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Flexible Cord and Fixture Wire

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Flexible Cord and Fixture Wire, UL 62

Sixteenth Edition, Dated October 15, 1997

Revisions: This Standard contains revisions through and including March 13, 2001. UL is in the process of converting its Standards for Safety to the Standard Generalized Markup Language (SGML), and implementing an SGML compliant document management and publishing system. SGML - an international standard (ISO 8879-1986) - is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Significant benefits that will result from UL's use of SGML and these new systems include increased productivity, reduced turnaround times, and data and information consistency, reusability, shareability, and portability. However, the fonts, pagination, and general formatting of UL's new electronic publishing system differ from that of UL's previous publishing system. Consequently, when revision pages are issued for a Standard with the new publishing system, these differences may result in the printing of pages on which no requirements have been changed - these additional pages result from relocation of text due to repagination and reformatting of the Standard with the new publishing system.

Announcement Bulletin(s): This Standard contains the announcement bulletin(s) dated October 30, 1997. The announcement bulletin is located at the end of the Standard (after the adoption bulletin(s)).

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated October 13, 2000, September 21, 2000, and September 5, 2000. The bulletin(s) is now obsolete and may be discarded.

The revisions dated March 13, 2001 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

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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.

As of July 2, 1998, all products, including those previously evaluated by UL, must comply with this Standard.

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 Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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The Department of Defense (DoD) has adopted UL 62 on November 6, 1987. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

PREFACE

Effective Date

Between October 15, 1997 and July 2, 1998, new product submittals may be evaluated using all the requirements in this Standard, or if requested in writing, evaluated using the requirements in the Fifteenth edition of UL 62.

As of July 2, 1998, all products, including those previously evaluated by UL, must comply with this Standard.

INTRODUCTION

1 Scope

Section 1 effective July 2, 1998

1.1 These requirements cover fixture wires, hoistway cables, and flexible cords for use in accordance with the National Electrical Code.

1.2 An elevator cable that contains one or more optical-fiber members is limited (see 8.6) to carrying optical energy that has been ruled not hazardous to the human body.

1.3 These requirements do not cover armored cords or assemblies of flexible cords or fixture wires with fittings or wiring devices of any sort (such as cord sets, power-supply cords, and Christmas-tree and decorative-lighting outfits, which are covered in requirements separate from this standard) nor do these requirements cover any type of wire or cord for use at a potential higher than 600 V.

1.4 These requirements do not cover the optical or other performance of any optical-fiber member or group of such members. See 8.6.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.5 revised February 6, 2001

2 Units of Measurement

Section 2 effective July 2, 1998

2.1 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements in this Standard is also stated in units that make the requirement conveniently usable in countries employing the various metric systems (practical SI and customary). Equivalent— although not necessarily exactly identical — results are to be expected from applying a requirement in USA or metric terms. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

3 References

Section 3 effective July 2, 1998

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

3.2 A fixture wire is a single conductor, whereas hoistway cable and flexible cord are assemblies of two or more conductors. Fixture wire has a solid conductor or either a 7-strand construction or a flexible stranding, whereas a flexible cord always has flexible stranding. Aside from the metal conductor itself, however, the requirements for fixture wire are essentially the same as for flexible cord.

3.3 It is to be noted that a flexible conductor is always stranded but that a stranded conductor is not necessarily flexible— for example, a 7-strand fixture wire is not a flexible conductor when compared with a wire having a larger number of finer strands.

CONSTRUCTION

GENERAL

4 Materials

Section 4 effective July 2, 1998

4.1 Each material used in a flexible cord, hoistway cable, or fixture wire shall be compatible with all of the other materials used in the cord or wire.

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.

5 Grounding Conductor

Section 5 effective July 2, 1998

5.1 No grounding conductor shall be included in any Type SPT-2W, SPT-1W, XTW, clock, CXTW, TPT, or TST cord regardless of the size of the circuit conductors or in any of the cords described in 16.3.1.2 and 16.3.2.1, but one or more grounding conductors are acceptable (see 8.3, 8.4, and 8.7 for size) in any other cord in which the circuit conductors are 18 AWG or larger. A grounding conductor shall not be sectioned.

5.1 revised February 6, 2001

6 Index Tables

Section 6 effective July 2, 1998

6.1 A flexible cord, hoistway cable, or fixture wire shall be one of the types indicated in Tables 6.1 – 6.21 and shall comply in all respects with the requirements for construction and test performance that apply to the particular type.

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6.2 Each of the Tables 6.1 – 6.21 serves as an index to the requirements for construction details and test performance of the types of fixture wire, hoistway cable, or flexible cord covered in the particular table.

6.3 Each vertical column serves as an index to the requirements that apply to the particular wire or cord whose type letters appear at the top of the column. The figures in parentheses are the numbers of the paragraphs in the text of this Standard to which reference should always be made. References in square brackets are to UL 1581.

Table 6.1
Thermoset-insulated fixture wires

Table 6.1 revised March 13, 2001

Type-letter designation		RFH-2	FFH-2
Temperature rating		75°C (167°F)	
Maximum voltage		600	
AWG sizes of conductor		18 – 16	
Conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1– 8.7, 9.1 – 9.3)	
	Stranding	Solid or 7-Strand	(11.1)
	Maximum length of lay of strands	7-Strand – 48 times diameter of individual strand (11.2) Flexible stranding (11.2)	
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Stranding, Section 10)	
Insulation	Class number ^c	31, 44	
	Minimum acceptable average thickness	30 mils or 0.76 mm (15.1 – 16.2.1)	30 mils or 0.76 mm (15.1 – 16.2.1)
	Minimum acceptable thickness at any point	(16.2.1)	
Braid or wrap		Covering optional for Type RFH-2 or FFH-2 with XLPE (Class 31) insulation. Otherwise: Solid or 7-strand – cotton braid (20.1.1– 20.3.3) ^b or wrap (21.1 – 21.6) ^b , Flexible stranding – cotton or rayon braid (20.1.1 – 20.3.3) ^b	
Tests on finished wire	Physical properties of insulation ^c	Unaged	31, 44
		After aging	
	Conductor corrosion	[500.1 of UL 1581]	
	VW-1 flame test (optional)	(42.1)	
	Dielectric	(50.1)	
	Flexibility of braid or wrap	(20.1.1 and 21.1)	
Durability of ink print		(64.1)	
Markings		(67.2, 68.1 – 68.3, 71.1, 74.1, 79.1, 81.1, 82.1, and 83.1)	
<p>^a See 6.3</p> <p>^b In place of the braid or wrap specified, an extruded covering of material such as nylon or other thermoplastic may be used if investigation shows that the thickness, flexibility, temperature rating, and other characteristics of the construction that are critical to the application provide a comparable covering. A glass braid coated with lacquer or a saturating compound may be used in place of cotton or rayon.</p> <p>^c The physical properties requirements for individual materials are in UL 1581. See 47.1 and index Table 47.1 in UL 1581. For test methods see 40.2 of UL 1581.</p>			

Table 6.2
PVC-insulated fixture wires^a

Table 6.2 revised March 13, 2001

Type-letter designation		TF	TFF	TFN	TFFN	
Temperature rating		60°C (140°F)		90°C (194°F)		
Maximum voltage		600				
AWG sizes of conductor		18 – 16				
Conductor	Material	Soft-annealed copper (7.1 and 7.2)				
	Size verification	(8.1 – 8.7, 9.1 – 9.3)				
	Stranding	Solid or 7-Strand	36 – 26 AWG (11.1)	Solid or 7-Strand	36 – 26 AWG (11.1)	
	Maximum length of lay of strands	7-Strand– 48 times diameter of individual strand (11.2) Flexible stranding (11.2)				
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)				
Insulation	Class number ^b	60°C Class 43		12B		
	Minimum acceptable average thickness	30 mils or 0.76 mm (15.1 – 16.2.1)		15 mils or 0.38 mm (15.1 – 16.2.1)		
	Minimum acceptable thickness at any point	(16.2.1)				
Braid or jacket		Braid optional (20.1.1 – 20.3.3)		Nylon jacket (28.3)		
Tests on finished wire	Physical properties of insulation	Unaged	60°C Class 43		12B	
		After aging				
	Conductor corrosion		[500.1 of UL 1581]			
	Heat-shock		(56.1)		(56.2)	
	VW-1/FT 1 flame test (optional)		(42.1)			
	Vertical flame test		(43.1)			
	Deformation		(57.1)		(57.3)	
	Cold-bend		(58.1)		(58.2)	
	Gasoline- and oil-resistant properties		(59.1 and 60.1)			
	Flexing of nylon jacket				(22.1)	
	Dielectric		(50.1)			
	Insulation resistance		(52.1 and 52.2)			
	Durability of ink print		(64.1)			
Markings		(67.2, 68.1, 68.2, 74.1, 79.1, 81.1, and 82.1)		(67.2, 68.1, 68.2, 68.5, 69.6, 71.1, 71.2, 73.1, 74.1, 79.1, 81.1, and 83.1)		
^a See 6.3						
^b The physical properties requirements for individual materials are in UL 1581. See 47.1 and index Table 47.1 in UL 1581. For test methods see 40.2 of UL 1581.						

