UL 758

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Appliance Wiring Material

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UL Standard for Safety for Appliance Wiring Material, UL 758

Second Edition, Dated April 24, 2006

Revisions: This Standard contains revisions through and including January 12, 2007.

Summary of Topics

This revision to UL 758 is issued to (1) Add Types mPPE and mPPE-PE Materials to Table 7.1, Index to Insulations and Jackets, and (2) Add Reference to Newly Approved mPPE Insulation Material for AWM to Table 19.1, Load, Temperature, and Decrease in Thickness for Deformation Test .

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The following table lists the future effective dates with the corresponding reference.

Future Effective Date	References
May 1, 2008	Paragraphs 7.2.2, 7.2.4, 8.4, 13.2.2, 14.1, 20.2, and 29.2; Table 3.6
October 24, 2007	Paragraphs 7.2.1, 7.2.2, 12.4, 12.5, 12.6, and 26.1; Tables 7.1, 7.2, 7.3, and 21.1

The revisions dated January 12, 2007 include a reprinted title page (page1) for this Standard.

The revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated November 10, 2006.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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37	October 6, 2006
38-39	April 24, 2006
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ANSI/UL 758-2007

1

UL 758

Standard for Appliance Wiring Material

First Edition – July, 2000

Second Edition

April 24, 2006

The most recent designation of ANSI/UL 758 as an American National Standard (ANSI) occurred on January 12, 2007.

This ANSI/UL Standard for Safety, which consists of the Second Edition with revisions through January 12, 2007, is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. 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 http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover Appliance Wiring Material (AWM) in the form of single insulated conductors, multi-conductor cables, optical fibers, individual insulated conductors, and fiber optic members for use as components in multi-conductor cables.

1.2 The appliance wiring material covered by the requirements of this Standard are solely for use as factory-installed wiring either within the overall enclosure of appliances and other equipment (internal wiring) or as external interconnecting cable for appliances (external wiring), or for further processing as components in multi-conductor cables.

1.3 These requirements do not cover any wire, cable, or cord types that are presently covered in the National Electrical Code (NEC), NFPA 70, and are not intended for installation in buildings or structures in accordance with the NEC except within the scope of the installation instructions of the end-product for which their use is intended.

1.4 These requirements cover appliance wiring material with operating temperatures from a minimum 60°C (140°F) dry temperature rating and voltage ratings from a minimum 30-volt rating. Conductor size ranges from 50 AWG to 2000 kcmil. Appliance wiring material (AWM) composed entirely of optical fiber members or electrical conductors in combination with optical fiber members are also covered by these requirements.

1.5 These requirements do not cover the optical performance of any optical-fiber member or group of such members.

1.6 In addition to these constructions, this Standard establishes guidelines for the evaluation of special constructions that, due to their specific end product use, are not required to meet all of the requirements for general construction AWM.

1.7 The final acceptance of AWM is dependent upon its use in complete equipment that conforms with the standards applicable to such equipment.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this Standard shall comply with the requirements for that component.

2.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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2.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.1.5 Polymeric materials evaluated for its intended use, are not prohibited from being used in the insulation and jacket applications indicated in Table 2.1.

Table 2.1
Polymeric materials for use in wire and cable and associated AWM ratings

AWM rating	Minimum average thickness of insulation, inch	(mm)	Compound's use or rating
Sunlight resistant	0.030	0.76	Outer PVC or TPE insulation or jacket rated for 720 hours sunlight resistance
60°C Wet	0.030	0.76	PVC insulation rated for use in Type TW thermoplastic-insulated wire
60°C or 75°C Wet	0.030	0.76	PVC insulated rated for use in Types THW or THHW thermoplastic-insulated wire
60°C or 75°C Wet	0.015	0.38	PVC insulation rated for use in Type THWN thermoplastic-insulated wire
60°C, 75°C, or 90°C Wet	0.015	0.38	PVC insulation rated for use in Type THWN-2 thermoplastic-insulated wire

2.2 Units of measurement

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2.2 Unless otherwise indicated, all voltage values mentioned in this Standard are root-mean-square (rms).

2.2.3 Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

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2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.3.2 Wherever the designation ″UL 1581″ is used in this Standard, reference is to be made to the designated part(s) of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

CONSTRUCTION

3 General

3.1 The acceptability of an AWM for use in a specific end-product is based on the construction and flame rating of each individual construction.

