.559	14.20	0.576	14.63
350	0.616	15.65	0.604	15.34	0.622	15.80
400	0.659	16.74	0.646	16.41	0.666	16.92
450	0.700	17.78	0.686	17.42	0.707	17.96
500	0.736	18.69	0.721	18.31	0.743	18.87
550	0.775	19.69	0.760	19.30	0.783	19.89
600	0.813	20.65	0.797	20.24	0.821	20.85
650	0.845	21.46	0.828	21.03	0.853	21.67
700	0.877	22.28	0.859	21.82	0.886	22.50
750	0.908	23.06	0.890	22.61	0.917	23.29
800	0.938	23.83	0.919	23.34	0.947	24.05
900	0.999	25.37	0.979	24.87	1.009	25.63

Table 20.2 Continued on Next Page

Table 20.2 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1000	1.060	26.92	1.039	26.39	1.071	27.20

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

Table 20.3
Diameters over round compressed concentric-lay-stranded ASTM Classes B, C, and D aluminum, uncoated copper, and coated copper conductors

Conductor size	Nominal ^b		Minimum ^c		Maximum ^c	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
14 AWG	0.071 ^a	1.80 ^a	0.070	1.79	0.072	1.83
13	0.080 ^a	2.03 ^a	0.078	1.98	0.081	2.06
12	0.089	2.26	0.087	2.21	0.090	2.29
11	0.100	2.54	0.098	2.49	0.101	2.57
10	0.113	2.87	0.111	2.82	0.114	2.90
9	0.126	3.20	0.123	3.12	0.127	3.23
8	0.142	3.61	0.139	3.53	0.143	3.63
7	0.159	4.04	0.156	3.96	0.161	4.09
6	0.178	4.52	0.174	4.42	0.180	4.57
5	0.200	5.08	0.196	4.98	0.202	5.13
4	0.225	5.72	0.221	5.61	0.227	5.77
3	0.252	6.40	0.247	6.27	0.255	6.48
2	0.283	7.19	0.277	7.04	0.286	7.26
1	0.322	8.18	0.316	8.03	0.325	8.26
1/0	0.362	9.19	0.355	9.02	0.366	9.30
2/0	0.405	10.3	0.397	10.08	0.409	10.39
3/0	0.456	11.6	0.447	11.35	0.461	11.71
4/0	0.512	13.0	0.502	12.75	0.517	13.13
250 kcmil	0.558	14.2	0.547	13.89	0.564	14.33
300	0.611	15.5	0.599	15.21	0.617	15.67
350	0.661	16.8	0.648	16.46	0.668	19.97

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Table 20.3 Continued on Next Page

Table 20.3 Continued

Conductor size	Nominal ^b		Minimum ^c		Maximum ^c	
	inch	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
400	0.706	17.9	0.692	17.58	0.713	18.11
450	0.749	19.0	0.734	18.64	0.756	19.20
500	0.789	20.0	0.773	19.63	0.797	20.24
550	0.829	21.1	0.812	20.62	0.837	21.26
600	0.866	22.0	0.849	21.56	0.875	22.23
650	0.901	22.9	0.883	22.43	0.910	23.11
700	0.935	23.7	0.916	23.27	0.944	23.98
750	0.968	24.6	0.949	24.10	0.978	24.84
800	1.000	25.4	0.980	24.89	1.010	25.65
900	1.060	26.9	1.039	26.39	1.071	27.20
1000	1.117	28.4	1.095	27.81	1.128	28.65
1100	1.173	29.8	1.150	29.21	1.185	30.10
1200 kcmil	1.225	31.1	1.200	30.48	1.237	31.42
1250	1.250	31.8	1.225	31.12	1.262	32.05
1300	1.275	32.4	1.250	31.75	1.288	32.72
1400	1.323	33.6	1.297	32.94	1.336	33.93
1500	1.370	34.8	1.343	34.11	1.384	35.15
1600	1.415	35.9	1.387	35.23	1.429	36.30
1700	1.459	37.1	1.430	36.32	1.474	37.44
1750	1.480	37.6	1.450	36.83	1.495	37.97
1800	1.502	38.2	1.472	37.39	1.517	38.53
1900	1.542	39.2	1.511	38.38	1.557	39.55
2000	1.583	40.2	1.551	39.40	1.599	40.61

^a Aluminum is for use in the 12 AWG – 2000 kcmil sizes, not in the 14 and 13 AWG sizes.