Table 6.3
FEP- and PTFE-insulated fixture wires^a

Table 6.3 revised March 13, 2001

Type-letter designation			PF	PFF	PGF	PGFF
Maximum temperature			200°C (392°F)	150°C (302°F)	200°C (392°F)	150°C (302°F)
Maximum voltage			600			
AWG sizes of conductor			18 – 14			
Conductor	Material		Soft-annealed copper (7.1 and 7.2)			
	Size verification		(8.1 – 8.7, 9.1 – 9.3)			
	Stranding		Solid or 7-Strand	(11.1)	Solid or 7-Strand	(11.1)
	Maximum length of lay of strands		7-Strand – 48 times diameter of individual strand (11.2) Flexible stranding (11.2)			
Insulation	General		Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)			
	Class number ^c		12A			
	Minimum acceptable average thickness		20 mils or 0.51 mm (15.1 – 16.2.1)		14 mils or 0.36 mm (15.1 – 16.2.1)	
	Minimum acceptable thickness at any point		(16.2.1)			
Braid			Braid optional (20.1.1) ^b		Lacquered or varnished glass braid (20.1.1) ^b	
Tests on finished wire	Physical properties of insulation	Unaged	12A			
		After aging				
	Conductor corrosion		[500.1 of UL 1581]			
	VW-1 flame test		(42.1)			
	Vertical flame test		(43.1)			
	Deformation		(57.2)			
	Cold-bend		(58.1)			
	Dielectric		(50.1)			
	Insulation resistance		(52.3)			
	Flexibility of braid or wrap		(20.1.1)			
Durability of Ink Print		(64.1)				
Markings			(67.2, 68.1, 68.2, 68.3, 71.1, 71.2, 74.1, 79.1, 81.1, 82.1, and 83.1)			
^a See 6.3.						
^b A covering other than a lacquered or varnished glass braid is acceptable if investigation shows that the flexibility, temperature rating and other characteristics of the construction that are critical to the application provide a comparable covering.						
^c The physical properties requirements for individual materials are in UL 1581. See 47.1 and index Table 47.1 in UL 1581. For test methods see 40.2 of UL 1581.						

Table 6.4
Silicone- and XLPO-insulated fixture wires^a

Table 6.4 revised March 13, 2001

Type-letter designation	Silicone				XLPO	
	SF-1	SF-2	SFF-1	SFF-2	XF	XFF
Maximum temperature	200°C (392°F)		150°C (302°F)			
Maximum voltage	300	600	300	600	300	
AWG sizes of conductor	18	18 – 14	18	18 – 14	18 – 10	
Material	Soft-annealed copper or nickel (7.1 and 7.2)					
Size verification	(8.1 – 8.7, 9.1 – 9.3)					
Stranding	(11.1)					
Maximum length of lay of strands	7-Strand – 48 times diameter of individual strand (11.2) Flexible stranding (11.2)					
General	Tinning, separators, splices, and continuity (12.1–14.1, Section 10)					
Class number ^c	22				38	
Minimum acceptable average thickness	15 mils or 0.38 mm (15.1 – 16.2.1)	30 mils or 0.76 mm (15.1 – 16.2.1)	15 mils or 0.38 mm (15.1 – 16.2.1)	30 mils or 0.76 mm (15.1 – 16.2.1)	18 – 14 AWG – 30 mils or 0.76 mm (15.1, 16.1.1, 16.2.1, 12 – 10 AWG – 45 mils or 1.14 mm (16.2.1)	
Minimum acceptable thickness at any point	(16.2.1)					
Braid	Glass braid (20.1.1) ^b					
Physical properties of insulation ^c	Unaged		22			
	After aging		38			
Conductor corrosion	[500.1 of UL 1581]					
Flexibility of finished wire	[1560.1 of UL 1581]					
VW-1 flame test	(Optional) (42.1)					
Vertical flame test	(43.1)					
Dielectric	(50.1)					
Insulation resistance	(55.1)					
Deformation	(57.4)					
Cold-bend	(58.5)					
Flexibility of braid or wrap	(20.1)					
Durability of ink print	(64.1)					
Markings	(68.1 – 68.3, 71.1, 71.2, 74.1, 79.1, 81.1, and 82.1)					
	(68.1, 68.2, 71.1, 71.2, 74.1, 79.1, 81.1, 82.1, and 83.1)					

^a See 6.3.

Table 6.4 Continued

Type-letter designation	Silicone				XLPO	
	SF-1	SF-2	SFF-1	SFF-2	XF	XFF
<p>b A covering other than a glass braid is acceptable if investigation shows that the flexibility, temperature rating, and other characteristics of the construction that are critical to the application provide a comparable covering.</p> <p>c The physical properties requirements for individual materials are in UL 1581. See 47.1 and index Table 47.1 in UL 1581. For test methods see 40.2 of UL 1581.</p>						

**Table 6.5
Tinsel cords^a**

Table 6.5 revised March 13, 2001

Type-letter designation		Parallel Tinsel Cords	Jacketed Tinsel Cords
		TPT ^c	TST
Temperature rating		60°C (140°F)	
Maximum voltage		300	
AWG sizes of conductor		27	
Number of conductors		2 ^b	
Material		Soft-annealed copper or nickel (7.1 and 7.2)	
Size verification		(9.1 – 9.3)	
Stranding		(11.3)	
Maximum length of lay of strands		Not specified	
General		Tinning, separators, splices (12.1 – 14.1, Section 10)	
Class number ^d		2.9	
Insulation		30 mils or 0.76 mm (15.1, 16.2.1, and 16.3.1.1)	15 mils or 0.38 mm (15.1–16.2.1)
		(15.1, 16.2.1, and 16.3.1.1)	13 mils or 0.33 mm (16.2.1)
Braid on each conductor			Optional (20.1.1 – 20.3.3)
Assembly of conductors		Parallel	Twisted together
Maximum length of lay of conductors			(23.1)
Fillers			Optional (24.1)
Braid, wrap, or serving over assembly			Optional (Section 18)
Class number ^d			1.7
Jacket		Jacket is integral with conductor insulation, and measurements of thickness of wall of insulation take care of the jacket thickness	
Minimum acceptable average thickness		30 mils or 0.76 mm (280.1 of UL 1581)	
Minimum acceptable thickness at any point		24 mils or 0.61 mm (280.2 and 280.3 of UL 1581)	
General		(25.1)	

Table 6.5 Continued

Type-letter designation	Parallel Tinsel Cords TPT ^c	Jacketed Tinsel Cords TST
Tests on finished insulated conductors or cord	Resistance of conductor	(11.3)
	Physical properties of insulation ^d	2.9
	Conductor corrosion	[500.1 of UL 1581]
	Physical properties of jacket ^d	1.7
	Heat Shock	(56.1)
	Cold Bend	(58.1)
	Horizontal Flame	(44.1 and 44.2)
	VW-1 Flame Test	(42.1)
	Dielectric	(51.1)
	Insulation resistance	(53.1)
Resistance of nonintegral jacket	(31.1)	
Durability of ink print	(64.1)	
Deformation of jacket		53.1
Polarity identification	(65.1.1, 65.4.1, 65.5.1, 65.6.1, and 65.7.1)	(65.1.1 – 65.4.1 and 65.8.1)
Markings	(68.1, 68.2, 68.4, 68.5, 74.1, 81.1, and 82.1)	(68.1, 68.2, 68.5, 69.1, 69.4, 74.1, 81.1, 82.1, and 83.1)
a See 6.3		
b Circuit conductors only. A grounding conductor is not acceptable (see 5.1).		
c Shaver cord, which is the same as Type TPT except for the construction of the conductors [see 11.4] and the optional provision for separation of the conductors (see Figure 16.5 and Table 16.7) and the optional provision of grounded-conductor polarity identification (see 65.1), is limited to use in factory-assembled detachable and nondetachable power-supply cords for hand-held 50-W and smaller hair clippers and shaving appliances. See 74.1(d).		
d The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.		

Table 6.6
Clock cord and decorative-lighting cords and wires^a
 Table 6.6 revised March 13, 2001

Descriptive name	Clock cord	Decorative-lighting cords	Decorative-lighting wire
Assembly of conductors	Parallel integral (29.1)	Parallel integral (16.3.1.1)	Twisted pair (16.1.1)
Use	Indoor	Aboveground	Aboveground
Type-letter designation	"clock cord"	XTW	CXTW
Temperature rating	60°C (140°F) ^b	105°C (221°F)	
Maximum voltage	125	300	300
AWG sizes of conductors (8.3)	20	22, 20, 18	22, 20, 18
Number of conductors	2 circuit conductors, no grounding conductor (5.1)	2-6 circuit conductors, no grounding conductor (5.1)	2 circuit conductors, no grounding conductor (5.1)
	Soft-annealed copper (7.1 and 7.2)		
CONDUCTOR	(8.1 – 8.7, 9.1 – 9.3)		
	(11.1, 11.2)		
	22 AWG: tests (11.2) 20 AWG: 1.25 inch or 32 mm (11.2) 18 AWG: Table 11.2 or 11.3		
	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)		
INSULATION	2.11		
	2.9, 2.11	Average: 30 mils or 0.76 mm (15.1–16.2.1)	
	Nominal: 30 mils or 0.76 mm (29.1 and Table 16.7)	Average: 30 mils or 0.76 mm (16.2.1 and Table 16.8)	
	(16.2.1 and Table 16.7)		
	30 x diameter over insulation on 1 conductor (23.1)		
Maximum length of lay of conductors	CXTW twisted pair		
Type-letter designation	"clock cord"	XTW parallel	CXTW 1 conductor

Table 6.6 Continued

Descriptive name	Physical properties of insulation		Clock cord	Decorative-lighting cords	Decorative-lighting wire
	Unaged	After aging			
Tests on finished wire or cord	Conductor corrosion		2.9, 2.11	2.11 [40.2 and Table 50.182 of UL 1581]	
	Heat shock				
	Deformation			[500.1 of UL 1581]	
	Tightness of insulation		(17.1)		(17.2)
	Cold bend		(38.1, 58.1)	(35.3, 35.4)	(35.3, 35.4)
	Sunlight resistance			(35.2)	
	Insulation resistance			(35.1)	
	15.6°C (60°F)			(35.5 – 35.7)	
	50°C (122°F)			Required (42.1)	
	Flame tests		Optional (42.1)	(44.1 and 44.2)	
	Required horizontal flame/FT2				
	Dielectric			(51.1)	(50.1)
	Durability of ink print			(64.1)	
	Tests on No. 22 AWG per note b to Table 11.1			(61.1)	
	Flexing			(62.1)	
Polarity Identification				Optional except 2-conductor XTW (29.1)	
Markings			(68.1, 68.2, 68.5, 69.1 – 69.3, 74.1, 77.1, 79.1, 81.1, 82.1, and 83.1)		

a See 6.3.

b The temperature limit is 105°C (221°F) if the clock-cord insulation is a Class 2.11 PVC.

c The physical properties requirements for individual materials are given in Table 15.2 of this Standard. For test methods see 40.2 of UL 1581.