3.2 Tables 3.1 – 3.7 serve as indices to requirements for construction details and basic test methods for typical AWM constructions.

Table 3.1
Single or multiple conductor with extruded insulation

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulation:	
Material	See Insulation, Section 7
Thickness	See Insulation, Section 7
Covering:	
Material	See Coverings, Section 8
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel or Carton, Section 48
Basic tests:	
Physical Properties of Insulation and Jacket, Unaged and Air Oven Aged, Section 14.	
Conductor Corrosion Test, Section 18	
Deformation Test (Thermoplastics and Class XL Only), Section 19.	
# Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section. 20.	
Heat Shock Test (Thermoplastic Materials Only), Section 21.	
Cold Bend Test, Section 22.	
Crush Resistance Test, Section 27.	
Dielectric Test, Method I, Section 28.	
Dielectric Test, Method II, Section 29.	
Dielectric Test, Method III, Section 30.	
Horizontal Flame Test for Internal Wiring, Section 39.	
Elective tests/ratings:	See Table 3.7

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Table 3.2
Single conductor with other-than-extruded insulation

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulation:	
Material	See Insulation, Section 7
Thickness	See Insulation, Section 7
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel or Carton, Section 48
Basic tests: Conductor Corrosion Test, Section 18. # Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section 20. Cold Bend Test, Section 22. Dielectric Test, Method I, Section 28. Dielectric Test, Method II, Section 29. Horizontal Flame Test for Internal Wiring, Section 39. Elective tests/ratings: See Table 3.7.	

Table 3.3
Parallel cable with extruded integral insulation and jacket

Table 3.3 revised April 24, 2006

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Integral insulation and jacket:	
Material	See Insulation, Section 7; Overall Jacket, Section 13
Thickness	See Insulation, Section 7; Overall Jacket, Section 13
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel or Carton, Section 48
Basic tests: Physical Properties of Insulation and Jacket, Unaged and Air Oven Aged, Section 14. Conductor Corrosion Test, Section 18. Deformation Test (Thermoplastics and Class XL Only), Section 19. # Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section 20. Heat Shock Test (Thermoplastic Materials Only), Section 21. Cold Bend Test, Section 22. Dielectric Test, Method I, Section 28. Dielectric Test, Method II, Section 29. Dielectric Test, Method III, Section 30. Horizontal Flame Test for Internal Wiring, Section 39. Cable Flame Test, Section 40. Elective tests/ratings: See Table 3.7.	

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Table 3.4
Multiple-conductor cable using non-integral jacket

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulated conductors:	See Insulation, Section 7 The voltage and temperature rating of the cable shall not exceed the lowest rating of either the insulated conductors or the fiber optic members. Cables rated 60°C, 75°C, and 90°C wet shall use insulated conductors that comply with the applicable wet rating.
Covering:	
Material	See Coverings, Section 8
Shield:	See Shield(s), Section 11
Jacket:	
Material	See Overall Jacket, Section 13
Thickness	See Overall Jacket, Section 13
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel, or Carton, Section 48
Basic tests: Insulated conductors tested in accordance with Tables 3.1, 3.2, 3.3, or 3.5. Physical Properties of Insulation and Jacket, Unaged and Air Oven Aged, Section 14 – Test jacket only. Deformation Test (Thermoplastics and Class XL Only), Section 19. # Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section 20 Heat Shock Test (Thermoplastic Materials Only), Section 21 Cold Bend Test, Section 22. Horizontal Flame Test for Internal Wiring, Section 39. Cable Flame Test, Section 40. Elective tests/ratings:	See Table 3.7.

Table 3.5
Bonded or laminated flat ribbon cable

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulation:	
Material	See Insulation, Section 7
Thickness	See Insulation, Section 7
Covering:	
Material	See Coverings, Section 8
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel, or Carton, Section 48
Basic tests: Physical Properties of Insulation and Jacket, Unaged and Air Oven Aged, Section 14 – Test bonded only. Conductor Corrosion Test, Section 18. Deformation Test (Thermoplastics and Class XL Only), Section 19. # Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section 20. Heat Shock Test (Thermoplastic Materials Only), Section 21. Cold Bend Test, Section 22. Delamination Test (Laminated Constructions Only), Section 23. Dielectric Test, Method I, Section 28.	