^b In no case is the diameter of a compressed-stranded conductor to be more than 3 percent smaller than the diameter of the conductor determined after the conductor is assembled and before it is compressed.

^c The values in these two columns apply where the wire standard (power principally) specifies maximum and minimum diameters for the conductor.

Table 20.3.1
Diameters over round compressed unilay-stranded ASTM Class B aluminum, uncoated copper,
and coated copper conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1 AWG	0.313	7.95	0.307	7.80	0.316	8.03
1/0	0.352	8.94	0.345	8.76	0.356	9.04
2/0	0.395	10.03	0.387	9.83	0.399	10.13
3/0	0.443	11.25	0.434	11.02	0.447	11.35
4/0	0.498	12.65	0.488	12.40	0.503	12.78
250 kcmil	0.542	13.77	0.531	13.49	0.547	13.89
300	0.594	15.09	0.582	14.78	0.600	15.24
350	0.641	16.28	0.628	15.95	0.647	16.43
400	0.685	17.40	0.671	17.04	0.692	17.58
450	0.727	18.47	0.712	18.08	0.734	18.64
500	0.766	19.46	0.751	19.08	0.774	19.66
550	0.804	20.42	0.788	20.02	0.812	20.62
600	0.840	21.34	0.823	20.90	0.848	21.54
650 kcmil	0.874	22.20	0.857	21.77	0.883	22.43
700	0.907	23.04	0.889	22.58	0.916	23.27
750	0.939	23.85	0.920	23.37	0.948	24.08
800	0.969	24.61	0.950	24.13	0.979	24.87
900	1.028	26.11	1.007	25.58	1.038	26.37
1000	1.084	27.53	1.062	26.97	1.095	27.81
1100	1.137	28.88	1.114	28.30	1.148	29.16
1200	1.187	30.15	1.163	29.54	1.199	30.45
1250	1.212	30.78	1.188	30.18	1.224	31.09
1300	1.236	31.39	1.211	30.76	1.248	31.70
1400	1.282	32.56	1.256	31.90	1.295	32.89
1500	1.327	33.71	1.300	33.02	1.340	34.04
1600	1.371	34.82	1.344	34.14	1.385	35.18
1700	1.413	35.89	1.385	35.18	1.427	36.25

Table 20.3.1 Continued on Next Page

Table 20.3.1 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1750	1.434	36.42	1.405	35.69	1.448	36.78
1800	1.454	36.93	1.425	36.20	1.469	37.31
1900	1.494	37.95	1.464	37.19	1.509	38.33
2000	1.533	38.94	1.502	38.15	1.548	39.32

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor. Otherwise, in no case is the diameter of a compressed-stranded conductor to be more than 3 percent smaller than the diameter of the conductor determined after the conductor is assembled and before it is compressed.

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Table 20.4
Diameters over ASTM Class B round concentric-lay-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
30 AWG	0.0113	0.287	0.0111	0.282	0.0114	0.290
29	0.0128	0.325	0.0125	0.318	0.0129	0.328
28	0.0143	0.363	0.0140	0.356	0.0144	0.356
27	0.0161	0.409	0.0158	0.401	0.0163	0.414
26	0.0180	0.457	0.0176	0.447	0.0182	0.462
25	0.0203	0.516	0.0199	0.505	0.0205	0.521
24	0.0228	0.579	0.0223	0.566	0.0230	0.584
23	0.0256	0.650	0.0251	0.638	0.0259	0.658
22 AWG	0.0287	0.729	0.0281	0.714	0.0290	0.737
21	0.0323	0.820	0.0317	0.805	0.0326	0.828
20	0.0362	0.919	0.0355	0.902	0.0366	0.930
19	0.0407	1.03	0.0399	1.013	0.0411	1.044
18	0.0456	1.16	0.0447	1.135	0.0461	1.171
17	0.0513	1.30	0.0502	1.275	0.0518	1.315
16	0.0576	1.46	0.0564	1.433	0.0582	1.478
15	0.0647	1.64	0.0635	1.613	0.0653	1.659
14	0.0727	1.85	0.0712	1.81	0.0734	1.86
13	0.0816	2.07	0.0800	2.03	0.0824	2.09
12	0.0915	2.32	0.0897	2.28	0.0924	2.35
11	0.103	2.62	0.101	2.57	0.104	2.64
10	0.116	2.95	0.114	2.90	0.117	2.97
9	0.130	3.30	0.127	3.23	0.131	3.33
8	0.146	3.71	0.143	3.63	0.147	3.73
7	0.164	4.17	0.161	4.09	0.166	4.22
6	0.184	4.67	0.180	4.57	0.186	4.72
5	0.206	5.23	0.201	5.11	0.208	5.28
4	0.232	5.89	0.227	5.77	0.234	5.94
3	0.260	6.60	0.255	6.48	0.263	6.68