Table 6.7
Lamp and twisted portable braided types of cords^a

Table 6.7 revised March 13, 2001

		Lamp cord	Twisted portable
Type-letter designation		C	PD
Temperature rating		60°C (140°F)	
Maximum Voltage		300 ^b	
AWG sizes of conductor		18 – 10	
Number of circuit conductors		2 or more	
Grounding conductor		One acceptable in addition to circuit conductors (5.1, 8.3, 8.4, 15.1– 15.4, 70.1, 71.1)	
Conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1, 9.1 – 9.3)	
	Stranding	(11.1 and 11.2)	
Insulation	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)	
	Class number ^e	2.4, 2.5, 2.9, 2.25	
	Minimal acceptable average thickness	18 – 16 AWG – 30 mils or 0.76 mm, 14 – 10 AWG – 45 mils or 1.14 mm (15.1 – 16.2.1)	
	Minimum acceptable thickness at any point	18 – 16 AWG – 27 mils or 0.69 mm, 14 – 10 AWG – 40 mils or 1.02 mm (15.1 – 16.2.1)	
Braid on each conductor		Cotton ^c (20.1)	
Assembly of conductors		Twisted together	
Maximum length of lay of conductors		(23.1)	
Fibrous fillers			Optional (Section 24)
Overall braid			Cotton or rayon (20.1.1)
Saturation of braid		d	
Tests on finished insulated conductors or cord	Physical properties of insulation ^e	Unaged	2.4, 2.5, 2.9, 2.25
		After aging	
	Conductor corrosion		[500.1 of UL 1581]
	Flexibility of braid		(20.1)
	Cold bend		(54.1)
	Horizontal flame/FT2		(44.1 and 44.2)
	VW-1/FT1 flame test (optional)		(35.1)
	Dielectric		(47.1)
Insulation resistance		(53.1)	
Polarity identification		(65.1.1, 65.4.1, and 67.1)	
Markings		(68.1, 68.2, 68.5, 68.6, 69.4, 74.1, 79.1, 81.1, 82.1, and 83.1)	

^a See 6.3.

^b The maximum voltage is 600, provided that the average thickness of insulation on the individual conductors is at least 45 mils or 1.14 mm.

^c Spun rayon may be used in place of cotton for the braids on the individual conductors. See 20.1.4.

^d A saturated braid is not required, but may be provided (see 20.3.1– 20.3.3) for cord used in damp locations. Type C cord with saturated braids is equivalent to a cord formerly known as "brewery cord". Type PD cord with a saturated overall braid is equivalent to a cord formerly known as "canvasite cord".

^e The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

Table 6.8
Integral thermoset and TPE parallel cords^a

Table 6.8 revised March 13, 2001

Type-letter designation	SP-1	SPE-1	SP-2	SPE-2	SP-3	SPE-3
Temperature rating	60°C (140°F)	90°C (194°F) ^b	60°C (140°F)	90°C (194°F) ^b	60°C (140°F)	90°C (194°F) ^b
Voltage rating	300					
AWG Sizes of circuit conductors	20 – 18					
Number of circuit conductors	2 or 3					
Grounding Conductor	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 8.4, 15.1 – 15.4, 16.3.3.1 – 16.3.3.5, 16.3.3.7, 16.3.3.8, 65.1.1, 69.3, and 70.1)					
Material	Soft-annealed copper (7.1 and 7.2)					
Size verification	(8.1 – 8.7, 9.1 – 9.3)					
Stranding	(11.1 and 11.2)					
General	Tinning, separators, splices, and continuity (12.1 and 12.2, Section 10)					
Class number ^c	2.4	2.20, 2.28	2.4	2.20, 2.28	2.4	2.20, 2.28
Nominal thickness	30 mils or 0.76 mm					
Minimum acceptable thickness at any point	(15.1 – 15.4, 16.1.1 – 16.3.1.2, and 16.3.3.1)					
Physical properties of insulation ^c	Unaged	2.4				
	After aging	2.4				
Conductor corrosion	[500.1 of UL 1581]					
Heat shock						(56.1)
Deformation						(57.6)
Cold bend	(58.1)	(58.4)	(58.1)	(58.4)	(58.1)	(58.4)
Tightness of insulation	(17.1)					
Flame tests	Optional VW-1/FT1 (42.1)					
Required horizontal flame/FT2	(44.1 and 44.2)					
Dielectric Withstand	(51.1)					
Durability of ink print.	(64.1)					
Polarity identification	(16.3.3.2 – 16.3.3.6, 65.1.1, 65.5.1, 65.6.1, and 67.1)					
Markings	(68.1, 68.2, 68.5, 69.1, 70.1, Section 74, 77.1, 79.1, 81.1, 82.1, and 83.1)					

^a See 6.3.

^b The temperature limit is 105°C (221°F) if the insulation and jacket are Class 2.20 and 1.14, respectively.

^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

Table 6.8A
Non-integral thermoset and TPE parallel cords^a

Table 6.8A revised March 13, 2001

Type-letter designation	NISP-1	NISPE-1	NISP-2	NISPE-2	
Temperature rating	60°C (140°F)	90°C (194°F) ^b	60°C (140°F)	90°C (194°F) ^b	
Maximum voltage	300				
AWG Sizes of circuit conductors	20 – 18				
Number of circuit conductors	2 or 3				
Grounding Conductor	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 8.4, 15.1 – 15.4, 16.3.3.2 – 16.3.3.6, 65.1.1, 69.3, and 70.1)				
CONDUCTOR	Soft-annealed copper (7.1 and 7.2)				
Material	(8.1 – 8.7, 9.1 – 9.3)				
Size verification	(11.1 and 11.2)				
Stranding	Tinning, separators, splices, and continuity (12.1 and 12.2, Section 10)				
General	2.4				
Class number ^c	2.20, 2.28				
Nominal thickness	15 mils or 0.38 mm (15.1 – 16.2.1)				
Minimum acceptable thickness at any point	30 mils or 0.76 mm (15.1 – 16.2.1)				
JACKET	1.2				
Class number ^c	1.14, 1.18				
Minimum acceptable average thickness	(15.1 – 15.4, 16.1.1 – 16.3.1.2, and 16.3.3.1)				
Minimum acceptable thickness at any point	1.2				
Overall Dimensions	Not specified				
Tests on finished insulated conductors or cord	Physical properties of insulation ^c	Unaged	2.4		
		After aging	2.4		
	Physical properties of jacket ^c	Unaged	1.2		
		After aging	1.2		
	Conductor corrosion	[500.1 of UL 1581]			
	Heat shock	(56.1)	(56.1)		
	Deformation	(57.6)	(57.6)		
	Cold bend	(58.1)	(58.4)	(58.4)	
	Resistance of nonintegral jacket	(31.1)			
	Flame tests	Optional VW-1/FT1	(42.1)		
Required horizontal flame/FT2		(44.1 and 44.2)			
Dielectric Withstand	(51.1)				
Durability of ink print.	(64.1)				
Deformation of jacket	(57.6)				
Polarity identification	(16.3.3.2 – 16.3.3.6, 65.1.1, 65.5.1, 65.6.1, and 67.1)				
Markings	(68.1, 68.2, 68.5, 69.1, 70.1, Section 74, 77.1, 79.1, 81.1, 82.1, and 83.1)				
^a See 6.3.					

Table 6.8A Continued on Next Page

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Table 6.8A Continued

Type-letter designation	NISP-1	NISPE-1	NISP-2	NISPE-2
b The temperature limit is 105°C (221°F) if the insulation and jacket are Class 2.20 and 1.14, respectively.				
c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.				

Table 6.9
Integral thermoplastic parallel cords^a

Table 6.9 revised March 13, 2001

Type-letter designation	SPT-1	SPT-1W	SPT-2	SPT-2W	SPT-3
Temperature rating	60°C (140°F) ^b	105°C (221°F)	60°C (140°F) ^b	105°C (221°F)	60°C (140°F) ^b
Maximum voltage	300				
AWG sizes of circuit conductors	20 – 18				
Number of circuit conductors	2 or 3	2	2 or 3	2	2
Grounding conductor	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 15.3, 15.4, 16.3.3.2 – 16.3.3.5, 67.1, and 70.1)	None	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 15.3, 15.4, 16.3.3.2 – 16.3.3.5, 67.1, and 70.1)	None	One acceptable in addition to 2 circuit conductors (5.1, 8.3, 15.3, 15.4, 16.3.3.2 – 16.3.3.5, 67.1, and 70.1)
CONDUCTOR	Material	Soft-annealed copper (7.1 and 7.2)			
	Size verification	(8.1 – 8.7, 9.1 – 9.3)			
	Stranding	(11.1 and 11.2)			
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)			
INSULATION	Circuit conductor class number ^c	2.9, 2.11, 2.22, 2.29			
	Grounding conductor class number ^c	2.9, 2.11, 2.13, 2.14, 2.20, 2.22, 2.26, 2.28, or 2.29	–	2.9, 2.11, 2.13, 2.14, 2.20, 2.22, 2.26, 2.28, or 2.29	–
	Nominal thickness	30 mils or 0.76 mm	45 mils or 1.14 mm		2.9, 2.11, 2.13, 2.14, 2.20, 2.22, 2.26, 2.28, or 2.29 (15.1 – 15.4, 16.1.1 – 16.3.1.1, and 16.3.3.1 – 16.3.3.8)
JACKET	Minimum acceptable thickness at any point	(15.1 – 15.4, 16.1.1 – 16.3.1.1, and 16.3.3.1)			
	Class number ^c	Nylon optional (22.1) ^d			