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Dielectric Test, Method II, Section 29	
Dielectric Test, Method III, Section 30.	
Horizontal Flame Test for Internal Wiring, Section 39.	
Elective tests/ratings:	See Table 3.7.

Table 3.6
High voltage DC wire with extruded insulation

Effective date for Table 3.6 changed from November 1, 2006 to May 1, 2008

Conductors:	
Material	See Conductor, Section 5
Size	See Conductor, Section 5
Insulation:	
Material	See Insulation, Section 7 (solid insulation only)
Thickness	See Insulation, Section 7
Covering:	
Material	See Coverings, Section 8
Markings:	See Surface Marking of AWM, Section 47, and Markings on Tag, Reel, or Carton, Section 48
Basic tests:	
Physical Properties of Insulation and Jacket, Unaged and Air Oven Aged, Section 14.	
Conductor Corrosion Test, Section 18.	
Deformation Test (Thermoplastics and Class XL Only), Section 19.	
# Flexibility Test of Insulation, Covering, and Jacket After Air Oven Conditioning, Section 20.	
Heat Shock Test (Thermoplastic Materials Only), Section 21.	
Shrinkback Test – Special Rating TV Wires Only, Section 24.	
Ozone Resistance Test – Special Rating TV Use Wires Only, Section 25.	
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method I, Section 31.	
High-Voltage DC Wire Dielectric Voltage-Withstand Test, Method II, Section 32.	
High-Voltage Cut-Through Test, Special Rated TV Wire Only, Section 33.	
Horizontal Flame Test for Internal Wiring, Section 39.	
VW-1 Flame Test (required for TV wire), Section 41.	
Elective tests/ratings:	See Table 3.7.

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Table 3.7
Elective tests and ratings

Flame tests:	VW-1 Flame Test, Section 41. FT-1 Flame Test, Section 42. FT-2 Flame Test, Section 43.
Mechanical test:	Crush Resistance Test, Section 27.
Sunlight resistance test:	Physical Properties of Insulation and Jacket, Sunlight Resistance, Section 17.
Oil and gasoline resistance tests:	Physical Properties of Insulation and Jacket, Oil Immersion Aging, Section 15. Physical Properties of Gasoline Resistant Insulation and Jacket, Section 16.
Wet ratings tests:	Temperature Correction Factor (Wet Rated AWM), Section 36. Capacitance and Relative Permittivity Tests (Wet Rated AWM), Section 37. Short Term Insulation-Resistance Test in Water at Room Temperature (Wet Rated AWM), Section 34, required for all wet rated wires. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 35, at 50°C required for wires rated 60°C wet. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 35, at 75°C required for wires rated 75°C wet. Long Term Insulation-Resistance Test in Water at Elevated Temperature (Wet Rated AWM), Section 35, at 90°C required for wires rated 90°C wet.

4 Materials

4.1 Each material used in AWM shall be compatible with all of the other materials used in the wire or cable.

4.2 Due to possible incompatibility, TPE materials of the styrenic type may not be suitable for use in cords whereby direct contact with PVC may occur. A separator is one acceptable means of avoiding direct contact. Other combinations of materials which could be incompatible, if any, are as yet undetected.

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5 Conductor

5.1 General

5.1.1 A conductor consisting of a single wire is designated as a solid conductor, while one consisting of a number of individual wires is designated as a stranded conductor. The American Wire Gauge (AWG) numbers, the kcmil (thousands of circular mils) sizes, and the square-millimeter sizes each signify a definite nominal total cross-sectional area (see Table 5.1) independent of the conductor material. The individual wires used in making up a stranded conductor are not required to correspond to any particular AWG or other standard gauge size.