Table 20.4 Continued on Next Page

Table 20.4 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
2	0.292	7.42	0.286	7.26	0.295	7.49
1	0.332	8.43	0.325	8.26	0.335	8.51
1/0	0.372	9.45	0.365	9.27	0.376	9.55
2/0	0.418	10.62	0.410	10.41	0.422	10.72
3/0	0.470	11.94	0.461	11.71	0.475	12.07
4/0	0.528	13.41	0.517	13.13	0.533	13.54
250 kcmil	0.575	14.61	0.564	14.33	0.581	14.76
300	0.630	16.00	0.617	15.67	0.636	16.15
350	0.681	17.30	0.667	16.94	0.688	17.48
400	0.728	18.49	0.713	18.11	0.735	18.67
450	0.772	19.61	0.757	19.23	0.780	19.81
500	0.813	20.65	0.797	20.24	0.821	20.85
550	0.855	21.72	0.838	21.29	0.864	21.95
600	0.893	22.68	0.875	22.23	0.902	22.91
650 kcmil	0.929	23.60	0.910	22.86	0.938	23.83
700	0.964	24.49	0.945	24.00	0.974	24.74
750	0.998	25.35	0.978	24.84	1.008	25.60
800	1.030	26.16	1.009	25.63	1.040	26.42
900	1.094	27.79	1.072	27.23	1.105	28.07
1000	1.152	29.26	1.129	28.68	1.164	29.57
1100	1.209	30.71	1.185	30.10	1.221	31.01
1200	1.263	32.08	1.238	31.45	1.276	32.41
1250	1.289	32.74	1.263	32.08	1.302	33.07
1300	1.314	33.38	1.288	32.72	1.327	33.71
1400	1.365	34.67	1.338	33.99	1.379	35.03
1500	1.412	35.86	1.384	35.15	1.426	36.22
1600	1.459	37.06	1.430	36.32	1.474	37.44
1700	1.504	38.20	1.474	37.44	1.519	38.58

Table 20.4 Continued on Next Page

Table 20.4 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	inches	mm	inches (0.98 x nominal)	mm	inches (1.01 x nominal)	mm
1750	1.526	38.76	1.495	37.97	1.541	39.14
1800	1.548	39.32	1.517	38.53	1.563	39.70
1900	1.590	40.39	1.558	39.57	1.606	40.79
2000	1.632	41.45	1.599	40.61	1.648	41.86

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

Table 20.4.1
Diameters over ASTM Class C round concentric-lay-stranded conductors

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	Inches	mm	Inches (0.98 x nominal)	mm	Inches (1.01 x nominal)	mm
30 AWG	0.0115	0.292	0.0113	0.338	0.0116	0.295
29	0.0130	0.330	0.0127	0.323	0.0131	0.333
28	0.0145	0.368	0.0142	0.361	0.0146	0.371
27	0.0163	0.414	0.0160	0.406	0.0165	0.419
26	0.0182	0.465	0.0178	0.452	0.0184	0.467
25	0.0205	0.521	0.0201	0.511	0.0207	0.526
24	0.0230	0.584	0.0225	0.572	0.0232	0.589
23	0.0259	0.658	0.0254	0.645	0.0262	0.665
22	0.0290	0.737	0.0284	0.721	0.0293	0.744
21 AWG	0.0327	0.830	0.0320	0.813	0.0330	0.838
20	0.0365	0.927	0.0358	0.909	0.0369	0.937
19	0.0412	1.046	0.0404	1.026	0.0416	1.057
18	0.0460	1.168	0.0451	1.146	0.0465	1.181
17	0.0519	1.318	0.0509	1.293	0.0524	1.331
16	0.0585	1.486	0.0573	1.455	0.0591	1.501
15	0.0655	1.664	0.0642	1.631	0.0662	1.681
14	0.0735	1.867	0.0720	1.829	0.0743	1.887
13	0.0825	2.096	0.0850	2.159	0.0833	2.116

Table 20.4.1 Continued on Next Page

Table 20.4.1 Continued

Conductor size	Nominal		Minimum ^a		Maximum ^a	
	Inches	mm	Inches (0.98 x nominal)	mm	Inches (1.01 x nominal)	mm
12	0.0925	2.350	0.0907	2.304	0.0934	2.372
11 AWG – 2000 kcmil	b	b	b	b	b	b

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

^b Use [Table 20.4](#).