Table 6.9 Continued on Next Page

Table 6.9 Continued

Type-letter designation		SPT-1	SPT-1W	SPT-2	SPT-2W	SPT-3
Physical properties of insulation ^c	Unaged	2.9, 2.11, 2.20, 2.22, 2.26, 2.28, 2.29	2.11	2.9, 2.11, 2.20, 2.22, 2.26, 2.28, 2.29	2.11	2.9, 2.11, 2.20, 2.22, 2.26, 2.28, 2.29
	After aging					
Conductor corrosion		[500.1 of UL 1581]				
Heat shock		(56.1)				
Deformation		(57.1)				
Tightness of insulation		(17.1)				
Flexing of nylon jacket		(22.1)				
Cold bend		(58.1, 58.3, 58.4)	(35.3, 35.4)	(58.1, 58.3, 58.4)	(35.3, 35.4)	(58.1, 58.3, 58.4)
Sunlight resistance			(35.2)		(35.2)	
Insulation resistance		(53.1)	(35.1)	(53.1)	(35.1)	(53.1)
Flame tests			(35.5 – 35.7)		(35.5 – 35.7)	
Dielectric Withstand				(42.1)		
Durability of ink print				(44.1 and 44.2)		
Deformation of jacket				(51.1)		
Polarity identification				(64.1)		
Markings				(57.1)		
a See 6.3.		(16.3.3.2 – 16.3.3.6, 65.1.1, 65.5.1, 65.6.1, and 67.1)				
b The temperature limit dry is 75°C (167°F) or 90°C (194°F) or 105°C (221°F) if material(s) of those temperature ratings are employed.		(68.1, 68.2, 68.5, 69.1, 70.1, Section 74, 77.1, 79.1, 81.1, 82.1, and 83.1)				
c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.						
d Type SPT-1 cord rated at 105°C (221°F) for use with long-chain portable electric lamps shall employ a nylon jacket over the finished cord. Measured by means of the pin-gauge dial micrometer or one of the optical devices described in 250.9 and 250.10 of UL 1581, the average thickness of the nylon elsewhere than on the slopes and at the bottoms of the valleys shall not be less than 3 mils or 0.8 mm. Measured by means of one of the optical devices described in 250.9 and 250.10 of UL 1581, the minimum thickness of the nylon at any point on the slopes and at the bottoms of the valleys shall not be less than 1 mil or 0.03 mm.						

Table 6.9A
Non-integral thermoplastic parallel cords^a

Table 6.9A revised March 13, 2001

Type-letter designation	NISPT-1	NISPT-2
Temperature rating	60°C (140°F) dry ^b	60°C (140°F) dry ^b
Maximum voltage	300	
AWG sizes of circuit conductors	20 – 18	18, 16
Number of circuit conductors	2 or 3	
Grounding conductor	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 15.3, 15.4, 16.3.3.2–16.3.3.5, 67.1, and 70.1)	One acceptable in addition to 2 circuit conductors but not in addition to 3 circuit conductors noted above (5.1, 8.3, 15.3, 15.4, 16.3.3.2–16.3.3.5, 67.1, and 70.1)
CONDUCTOR	Material	Soft-annealed copper (7.1 and 7.2)
	Size verification	(8.1 – 8.7, 9.1 – 9.3)
	Stranding	(11.1 and 11.2)
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)
INSULATION	Circuit conductor class number ^c	2.9, 2.11, 2.22, 2.29
	Grounding conductor class number ^c	2.9, 2.11, 2.13, 2.14, 2.20, 2.22, 2.26, 2.28, or 2.29
	Nominal thickness	15 mils or 0.38 mm (15.1 – 16.2.1) 30 mils or 0.76 mm (15.1 – 16.2.1)
	Minimum acceptable thickness at any point	(15.1 – 15.4, 16.1.1 – 16.3.1.1, and 16.3.3.1)
JACKET	Class number ^c	1.7, 1.8, 1.16, 1.19
	Minimum acceptable average thickness	(15.1 – 15.4 and 16.1.1 – 16.3.3.6)
	Minimum acceptable thickness at any point	
Overall dimensions	Not specified	

Table 6.9A Continued

Type-letter designation		NISPT-1	NISPT-2
Tests on finished insulated conductors or cord	Physical properties of insulation ^c	Unaged After aging	2.9, 2.11, 2.20, 2.22, 2.26, 2.28, 2.29
	Physical properties of jacket	Unaged After aging	1.7, 1.8, 1.16, 1.19
	Conductor corrosion		[500.1 of UL 1581]
	Heat shock		(56.1)
	Deformation		(57.1)
	Resistance of nonintegral jacket		(31.1)
	Cold bend		(58.1, 58.3, 58.4)
	Sunlight resistance		
	Insulation resistance	15.6°C (60°F) 50°C (122°F)	(53.1)
	Flame tests	Optional VW-1/FT1	(42.1)
		Required horizontal flame/FT2	(44.1 and 44.2)
	Dielectric Withstand		(51.1)
	Durability of ink print		(64.1)
	Deformation of jacket		(57.1)
	Polarity identification		(16.3.3.2 – 16.3.3.6, 65.1.1, 65.5.1, 65.6.1, and 67.1)
Markings		(68.1, 68.2, 68.5, 69.1, 70.1, Section 74, 77.1, 79.1, 81.1, 82.1, and 83.1)	

^a See 6.3.

^b The temperature limit dry is 75°C (167°F) or 90°C (194°F) or 105°C (221°F) if material(s) of those temperature ratings are employed.

^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

Table 6.10
Oil-resistant vacuum-cleaner cords^a

Table 6.10 revised March 13, 2001

Type-letter designation	SVOO ^b , SVO ^c	SVEO ^c , SVEOO ^b	SVTOO ^b , SVTO ^c
Temperature rating	60°C (140°F) ^d	90°C (194°F) ^f	60°C (140°F) ^d
Maximum voltage	300		
AWG sizes of conductors	18, 17, 16		
Number of conductors	2 or 3		
Grounding conductor	(5.1, 8.3, 8.4, 15.1 – 15.4, 23.1 and 67.1)		
Conductor	Soft-annealed copper (7.1 and 7.2)		
Material	(8.1–8.7, 9.1 – 9.3)		
Size verification	(11.1 and 11.2)		
Stranding	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)		
General	2.4, 2.5, 2.5A, 2.16, 2.17, 2.23A, 2.30		
Circuit conductor Class number ^e	2.20, 2.28		2.9, 2.11, 2.22, 2.29
Grounding conductor Class number ^e	2.4, 2.5, 2.5A, 2.13, 2.14, 2.16, 2.17, 2.23A, 2.30		
Insulation	Average – 15.0 mils or 0.38 mm; minimum at any point – 13.0 mils or 0.33 mm (15.1 – 16.2.1) (12 mils or 0.30 mm at line of contact between conductors)		
Thicknesses	Optional braid (Section 20) or optional nylon jacket: minimum 0.0002 inch or 0.05 mm (22.1)		
Braid or jacket on each conductor	Cabled		
Assembly of conductors	(23.1)		
Maximum length of lay of conductors	Optional (Section 39)		
Shielding	Optional (Section 24)		
Fillers	Optional (Section 18)		
Braid, wrap, or serving over assembly	SVOO ^b , SVO ^c		
Type-letter designation	SVEO ^c , SVEOO ^b		
Class number ^e	1.2, 1.3, 1.10, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19
Minimum acceptable average thickness	30 mils or 0.76 mm [Section 280 of 1581]		
Minimum acceptable thickness at any point	24 mils or 0.61 mm [Section 280 of UL 1581]		
Jacket	(27.1)		
General	(Section 40)		
Overall diameter			

Table 6.10 Continued on Next Page

Table 6.10 Continued

Type-letter designation	Physical properties of insulation ^e		SVOO ^b , SVO ^c	SVEO ^c , SVEOO ^b	SVTOO ^b , SVTO ^c
	Unaged	After aging			
Tests on finished insulated conductors or cord	Physical properties of jacket ^e	Unaged	2.4, 2.5, 2.5A, 2.13, 2.14, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.29
		After aging	1.2, 1.3, 1.10, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19
	Conductor corrosion		[500.1 of UL 1581]		
	Heat shock				(56.1)
	Deformation			(57.6)	(57.1 and 57.6)
	Cold bend		(58.1)	(58.4)	(58.1 and 58.4)
	Resistance of nonintegral jacket			(31.1)	
	Mechanical strength			(41.1)	
	VW-1 flame test			(42.1)	
	Horizontal flame			(44.1 and 44.2)	
	Dielectric			(51.1)	
	Insulation resistance			(53.1)	
	Flexing of shielded cords			(63.1)	
	Durability of ink print			(64.1)	
Polarity identification			(65.1.1, 65.4.1, 65.8.1, and 67.1)		
Markings			(68.1, 68.2, 68.5, 69.1 – 69.4, 69.6, 74.1, 79.1, 80.1, 81.1, 82.1, and 83.1)		

^a See 6.3

^b The OO in the type letters indicates that both the insulation and jacket are for continuous immersion in oil at temperatures not exceeding 60°C (140°F).

^c The O in the type letters indicates that the jacket (not the insulation) is for continuous immersion in oil at temperatures not exceeding 60°C (140°F).