Table 5.1
Conductor dimensions

Table 5.1 revised April 24, 2006

Size of conductor, AWG	Diameter of solid conductor				Cross-sectional area of stranded conductor			
	Nominal,		Minimum,		Nominal,		Minimum,	
	Mils	(mm)	Mils	(mm)	Cmils	(mm^2)	Cmils	(mm^2)
50	0.99	0.0251	0.98	0.025	0.980	0.000497	0.960	0.000486
49	1.11	0.0282	1.10	0.028	1.23	0.000624	1.21	0.000613
48	1.24	0.0315	1.23	0.031	1.54	0.000768	1.51	0.000765
47	1.40	0.0356	1.39	0.035	1.96	0.000993	1.92	0.000973
46	1.57	0.0399	1.55	0.039	2.46	0.00125	2.41	0.00122
45	1.76	0.0447	1.74	0.044	3.10	0.00157	3.04	0.00154
44	2.0	0.051	1.98	0.050	4.00	0.00203	3.92	0.00198
43	2.2	0.056	2.18	0.055	4.84	0.00245	4.74	0.00240
42	2.5	0.064	2.48	0.063	6.25	0.00317	6.13	0.003115
41	2.8	0.071	2.77	0.070	7.84	0.00397	7.68	0.00389
40	3.1	0.079	3.07	0.078	9.61	0.00487	9.42	0.00477
39	3.5	0.089	3.47	0.088	12.2	0.00621	11.9	0.00603
38	4.0	0.102	3.96	0.101	16.0	0.00811	15.7	0.00796
37	4.5	0.114	4.46	0.113	20.2	0.0103	19.8	0.0100
36	5.0	0.127	4.95	0.126	25.0	0.0127	24.5	0.0124
35	5.6	0.142	5.54	0.141	31.4	0.0159	30.8	0.0156
34	6.3	0.160	6.24	0.158	39.7	0.020	38.9	0.0197
33	7.1	0.180	7.03	0.179	50.4	0.0255	49.4	0.0250
32	8.0	0.203	7.92	0.201	64.0	0.0324	62.7	0.0318
31	8.9	0.226	8.81	0.224	79.2	0.0401	77.6	0.0393
30	10.0	0.254	9.9	0.251	100	0.0507	98	0.0497
29	11.3	0.287	11.2	0.284	128	0.0647	125	0.0633
28	12.6	0.320	12.5	0.318	159	0.0804	156	0.0790
27	14.2	0.361	14.1	0.358	202	0.102	198	0.100
26	15.9	0.404	15.7	0.399	253	0.128	248	0.126
25	17.9	0.455	17.7	0.450	320	0.162	314	0.159
24	20.1	0.511	19.9	0.506	404	0.205	396	0.201
23	22.6	0.574	22.4	0.569	511	0.259	501	0.254
22	25.3	0.643	25.0	0.635	640	0.324	627	0.318
21	28.5	0.724	28.2	0.716	812	0.412	796	0.404
20	32.0	0.813	31.7	0.805	1020	0.519	1000	0.509
19	35.9	0.912	35.6	0.904	1290	0.653	1264	0.641
18	40.3	1.02	40.0	1.016	1620	0.823	1588	0.807
17	45.3	1.15	44.9	1.140	2050	1.04	2009	1.02

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Table 5.1 Continued

Size of conductor, AWG	Diameter of solid conductor				Cross-sectional area of stranded conductor			
	Nominal,		Minimum,		Nominal,		Minimum,	
	Mils	(mm)	Mils	(mm)	Cmils	(mm^2)	Cmils	(mm^2)
16	50.8	1.29	50.3	1.278	2580	1.31	2528	1.28
15	57.1	1.45	56.5	1.435	3260	1.65	3195	1.62
14	64.1	1.63	63.5	1.613	4110	2.08	4028	2.04
13	72.0	1.83	71	1.80	5180	2.63	5076	2.58
12	80.8	2.05	80	2.03	6530	3.31	6399	3.24
11	90.7	2.30	90	2.29	8230	4.17	8065	4.09
10	101.9	2.588	101	2.57	10380	5.261	10172	5.16
9	114.4	2.906	113	2.87	13090	6.631	12828	6.50
8	128.5	3.264	127	3.23	16510	8.367	16180	8.20
7	144.3	3.665	143	3.63	20820	10.55	20404	10.34
6	162.0	4.115	160	4.06	26240	13.30	25715	13.03
5	181.9	4.620	180	4.57	33090	16.77	32428	16.43
4	204.3	5.189	202	5.13	41740	21.15	40905	20.73
3	229.4	5.827	227	5.77	52620	26.67	51568	26.14
2	257.6	6.543	255	6.48	66360	33.62	65033	32.95
1	289.3	7.348	286	7.26	83690	42.41	82016	41.56
1/0	324.9	8.252	322	8.18	105600	53.49	103488	52.42
2/0	364.8	9.226	361	9.17	133100	67.43	130438	66.08
3/0	409.6	10.40	406	10.31	167800	85.01	164444	83.31
4/0	460.0	11.68	455	11.56	211600	107.2	207368	105.1
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
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
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	1010	1960	993.1