Table 20.5
Nominal dimensions of round strands

AWG size of strand	Diameter		Cross-sectional area	
	Mils	mm	cmil	mm ²
40	3.1	0.079	9.61	0.00487
39	3.5	0.089	12.2	0.00621
38	4.0	0.102	16.0	0.00811
37	4.5	0.144	20.2	0.0103
36	5.0	0.127	25.0	0.0127
35	5.6	0.142	31.4	0.0159
34	6.3	0.160	39.7	0.0201
33	7.1	0.180	50.4	0.0255
32	8.0	0.203	64.0	0.0324
31	8.9	0.226	79.2	0.0401
30	10.0	0.254	100	0.0507
29	11.3	0.287	128	0.0647
28	12.6	0.320	159	0.0804
27	14.2	0.361	202	0.102
26	15.9	0.404	253	0.128
25	17.9	0.455	320	0.162
24	20.1	0.511	404	0.205
23	22.6	0.574	511	0.259
22	25.3	0.643	640	0.324
21	28.5	0.724	812	0.412
20	32.0	0.813	1020	0.519

Table 20.6
Nominal strand and conductor dimensions for 19-wire combination round-wire unilay-stranded copper or aluminum conductors

AWG conductor size	Nominal strand dimensions								Conductor diameter					
	Large strand				Small strand				E = 3A + 2C		F = 0.98 x E		G = 1.01 x E	
	A Diameter		B Cross-sectional area		C Diameter		D Cross-sectional area		Nominal		Minimum ^a		Maximum ^a	
	inch	mm	cmil	mm ²	inch	mm	cmil	mm ²	inch	mm	inch	mm	inch	mm
14	0.0159	0.4	253	0.128	0.0117	0.3	137	0.069	0.071	1.80	0.70	1.78	0.72	1.83
12	0.0201	0.5	404	0.205	0.0147	0.4	216	0.109	0.090	2.29	0.88	2.24	0.091	2.31
10	0.0253	0.6	640	0.324	0.0185	0.5	342	0.173	0.113	2.87	1.11	2.87	0.114	2.90
9	0.0284	0.7	807	0.408	0.0208	0.5	433	0.219	0.127	3.23	0.127	3.14	0.128	3.25
8	0.0319	0.8	1018	0.515	0.0234	0.6	548	0.277	0.143	3.63	1.40	3.56	0.144	3.66
7	0.0358	0.9	1282	0.649	0.0262	0.67	686	0.347	0.160	4.06	0.157	3.99	0.162	4.11
6	0.0402	1.0	1616	0.818	0.0294	0.7	864	0.437	0.179	4.55	0.175	4.45	0.181	4.60
5	0.0452	1.1	2043	1.034	0.0331	0.8	1096	0.555	0.202	5.13	0.198	5.03	0.204	5.18
4	0.0507	1.3	2570	1.301	0.0371	0.9	1376	0.696	0.226	5.74	0.221	5.61	0.228	5.79
3	0.0570	1.4	3249	1.644	0.0417	1.1	1739	0.880	0.254	6.45	0.249	6.32	0.257	6.53
2	0.0640	1.6	4096	2.073	0.0468	1.2	2190	1.108	0.286	7.26	0.280	7.11	0.289	7.34
1	0.0718	1.8	5155	2.609	0.0526	1.3	2767	1.400	0.321	8.15	0.316	8.03	0.324	8.23
1/0	0.0807	2.1	6512	3.296	0.0591	1.5	3493	1.768	0.360	9.14	0.353	8.97	0.364	9.25
2/0	0.0906	2.3	8208	4.154	0.0663	1.7	4396	2.225	0.404	10.26	0.396	10.06	0.408	10.36
3/0	0.1017	2.6	10343	5.234	0.0745	1.9	5550	2.809	0.454	11.53	0.445	11.30	0.459	11.66
4/0	0.1142	2.9	13042	6.600	0.0836	2.1	6989	3.537	0.510	12.95	0.500	12.70	0.515	13.08

^a The values in these two columns apply where the wire standard (power cables principally) specifies maximum and minimum diameters for the conductor.

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