^d If both the conductor insulation and the jacket are for use at the temperature in question, the temperature limits are: Type SVO or SVOO-75°C (167°F) or 90°C (194°F), SVTO or SVTOO-75°C (167°F) or 90°C (194°F) or 105°C (221°F). See 30.1.

^e The physical properties requirements for individual materials are in given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

^f The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14, respectively. See 30.1.

Table 6.11
Non-oil-resistant vacuum-cleaner cords^a

Table 6.11 revised March 13, 2001

Type-letter designation	SV	SVE	SVT
Temperature rating	60°C (140°F) ^b	90°C (194°F) ^d	60°C (140°F) ^b
Maximum voltage	300		
AWG sizes of conductor	18 – 17 – 16		
Number of conductors	2 or 3		
Grounding conductor	(5.1, 8.3, 8.4, 15.1 – 15.4, 40.1, 41.1, and 67.1)		
Material	Soft-annealed copper (7.1 and 7.2)		
Size verification	(8.1 – 8.7, 9.1 – 9.3)		
Stranding	(11.1 and 11.2)		
General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)		
Circuit conductor Class number ^c	2.4, 2.5, 2.5A, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.29
Grounding conductor Class number ^c	2.4, 2.5, 2.5A, 2.13, 2.14, 2.16, 2.17, 2.23A, 2.30		
Thicknesses	Average – 15.0 mils or 0.38 mm; minimum at any point – 13.0 mils or 0.33 mm (15.1, 16.2.1) (12 mils or 0.30 mm at line of contact between conductors)		
Braid or jacket on each conductor	Optional braid (Section 20) or optional jacket: minimum 0.002 inch or 0.05 mm (22.1)		
Assembly of conductors	Cabled (23.1)		
Maximum length of lay of conductors	Optional (Section 39)		
Shielding	Optional (Section 24)		
Fillers	Optional (Section 18)		
Braid, wrap, or serving over assembly	Optional (Section 18)		
Class number ^c	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19
Minimum acceptable average thickness	30 mils or 0.76 mm [Section 280 of UL 1581]		
Minimum acceptable thickness at any point	24 mils or 0.61 mm [Section 280 of UL 1581]		
General	(27.1)		
Overall diameter	(Section 40)		

Table 6.11 Continued on Next Page

Table 6.11 Continued

Type-letter designation	SV		SVE	SVT
	Unaged	After aging		
Physical properties of insulation ^c	Unaged	2.4, 2.5, 2.5A, 2.13, 2.14, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.29
	After aging			
Physical properties of jacket ^c	Unaged	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19
	After aging			
Conductor corrosion	[500.1 of UL 1581]			
Heat shock			(56.1)	(56.1)
Deformation			(57.6)	(57.1 and 57.6)
Cold bend		58.1	(58.4)	(58.1 and 58.4)
Resistance of nonintegral jacket			(31.1)	
Mechanical strength			(41.1)	
VW-1 flame test			(42.1)	
Horizontal flame			(44.1 and 44.2)	
Dielectric			(51.1)	
Insulation resistance			(53.1)	
Flexing of shielded cords			(63.1)	
Durability of ink print			(64.1)	
Polarity Identification			(65.1.1, 65.4.1, 65.8.1, and 67.1)	
Markings			(68.1, 68.2, 68.5, 69.1 – 69.4, 69.6, 74.1, 79.1, 80.1, 81.1, 82.1, and 83.1)	

^a See 6.3.

^b If both conductor insulation and jacket are for use at the temperature in question, the temperature limits are: Type SV – 75°C (167°F) or 90°C (194°F), SVT – 75°C (167°F), 90°C (194°F), or 105°C (221°F). See 30.1.

^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

^d The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14, respectively. See 30.1

Table 6.12
Oil-resistant hard-service cords^a

Table 6.12 revised March 13, 2001

Type-letter designation	SJOO ^b , SJOOW ^b	SJO ^c , SJOW ^c	SJEOO ^b , SJEOOW ^b , SJEO ^c , SJEOW ^c	SJTOO ^b , SJTOOW ^b	SJTO ^c , SJTOW ^c
Temperature rating	60°C (140°F) ^d				
Maximum voltage	300				
AWG sizes of circuit conductors	18 – 10				
Number of circuit conductors	2 – 5				
Grounding conductor	One or more acceptable(5.1, 8.4, 15.1 – 15.4, 32.3, 37.1, 41.1, 66.1, and 67.1)				
Material	Soft-annealed copper (7.1 and 7.2)				
Size verification	(8.1 – 8.7, 9.1 – 9.3)				
Stranding	(11.1 and 11.2)				
General	Tinning, separators, splices, and continuity (12.1– 14.1, Section 10)				
Circuit conductor class number ^g	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30		2.20, 2.28		
Grounding conductor class number ^g	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30		2.9, 2.11, 2.22, 2.24, 2.26 (low leakage-current), 2.29		
Thicknesses	(Section 16)				
Braid or jacket on each conductor	Optional braid (Section 20) or optional nylon jacket: minimum 0.002 inch or 0.05 mm (22.1)				
Assembly of conductors	Cabled				
Maximum length of lay of conductors	(23.1)				
Shielding	Optional (Section 39)				
Fillers	Optional (Section 24)				
Braid, wrap, or serving over assembly	Optional (Section 18)				
Class number ^g	1.2, 1.3, 1.10, 1.17, 1.20		1.14, 1.18		
Minimum acceptable average thickness	18 – 14 AWG: 30 mils or 0.76 mm; 12 AWG: 45 mils or 1.14 mm; 10 AWG: 60 mils or 1.52 mm; Table 28.3A; [Section 280 of UL 1581], Table 28.3A				
Minimum acceptable thickness at any point	18 – 14 AWG: 24 mils or 0.61 mm; 12 AWG: 36 mils or 0.91 mm; 10 AWG: 48 mils or 1.22 mm [Section 280.2 of UL 1581]				
General	(27.1)				
Overall diameter	(Section 40)				

Table 6.12 Continued on Next Page

Table 6.12 Continued

Type-letter designation	SJOO ^b , SJOOW ^b	SJOC ^c , SJOW ^c	SJEOO ^b , SJEOOW ^b , SJEOC ^c , SJEOW ^c	SJTOO ^b , SJTOOW ^b	SJTOC ^c , SJTOW ^c
Physical properties of insulation ^g	Unaged	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.24, 2.26, 2.29	
	After aging				
Physical properties of jacket ^g	Unaged	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19	
	After aging				
Conductor corrosion	[500.1 of UL 1581]				
Heat shock			(56.1)		(56.1)
Deformation			(57.6)		(57.1 and 57.6)
Cold bend	W Types		(32.6 and 32.7)		
	Other Types	(58.1)	(58.4)		(58.1 and 58.4)
Sunlight resistance of W Types			(32.5)		
Swelling and blistering of thermoset jackets of W Types		(32.13)			
Resistance of nonintegral jacket			(31.1)		
Relative permittivity and stability factor of insulation of W Types		Thermosets and TPE (32.8 and 32.9)			
A-C leakage current					Low-leakage-current cords (37.1)
Mechanical strength			(41.1)		
Flame tests	Optional VW-1/FT1		(42.1)		
	Required horizontal/FT2		(44.1 and 44.2)		
Dielectric			(51.1)		
	Insulation resistance (W Types)		(32.4)		(32.10 – 32.12)
Insulation resistance of indoor Types			(53.1)		
Durability of ink print			(64.1)		
Flexing of Shielded Cords			(63.1)		
Polarity identification			(65.1.1, 65.4.1, 65.8.1, and 67.1)		
Markings			(68.1, 68.2, 68.5, 69.1–69.4, 69.6, 74.1, 76.1, 76.2, 76.3, 78.1, 79.1, 80.1, 81.1, 82.1, and 83.1)		

a See 6.3.
 b The OO in the type letters indicates that both the insulation and jacket are for continuous immersion in oil at temperatures not exceeding 60°C (140°F).
 c The O in the type letters indicates that the jacket (not the insulation) is for continuous immersion in oil at temperatures not exceeding 60°C (140°F).
 d If both the conductor insulation and the jacket are for use at the temperature in question, the temperature limits are: Type SJO, SJOW, SJOO, SJOOW, SJTO, SJTOW, SJTOOW, or SJTOO – 75°C (167°F) or 90°C (194°F) or 105°C (221°F). See 28.1.
 e The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.
 f The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14 respectively. See 30.1.

Table 6.12 Continued

Type-letter designation	SJOO ^b , SJOW ^b	SJOC, SJOW ^c	SJEOO ^b , SJEOOW ^b , SJEO ^c , SJEOW ^c	SJTOO ^b , SJTOOW ^b	SJTO ^c , SJTOW ^c
g See 4.2 h Maximum combined number of circuit and grounding conductors is 6.					