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5.1.2 A fibrous thread used within the conductor stranding and used as a reinforcing member to improve breaking strength is not prohibited from being used. The construction and arrangement of the threads is not specified.

5.2 Metal

5.2.1 A solid or stranded conductor shall not be used where subjected to any temperature that exceeds that shown for the metal as indicated in the third column of Table 5.2. The metal shall comply with the applicable ASTM specification, when specified, as indicated in Table 5.2.

Table 5.2
Conductor – metal specifications

Table 5.2 revised April 24, 2006

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Copper, uncoated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 3	150 (302)	
Copper, uncoated, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 3	200 (392)	
Copper, tin-coated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 33	150 (302)	
Copper, tin-coated, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 33	200 (392)	
Copper, lead-base-alloy coated, each strand less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 189	150 (302)	
Copper, lead-base alloy coated, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 189	200 (392)	
Copper, uncoated or tin coated, each strand less than 0.015 inch (0.38 mm) in diameter, overcoated with tin	ANSI/ASTM B 286	150 (302)	For use where flexibility is not a concern.
Copper, uncoated or tin coated, each strand at least 0.015 inch (0.38 mm) in diameter, overcoated with tin	ANSI/ASTM B 286	200 (392)	For use where flexibility is not a concern.
Copper, silver-coated	ANSI/ASTM B 298	200 (392)	
Copper, nickel-coated	ANSI/ASTM B 355	250 (482)	
Copper, nickel-coated, Type A, 27 percent minimum nickel coated copper	ANSI/ASTM B 355	550 (1022)	
Copper alloy, hard-drawn, less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 105	150 (302)	May be uncoated or provided with a tin, or lead-base-alloy coating
Copper alloy, hard-drawn, each strand at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 105	200 (392)	May be uncoated or provided with a tin, lead-base-alloy, silver, or nickel coating

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Table 5.2 Continued

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Copper alloy, annealed, less than 0.015 inch (0.38 mm) diameter		150 (302)	High-strength copper-alloy (minimum tensile strength 55,000 psi or 379 MN/m^2 or 37.9 kN/cm^2 or 38.7 kgf/mm), 85 percent IACS[a] minimum conductivity, 6 percent minimum elongation. May be uncoated or provided with a tin, or lead based alloy coating
Copper alloy, annealed, at least 0.015 inch (0.38 mm) diameter		200 (392)	High-strength copper alloy (minimum tensile strength 55,000 psi or 379 MN/m^2 or 37.9 kN/cm^2 or 38.7 kN/cm^2 or 38.7 kgf/mm^2), 85 percent IACS[a] minimum conductivity, 6 percent minimum elongation. May be uncoated or provided with a tin, or lead based alloy coating
Copper alloy, annealed or hard-drawn, silver-coated		200 (392)	
Copper alloy, annealed, or hard-drawn, nickel-coated		250 (482)	
Copper-clad aluminum, annealed or hard-drawn, 6530 circular mils or 3.31 mm^2 (12 AWG) and larger	ASTM B 566	90 (194)	Class 10A
Copper-clad steel less than 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 452	150 (302)	Minimum conductivity of 30 percent IACS[a]
Copper-clad steel at least 0.015 inch (0.38 mm) in diameter	ANSI/ASTM B 452	200 (392)	Minimum conductivity of 30 percent IACS[a]
Copper-clad steel, silver-coated	ANSI/ASTM B 501	200 (392)	Minimum conductivity of 30 percent IACS[a]
Aluminum, 6,530 – 16,510 circular mils or 3.31 – 8.367 mm^2 (12 – 8 AWG), solid	ANSI/ASTM B 800	90 (194)	Tensile-strength 15,000 – 22,000 psi or 103 – 152 MN/m^2 or 10.3 – 15.2 kN/cm^2 or 10.5 – 15.5 kgf/mm^2, elongation 10 percent or more with 10-inch or 250-mm gauge length – component aluminum wire stock (conductor material), formerly "aluminum conductor material (ACM)"
Aluminum, 26,240 – 211,600 circular mils or 13.30 – 107.2 mm^2 (6 – 4/0 AWG), solid 1/2 or 3/4 hard; or Aluminum, 6530 circular mils or 3.31 mm^2 (12 AWG) and larger, stranded, 1/2, 3/4, or hard:		90 (194)	
Aluminum, 3/4 hard	ANSI/ASTM B 609	90 (194)	Tensile strength 15,000 – 22,000 psi or 103 – 152 MN/m^2 or 10.3 – 15.2 kN/cm^2 or 10.5 – 15.5 kgf/mm^2