Table 6.13
Non-oil-resistant hard-service cords^a

Table 6.13 revised March 13, 2001

Type-letter designation	SJ	SJE, SJEW	SJT, SJTW
Temperature rating	60°C (140°F) ^b	90°C (194°F) ^d	60°C (140°F) ^b
Maximum voltage	300		
AWG sizes of circuit conductors	18 – 10		
Number of circuit conductors	2 – 5		
Grounding conductor	One or more acceptable ^e (5.1, 8.4, 15.1 – 15.3, 23.1, 31.1, 37.1, 41.1, 66.1, and 67.1)		
Conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1–8.7, 9.1 – 9.3)	
	Stranding	(11.1 and 11.2)	
Insulation	General	Tinning, separators, splices, and continuity (12.1– 14.1, Section 10)	
	Circuit conductor class number ^c	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28 2.9, 2.11, 2.22, 2.24, 2.26 (low-leakage-current), 2.29
	Grounding conductor class number ^c		2.9, 2.11, 2.22, 2.24, 2.26 (low-leakage-current), 2.29
Thickness	(15.1 – 16.2.1)		
Braid or jacket on each conductor	Optional braid (Section 20) or optional nylon jacket: minimum 0.002 inch or 0.05 mm (22.1)		
Assembly of conductors	Cabled		
Maximum length of lay of conductors	(23.1)		
Shielding	Optional (Section 39)		
Fillers	Optional (Section 24)		
Braid, wrap, or serving over assembly	Optional (Section 18)		
Jacket	Class number ^c	1.2, 1.3, 1.10, 1.17, 1.20	1.7, 1.8, 1.16, 1.19
	Minimum acceptable average thickness	18 – 14 AWG: 30 mils or 0.76 mm; 12 AWG: 45 mils or 1.14 mm; 10 AWG: 60 mils or 1.52 mm, Table 28.3A [Section 280 of UL 1581]	
	Minimum acceptable thickness at any point	18 – 14 AWG: 24 mils or 0.61 mm; 12 AWG: 36 mils or 0.91 mm; 10 AWG: 48 mils or 1.22 mm [Section 280 of UL 1581]	
Overall diameter	General (27.1) (Section 40)		

Table 6.13 Continued on Next Page

Table 6.13 Continued

Type-letter designation		SJ	SJE, SJEW	SJT, SJTW
Physical properties of insulation ^e	Unaged	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.24, 2.26, 2.29
	After aging			
Physical properties of jacket ^e	Unaged	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19
	After aging			
Conductor corrosion		[500.1 of UL 1581]		
Heat shock		(56.1)		
Deformation		(57.6)		
Cold bend	W Types	(32.6 and 32.7)		
	Other Types	(58.4)	(58.1)	
Sunlight resistance of W Types		(32.5)		
Resistance of nonintegral jacket		(31.1)		
Relative permittivity and stability factor of insulation of W Types		(32.8 and 32.9)		
A-C leakage current		Low-leakage-current cords (37.1)		
Mechanical strength		(41.1)		
Flame tests	Optional VW 1/FT1	(42.1)		
	Required horizontal flame/FT2	(44.1 and 44.2)		
Dielectric		(51.1)		
Insulation resistance (W Types)	15.6°C (60°F)	(32.4)		
	50° C (122° F)	Class 2.9, 2.11, 2.22, 2.29 PVC (32.10 – 32.12)		
Insulation resistance of indoor Types		(Section 53)		
Durability of Ink Print		(64.1)		
Flexing of Shielded Cords		(63.1)		
Polarity identification		(65.1.1, 65.4.1, 65.8.1, and 67.1)		
Markings		(68.1, 68.2, 68.5, 69.1 – 69.4, 69.6, 74.1, 76.1 – 76.3, 78.1, 79.1, 80.1, 81.1, 82.1, and 83.1)		

a See 6.3.
b If both the conductor insulation and the jacket are for use at the temperature in question, the temperature limits are: Type SJ, SJE, or SJTW – 75°C (167°F) or 90°C (194°F) or 105°C (221°F). See 30.1.
c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test method see 40.2 of UL 1581.
d The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14, respectively. See 30.1.
e Maximum combined number of circuit and grounding conductors is 6.

Table 6.14
Oil-resistant extra-hard-service cords^a

Table 6.14 revised March 13, 2001

Type-letter designation	SOO ^b , SOOW ^b	SO ^c , SOW ^c	SEOO ^b , SEOO ^b , SEO ^c , SEOW ^c	STOO ^b , STOOW ^b	STO ^c , STOW ^c
Temperature rating	60°C (140°F) ^d				
Maximum voltage	600				
AWG sizes of circuit conductors	18 – 2				
Number of circuit conductors	2 or more				
Grounding conductor	One or more acceptable (5.1, 8.4, 15.1–15.4, 37.1, 41.1, 66.1 and 67.1)				
Conductor	Soft-annealed copper (7.1 and 7.2)				
Material	(8.1 – 8.7, 9.1 – 9.3)				
Size verification	(11.1 and 11.2)				
Stranding	Timing, separators, splices, and continuity (12.1–14.1, Section 10)				
General					
Insulation	Circuit conductor class number ^e	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.29	2.9, 2.11, 2.22, 2.26 (low-leakage-current), 2.29
	Grounding conductor class number ^e				2.9, 2.11, 2.22, 2.26 (low-leakage-current), 2.29
Thicknesses	(Section 16)				
Braid or jacket on each conductor	Optional braid (Section 20) or optional nylon jacket: minimum 0.002 inch or 0.05 mm (22.1)				
Assembly of conductors	Cabled				
Maximum length of lay of conductors	(23.1)				
Shielding	Optional (Section 39)				
Fillers	Optional (Section 24)				
Braid, wrap, or serving over assembly	Optional (Section 18)				
Jacket	Class number ^h	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19	
	Minimum acceptable average thickness	(28.1)			
	Minimum acceptable thickness at any point				
General	(27.1)				
Overall diameter	(Section 40)				

Table 6.14 Continued on Next Page

Table 6.14 Continued

Type-letter designation	SOOB ^b , SOOW ^b		SO ^c , SOW ^c		SEOO ^b , SEOOOW ^b , SEO ^c , SEOW ^c		STOO ^b , STOOOW ^b		STO ^c , STOW ^c		
	Physical properties of insulation ^d	Unaged	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.24, 2.26, 2.29	2.9, 2.11, 2.22, 2.29	2.9, 2.11, 2.22, 2.29	2.9, 2.11, 2.22, 2.29	2.9, 2.11, 2.22, 2.24, 2.26, 2.29	2.9, 2.11, 2.22, 2.24, 2.26, 2.29
Physical properties of jacket ^d	Unaged	1.2, 1.3, 1.10, 1.17, 1.20	1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19	1.7, 1.8, 1.16, 1.19	1.7, 1.8, 1.16, 1.19	1.7, 1.8, 1.16, 1.19	1.7, 1.8, 1.16, 1.19	1.7, 1.8, 1.16, 1.19	
Conductor corrosion		[500.1 of UL 1581]									
Heat shock				(56.1)			(56.1)				
Deformation				(57.6)			(57.1 and 57.6)				
Cold bend	W Types			(32.6 and 32.7)							
	Other Types		(58.1)	(58.4)			(58.1 and 58.4)				
Sunlight resistance of W Types				(32.5)							
Swelling and blistering of thermoset jackets of W Types				(32.13)							
Resistance of nonintegral jacket				(31.1)							
Relative permittivity and stability factor of insulation of W Types			(32.8 and 32.9)								
A-C leakage current				(41.1)			Low-leakage-current cords (37.1)				
Mechanical strength				(42.1)							
Flame tests	Optional VW-1/FT1			(44.1 and 44.2)							
	Required horizontal flame / FT2										
Dielectric				(51.1)							
Insulation resistance (W Types)	15.6°C (60°F)			(32.4)							
	50°C (122°F)						Class 2.9, 2.11, 2.22, 2.29 PVC (32.10 – 32.12)				
Insulation resistance of indoor Types				(53.1)							
Durability of ink print				(64.1)							
Flexing of shielded cords				(63.1)							
Polarity identification				(65.1.1, 65.4.1, 65.8.1, and 67.1)							
Markings				(68.1, 68.2, 68.5, 69.1 – 69.4, 69.6, 75.1, 75.2, 76.1 – 76.3, 78.1, 79.1, 80.1, 81.1, 82.1, and 83.1)							

^a See 6.3.

^b The OO in the type letters indicates that both the insulation and jacket are for continuous immersion in oil at temperatures not exceeding 60°C (140°F).

^c The O in the type letters indicates that the jacket (not the insulation) is for continuous immersion in oil at temperatures not exceeding 60°C (140°F).

^d If both the conductor insulation and the jacket are for use at the temperature in question, the temperature limits are: Type SO or SOO, SO, SOOW, STO, STOO, STOW or STOOOW – 75°C (167°F) or 90°C (194°F) or 105°C (221°F). See 30.1.

^e The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

^f The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14, respectively. See 30.1

Table 6.15
Non-oil-resistant extra-hard-service cords^a

Table 6.15 revised March 13, 2001

Type-letter designation	S	SE, SEW	ST, STW
Temperature rating	60°C (140°F) ^b	90°C (194°F) ^d	60°C (140°F) ^b
Maximum voltage	600		
AWG sizes of circuit conductors	18 – 2		
Number of circuit conductors	2 or more		
Grounding conductor	One or more acceptable (5.1, 8.3, 8.4, 15.1 – 15.3, 31.1, 37.1, 40.1, 41.1, 66.1, 67.1, and 69.3)		
Conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1 – 8.7, 9.1 – 9.3)	
	Stranding	(11.1 and 11.2)	
Insulation	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)	
	Circuit conductor class number ^f	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.23A, 2.30	2.9, 2.11, 2.22, 2.26 (low-leakage-current), 2.29
	Grounding conductor class number ^f	2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.17, 2.23A, 2.30	2.20, 2.28 2.9, 2.11, 2.22, 2.24, 2.26 (low-leakage-current), 2.29
Thickness	(Section 16)		
Braid or jacket on each conductor	Optional braid (Section 20) or optional nylon jacket: minimum 0.002 inch or 0.05 mm (22.1)		
Assembly of conductors	Cabled		
Maximum length of lay of conductors	(23.1)		
Shielding	(Section 39)		
Fillers	Optional (Section 24)		
Braid, wrap, or serving over assembly	Optional (Section 18)		
Jacket	Class number ^c	1.2, 1.3, 1.10, 1.17, 1.20	1.7, 1.8, 1.16, 1.19
	Minimum acceptable average thickness	1.14, 1.18	(28.1)
	Minimum acceptable thickness at any point	(27.1)	
Overall diameter	(40.1 and 40.2)		

Table 6.15 Continued

Type-letter designation	Physical properties of insulation ^c		S	SE, SEW	ST, STW	
	Unaged	After aging				
Tests on finished insulated conductors or cord	Physical properties of insulation ^c		2.4, 2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.23A, 2.30	2.20, 2.28	2.9, 2.11, 2.22, 2.24, 2.26, 2.29	
	Physical properties of jacket ^c		1.2, 1.3, 1.10, 1.17, 1.20	1.14, 1.18	1.7, 1.8, 1.16, 1.19	
	Conductor corrosion		[500.1 of UL 1581]			
	Heat shock		(56.1)			
	Deformation		(57.6)			
	Cold bend		W Types	(32.6 and 32.7)		
			Other Types	(58.4)		
	Sunlight resistance of W Types		(32.5)			
	Resistance of nonintegral jacket		(31.1)			
	Relative permittivity and stability factor of insulation of W Types		Thermosets and TPE (32.8 and 32.9)			
	A-C leakage current		Low-leakage-current cords (37.1)			
	Mechanical strength		(41.1)			
	Flame tests		Optional VW-1/FT1	(42.1)		
			Required horizontal/FT2	(44.1 and 44.2)		
Dielectric		(51.1)				
Insulation resistance (W Types)		15.6°C (60°F)	(32.4)			
		50°C (122°F)	Class 2.9, 2.11, 2.22, 2.29 PVC (32.10 – 32.12)			
Insulation resistance of indoor Types		(53.1)				
Durability of ink print		(64.1)				
Flexing of shielded cords		(63.1)				
Polarity identification		(65.1.1, 65.4.1, 65.8.1, and 67.1)				
Markings		(68.1, 68.2, 68.5, 69.1 – 69.4, 69.6, 74.1, 75.1, 75.2, 76.1 – 76.3, 78.1, 79.1, 80.1, 81.1, 82.1, and 83.1)				

a See 6.3

b If both the conductor insulation and the jacket are for use at the temperature in question, the temperature limits are: Type S, SW, ST, or STW, SO or SOO or STO or STOO – 75°C (167°F) or 90°C (194°F) or 105°C (221°F). See 30.1.

c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

d The temperature limit is 105°C (221°F) if both the conductor insulation and the jacket are of Class 2.20 and 1.14, respectively. See 30.1.

Table 6.16
Heater cords^a

Table 6.16 revised March 13, 2001

Type-letter designation	HSJ, HSJO ^e , HSJOO ^f	HPN
Temperature rating	90°C (194°F) ^d	90°C (194°F) ^e
Maximum voltage	300	
AWG sizes of circuit conductors	18 – 12	
Number of circuit conductors	2, 3, or 4	2 (16.3.3.2– 16.3.3.6 and 67.1)
Grounding conductor	One acceptable in addition to circuit conductors (5.1, 8.3, 8.4, 15.1 – 15.3, 66.1, 67.1, and 69.3.)	One (5.1, 8.3, 8.4, 15.1 – 15.4, 16.3.3.2– 16.3.3.6, 67.1, and 70.1)
Conductor	Material	Soft-annealed copper (7.1 and 7.2)
	Size verification	(8.1 – 8.7, 9.1 – 9.3)
	Stranding	(11.1 and 11.2)
	General	
Insulation	Circuit conductor class number ^b	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)
	Grounding conductor class number ^b	2.5, 2.5A, 2.15, 2.16, 2.17, 2.23A
	Minimum average thickness	2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.23A
	Minimum thickness at any point	(15.1 – 15.3, 16.1.1 – 16.3.1.1, and 16.3.3.1 – 16.3.3.8)
Braid on each conductor	(16.2.1)	(same as above)
Assembly of conductors	Optional (Section 20)	
Maximum length of lay of conductors	Cabled	Parallel
Fillers	(23.1)	
Braid, wrap, or serving over assembly	Optional (Section 24)	
	Optional (Section 18)	
	1.3, 1.10, 1.17	
Jacket	Class number ^b	
	Minimum acceptable average thickness	30 mils or 0.76 mm [Section 280 of UL 1581]
	Minimum acceptable thickness at any point	23 mils or 0.58 mm [Section 280 of UL 1581]
General	(27.1)	

Table 6.16 Continued

Type-letter designation		HSJ, HSJOC, HSJOO ^f	HPN
Physical properties of insulation ^b	Unaged	2.5, 2.5A, 2.15, 2.16, 2.17, 2.23A	2.5, 2.5A, 2.13, 2.14, 2.15, 2.16, 2.23A
	After aging		
Physical properties of jacket ^b	Unaged	1.3, 1.10, 1.17	
	After aging		
Conductor corrosion		[500.1 of UL 1581]	
Tightness of insulation			[1280.1 of UL 1580]
Tests on finished insulated conductors or cord	Arcing		(48.1)
	Flame Broken strands		(49.1)
Resistance of nonintegral jacket		(31.1)	
VW-1/FT1 flame test (optional)		(42.1)	
Cold bend		(58.1)	
Horizontal flame/FT2		(44.1 and 44.2)	
Dielectric		Finished cord (51.1)	
Durability of ink print		(64.1)	
Polarity identification		Optional (65.1.1)	
Markings		(68.5, 69.1 – 69.4, 66.1, 79.1, 81.1, 82.1, and 83.1)	
<p>a See 6.3</p> <p>b The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.</p> <p>c The O in the type letters indicates that the jacket (not the insulation) is for continuous immersion in oil at temperatures not exceeding 60°C (140°F).</p> <p>d A temperature limit of 105°C (221°F) applies to cord employing Class 2.16 or 105°C Class 2.23A or 2.30 insulation and Class 1.17 jacket; otherwise the temperature limit is 90°C (194°F).</p> <p>e A temperature limit of 105°C (221°F) applies to cord employing Class 2.16 insulation; otherwise the temperature limit is 90°C (194°F).</p> <p>f The OO in the type letters indicates that both the insulation and jacket are for continuous immersion in oil at temperatures not exceeding 60°C (140°F).</p>			

Table 6.17
Braided heater cord^a
 Table 6.17 revised March 13, 2001

Type-letter designation	HPD	
Temperature rating	90°C (194°F) ^b	
Maximum voltage	300	
AWG sizes of circuit conductors	18 – 12	
Number of circuit conductors	2, 3, or 4	
Grounding conductor	One acceptable in addition to circuit conductors (5.1, 8.3, 8.4, 15.1 – 15.4, 66.1, and 67.1)	
Conductor	Material	Soft-annealed copper (7.1 and 7.2)
	Size verification	(8.1 – 8.7, 9.1 – 9.3)
	Stranding	(11.1 and 11.2)
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)
Insulation	Class number ^c	2.5, 2.5A, 2.15, 2.16, 2.17, 2.23A
	Minimum acceptable average thickness	18 – 16 AWG 30 mils or 0.76 mm, 14 – 12 AWG 45 mils or 1.14 mm (15.1 – 16.2.1)
	Minimum acceptable thickness at any point	(16.2.1)
Braid on each Conductor	(20.1.1 – 20.1.3)	
Assembly of conductors	Twisted together	
Maximum length of lay of conductors	(23.1)	
Fillers	Optional (Section 24)	
Braid, wrap, or serving over assembly	Optional (Section 18)	
Over-all braid	Cotton or rayon (20.1.1)	
Tests on finished insulated conductors or cord	Physical properties of insulation ^c	Unaged After aging
	Conductor corrosion	
	Flexibility of braid	Cord (20.1.1)
	VW-1/FT1 flame test (optional)	(42.1)
	Cold bend	(58.1)
	Horizontal Flame	(44.1 and 44.2)
	Dielectric	Finished cord (51.1)
	Durability of ink print	(64.1)
	Polarity Identification	Optional (65.1.1)
	Markings	(68.1, 68.2, 68.5, 69.1 – 69.4, 74.1, 81.1, 82.1, and 83.1)
^a See 6.3.		

Table 6.17 Continued on Next Page

Table 6.17 Continued

Type-letter designation	HPD
^b A temperature limit of 105°C (221°F) applies to cord employing Class 2.16 or Class 2.23A insulation; otherwise the temperature limit is 90°C (194°F).	
^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.	

Table 6.18
Range and dryer cables^a

Table 6.18 revised March 13, 2001

Type-letter designation	SRD 60°C (140°F)	SRDE 90°C (194°F) ^e	SRDT 60°C (140°F) ^b
Temperature rating	60°C (140°F)	90°C (194°F) ^e	60°C (140°F) ^b
Maximum voltage	300		
AWG size of circuit conductors	10 – 4		
Number of circuit conductors	(2 – 4) ^c		
Grounding conductor	One acceptable in addition to circuit conductors (5.1, 8.3, 8.4, 16.1 – 16.4, 30.1, 66.1, 67.1, and 69.3)		
Conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1 – 8.7, 9.1 – 9.3)	
	Stranding	(11.1 and 11.2)	
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)	
Insulation	Class number ^d	2.20, 2.28	2.9, 2.22
	Minimum acceptable average thickness	45 mils or 1.14 mm (15.1 – 16.2.1)	
	Minimum acceptable thickness at any point	40 mils or 1.02 mm (16.2.1)	
Braid on each conductor	Optional (20.1.1)		
Assembly of conductors	Twisted together or parallel		
Maximum length of lay of conductors	(23.1)		
Fillers	Optional (Section 24)		
Braid, wrap, or serving over assembly	Optional (Section 18)		
Jacket	Class number ^d	1.14, 1.18	1.7, 1.16
	Minimum acceptable average thickness	60 mils or 1.52 mm [Section 280 of UL 1581]	
	Minimum acceptable thickness at any point	48 mils or 1.22 mm [Section 280 of UL 1581]	
Web	General	(27.1)	
		(16.4.1)	