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Table 5.2 Continued

Conductor metal	ASTM reference for the metal	Temperature limit for the metal, °C (°F)	Other limits
Aluminum, 1/2 hard	ANSI/ASTM B 609	90 (194)	Tensile strength 15,000 – 22,000 psi or 103 – 152 MN/m^2 or 10.3 – 15.2 kN/cm^2 or 10.5 – 15.5 kgf/mm^2
Aluminum, hard	ANSI/ASTM B 609	90 (194)	
Stainless steel		250 (482)	
Nickel-plated iron		250 (482)	
Nickel, alloy		550 (1022)	Tensile strength 50,000 – 80,000 psi or 345 – 552 MN/m^2 or 34.5 – 55.2 kN/cm^2 or 35.1 – 56.2 kgf/mm^2; elongation at least 35 percent; nominal volume resistivity 66 ohm circular mil/foot at 20°C (68°F) or 0.110 ohm mm^2/m at 20°C (68°F)
Nickel-chromium-iron		550 (1022)	

NOTE – ″Copper, tin coated″ mentioned in this table refers to copper strands of a conductor that are coated with tin before they are twisted. ″Copper, overcoated with tin″ mentioned in this table refers to copper strands that are twisted and then coated with tin.

[a] IACS – International Annealed Copper Standard

5.3 Size and cross-sectional area

5.3.1 The size of a conductor shall not be less than indicated in Table 5.1 when measured in accordance with Conductor Diameter, Section 200 of UL 1581.

5.3.2 Tinsel conductors may be used when they have been successfully evaluated for the particular use. Tinsel conductor requirements, including maximum temperature use, size, and construction, shall be in accordance with the requirements in the Standard for Flexible Cord and Fixture Wire, UL 62.

5.3.3 The cross-sectional area of a stranded conductor shall not be less than indicated in Table 5.1 when determined by either of the following:

a) The sum of the areas of its component round strands.

b) The weight method outlined in UL 1581, for a round compact-stranded aluminum conductor or a round compressed-stranded copper or aluminum conductor.

5.3.4 The determination of conductor resistance described in 5.6.1 – 5.6.3 may be used as an alternative method for determining conductor cross-sectional area of AWG-sized conductors. Conductors of Insulated Cables, IEC 60228, shall be used for metric-sized conductors, and shall be used as the referee method of determining conductor size.

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5.4 Metal coating

5.4.1 When the insulation adjacent to a copper or copper-clad aluminum conductor is of a material that corrodes unprotected copper as determined in the test in Conductor Corrosion – General, Section 500 of UL 1581, and when a protective separator is not provided, the solid conductor and each of the individual strands of a stranded conductor shall be separately covered with a metal or alloy coating complying with 4.1 as applicable to the finished wire.

5.4.2 In the case of a stranded conductor on which a coating is not required for corrosion protection and is solely to keep the insulation from adhering to copper, it is not prohibited to coat only the wires of the outer layer.

5.5 Joints

5.5.1 A joint (splice) in a solid conductor or in one of the individual wires of a stranded conductor shall not change the diameter of the solid conductor, the individual wire strand, or the overall stranded conductor. In other than flexing applications, a joint may be made in a stranded conductor as a whole or may be made by joining each individual wire. For flexing applications, joints shall be made by separately joining each individual strand. A joint shall be made only before any coverings are applied to an insulated conductor. The insulation applied to such joints shall be equivalent to that removed and shall comply with the requirements in this Standard. A joint in a compact or compressed-stranded conductor shall be made before compacting or compressing.

5.5.2 In a rope-lay-stranded conductor which consists of a central core surrounded by one or more layers of stranded members (primary groups), each member shall be spliced as a unit. These splices are not to be any closer together than two lay lengths.

5.6 Resistance

5.6.1 Conductor resistance shall be equal to or less than the maximum resistance values according to D-C Conductor Resistance, Tables 30.1 – 30.11 of UL 1581 for conductors in Sizes 14 AWG through 2000 kcmil; Tables 30.1 – 30.5 of UL 1581 for conductors between 15 – 30 AWG; and the Standard Specification for Fine-Wire Bunch-Stranded and Rope-Lay Bunch-Stranded Copper Conductors for Use as Electrical Conductors, ASTM B738 for conductors smaller than 30 AWG.

5.6.2 For conductors having a conductivity other than 100 percent as noted in Table 5.2, the maximum resistance is to be determined by multiplying the maximum resistance for uncoated copper by the ratio of 100 percent IACS (International Annealed Copper Standard) to the percent conductivity applicable to the conductor under consideration. For example, to determine the maximum resistance of a 12 AWG (6530 cmil or 3.31 mm^2) solid 40-percent-conductivity copper-clad steel conductor:

a) R[12 AWG copper-clad steel at 20°C (68°F)] = R(12 AWG copper at 20°C) X 100/40 = R(12 AWG copper at 20°C or 68°F) X 2.5.

b) R[12 AWG copper at 20°C (68°F)] = 1.62 ohms/1000 feet or 5.31 ohms/1000 kilometer.

c) R[12 AWG copper-clad at 20°C (68°F)] = 1.62 X 2.5 = 4.05 ohms/1000 feet or 5.31 X 2.5 = 13.28 ohms-kilometer.

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5.6.3 Special alloy copper conductors having a conductivity of not less than 80 percent of stranded copper are not prohibited from being used when the finished wire or cable is suitable for the use, and when the cross section of the conductor is sufficient to give it a conductivity of not less than 80 percent of the standard conductor and the tag is marked to indicate its nominal AWG size.

5.7 Stranding

5.7.1 Stranded conductors shall use a method of stranding that complies with the requirements in 5.7.2 – 5.7.7.

5.7.2 Conductors of intermediate nominal area shall comply with the requirement for the length of lay of the next smaller conductor as shown in Maximum lay of single-bunch, bunch stranded copper conductors, Table 5.3. The American Wire Gauge (AWG) sizes shown in Table 5.3 represent conductors of intermediate nominal area.

5.7.3 The individual wires used in making up a stranded conductor are usually drawn to the same diameter, which is not required to be the diameter of any AWG or other standard gauge number. The individual wires of a concentric-lay-stranded conductor are not required to be all of the same diameter.

5.7.4 A 19-wire combination round-wire unilay-stranded conductor of soft-annealed copper or an aluminum alloy indicated in this section shall be round and shall consist of:

a) A straight central wire,

b) An inner layer of six wires of the same diameter as the central wire with the six wires having identical lengths of lay, and

c) An outer layer consisting of six wires of the same diameter as the central wire alternated with six smaller wires having a diameter of 0.732 times the diameter of the central wire and with all twelve wires of the outer layer having the same length of lay and direction of lay as the six wires of the inner layer (see Nominal strand and conductor dimensions for 19-wire combination round-wire unilay-stranded copper conductors, Table 20.6 of UL 1581).

No particular assembly of the individual wires of any other stranded conductor is required. However, simple bunching (untwisted strands) shall not be used for the entire conductor or any part thereof. The length of lay of the strands in a single-bunch bunch-stranded conductor shall not be greater than indicated in Table 5.3. The direction of lay of the strands in a single-bunch bunch-stranded conductor shall be left-hand. Any type of stranding indicated in Nominal strand and conductor dimensions for 19-wire combination round-wire unilay-stranded copper conductors, Table 210.2 of UL 1581 other than compact stranding or single-bunch bunch-stranding shall comply with 5.7.6 or 5.7.7 as applicable. The direction of lay of the outer layer shall be left-hand in all cases.

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