Table 6.18 Continued on Next Page

Table 6.18 Continued

Type-letter designation	Physical properties of insulation ^d		SRD	SRDE	SRDT
	Unaged	After aging			
Tests on finished insulated conductors or cord	Physical properties of insulation ^d	Unaged	2.4	2.20 or 2.28	2.9, 2.22
	Physical properties of jacket ^d	Unaged	1.2	1.14, 1.18	1.7, 1.16
	Conductor corrosion	After aging		[500.1 of UL 1581]	
	VW-1/FT1 flame test (optional)			(42.1)	
	Heat shock				(56.1)
	Deformation		(58.1)	(57.6)	(57.1 and 57.6)
	Cold bend			(58.4)	(58.1 and 58.4)
	Horizontal flame/FT2			(44.1 and 44.2)	
	Dielectric			(51.1)	
	Durability of ink print			(64.1)	
Insulation resistance				(53.1)	
Polarity identification				(65.1.1, 65.5.1, 65.6.1, and 67.1)	
Markings				(68.1, 68.2, 68.5, 69.1 – 69.3, 69.5, 74.1, 77.1, 79.1, 81.1, 82.1, and 83.1)	

a See 6.3.
 b The temperature limit is 90°C (194°F) if the compound used throughout is 90°C (194°F) Class 2.22 PVC. A rating of 75°C (167°F) is not acceptable.
 c For cables with 2 circuit conductors with or without one grounding conductor and for cables with 3 circuit conductors without a grounding conductor, the parallel construction is acceptable with 60°C (140°F) Class 1.2 neoprene or SBR/NR used for Type SRD, with 60°C (140°F) or 90°C (194°F) Class 1.7 or 1.16 PVC used for Type SRDT, and with Class 1.18 used for Type SRDE. See 16.4.1. Tests on finished cable shall be as specified in Table 6.9 for Types SP-3 and SPT-3, respectively.
 d The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.
 e The temperature limit is 105°C (221°F) if the conductor insulation is Class 2.20 TPE and jacketing material is Class 1.14 TPE for use at a maximum of 105°C (221°F). See 30.1.

Table 6.19
 Thermoset-insulated elevator cables^a

Table 6.19 revised March 13, 2001

Type-letter designation	E ^b	EO ^b
Temperature rating		60°C (140°F)
Maximum voltage		300 (20 – 12 AWG; 600 (12 – 2 AWG)
AWG sizes of circuit conductors		20 – 2
Number of circuit conductors		2 or more

Table 6.19 Continued

Type-letter designation		E ^b	EO ^b
Circuit conductor	Material	Soft-annealed copper (7.1 and 7.2)	
	Size verification	(8.1–8.7, 9.1–9.3)	
	Stranding	(11.1 and 11.2)	
	General	Tinning, separators, splices, and continuity (12.1–14.1, Section 10)	
Covering on each conductor	Class number ^c	2.4	
	Minimum acceptable average thickness	(15.1–16.2.1 and 45.1.1)	
	Minimum acceptable thickness at any point		
Assembly of conductors		braid (45.2.1); Fibrous covering (18.1)	
Maximum length of lay of conductors		Twisted together	
Fillers		(45.3.1)	
Optical fiber members		(46.1.1)	
Braid, wrap, or serving over assembly		1.2, 1.4, 8.4, 8.5, 8.6, and 46.1.1	
Overall braid		Braid (45.4.1); Fibrous covering (Section 18)	
Coverings on central steel support member	Insulation class number ^c	2.4 (Section 26)	
	Minimum acceptable average insulation thickness	10 mils or 0.25 mm	
	Optional braid over insulation	Fibrous covering (18.1)	
	Class number ^c		60°C Class 1.2
Jacket	Minimum acceptable average thickness		(28.2)
	Minimum acceptable thickness at any point		(28.2)
	General		(27.1)
	Physical properties of insulation ^c		2.4
Tests on finished insulated circuit conductors or cords	Physical properties of jacket ^c		
	Unaged		
	After aging		1.2
	Conductor corrosion		
Markings	Flame	[500.1 of UL 1581]	
	FT1 (required)		(Section 42)
	VW-1 (optional)		
	Cold bend		(58.1)
	Dielectric		(51.1)
	Durability of ink print		(64.1)
		(68.1, 68.2, 68.5, 68.6, 74.1, 81.1, 82.1, and 83.1)	

^a See 6.3.

^b Optical-fiber members, coaxial-cable members, and/or twisted pairs of No. 20 AWG or larger conductors for use in telephone, audio, or higher-frequency communications circuits may be included in a Type E or EO elevator cable, or the cable may consist entirely of twisted pairs or optical-fiber members. See 8.4(c), 8.5, and 8.6.

^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 41.2 of UL 1581.

Table 6.20
Thermoplastic-insulated elevator cables^a

Table 6.20 revised March 13, 2001

Type-letter designation	ETT ^b	ETP ^b
Temperature rating	60°C (140°F)	
Maximum voltage	300 (20 – 12 AWG); 600 (12 – 2 AWG)	
AWG sizes of circuit conductors	20 – 2	
Number of circuit conductors	2 or more	
Circuit conductors	Material	Soft-annealed copper (7.1 and 7.2)
	Size verification	(8.1– 8.7, 9.1 – 9.3)
	Stranding	(11.1 and 11.2)
	General	Tinning, separators, splices, and continuity (12.1 – 14.1, Section 10)
	Class number ^c	2.9
Insulation	Minimal acceptable average thickness	(15.1– 16.2.1 and 45.1.1)
	Minimum acceptable thickness at any point	
Braid on each conductor (optional)	Fibrous (45.2.1)	
Assembly of conductors	Twisted together (45.3.1)	8.4(c)
Maximum length of lay of conductors	(46.1.1 and 46.2.1)	
Conductor Assembly	1.2, 1.4, 8.4, 8.5, 8.6, and 46.1.1	
Optical-fiber members	Fibrous (45.4.1)	
Braid, wrap, or serving over assembly	(45.4.1); Fibrous covering (18.1)	
Overall braid		2.9
Coverings on central steel support member	Insulation class number ^c	
	Minimum acceptable average insulation thickness	10 mils or 0.25 mm (Optional)
	Optional braid over insulation	
Jacket	Class Number ^d	1.7
	Minimum acceptable average thickness	Table 28.5
	Minimum acceptable thickness at any point	(28.2)
	Maximum Acceptable Thickness at Any Point	(27.1)
Web	General	Table 28.5

Table 6.20 Continued on Next Page

Table 6.20 Continued

Type-letter designation	Physical properties of conductor insulation ^c		ETT ^b	ETP ^b
	Unaged	After aging		
Tests on finished insulated circuit conductors or cable	Physical properties of jacket ^c	Unaged After aging	[500.1 of UL 1581]	2.9
	Conductor corrosion	Unaged After aging		
	Heat shock		(56.1)	
	Deformation		(57.1)	
	Cold bend		(58.1)	
	Flame		(Section 42)	
	FT1 (required)		(51.1)	
	VW-1 (optional)		(64.1)	
	Dielectric		(53.1)	
	Durability of ink print		(68.1, 68.2, 68.5, 68.6, 69.5, 74.1, 81.1, 82.1, and 83.1)	
Insulation resistance				
Markings				

^a See 6.3.

^b Optical-fiber members, coaxial-cable members, and/or twisted pairs of No. 20 AWG or larger conductors for use in telephone, audio, or higher-frequency communications circuits may be included in a Type ETT or ETP elevator cable, or the cable may consist entirely of twisted pairs or optical-fiber members. See 8.4(c), 8.5, 8.6.

^c The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods see 40.2 of UL 1581.

Table 6.21
Hoistway cables

Table 6.21 revised March 13, 2001

Temperature rating	60°C (140°F)	60°C (140°F)	60°C (140°F)	90°C (194°F)	90°C (194°F)
	Maximum voltage	300	600	300	300
AWG sizes of circuit conductors	20 – 12	18 – 12	20 – 12	20 – 12	18 – 12
Number of circuit conductors	2 to 75				
	(7.1)				
Circuit conductors	Metal	(Table 11.1)			
	Insulation	Tinning, splices, and continuity (12.1, 14.1, Section 10) Size verification (9.1 – 9.3)			
Assembly of conductors ^b	Class number ^a	2.9	2.22		
	Insulation thickness	See Table 6.22, 6.23			
Length of lay of strands	Twisted together or parallel ^c				
Length of conductor assembly	7-strand – 48 times diameter of individual strand. See flexible stranding, Table 11.2				
	Maximum 36 inches or 916 mm				

Table 6.21 Continued on Next Page

Table 6.21 Continued

Temperature rating	60°C (140°F)	60°C (140°F)	90°C (194°F)	90°C (194°F)
Binder (optional)	A suitable binder may be applied over the twisted conductor assembly with or without a jacket.			
Jacket (optional)	1.7			1.16
Class number ^a	See Table 6.24, 6.25			
Thickness	[500.1 of UL 1581]			
Conductor corrosion	(56.1 and 56.2)			
Heat shock resistance	(57.1 and 57.3)			
Deformation (insulation and jacket)	(58.1 and 58.2)			
Cold bend	(Section 42)			
Flame				
FT1 (required)				
VW-1 (optional)				
Spark and dielectric voltage-withstand tests	(51.1 and Table 51.1)			
Insulation Resistance	(53.1)			
Jacket resistance	(27.1)			
Durability of ink print	(64.1)			
Markings	(68.1, 68.2, 68.5, 69.5, 74.1, 81.1, 82.1, and 83.1)			

^a The physical properties requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard. For test methods, see 40.2 of UL 1581.
^b Coaxial cable, optical-fiber member(s), telephone pair(s) may be included. See 8.5 and 8.6.
^c Parallel construction— The parallel construction consists of 2 to 4 conductors size No. 18 AWG, solid or stranded.

Table 6.22
Insulation thickness of hoistway cables – mils

Size AWG	600 V Cables		300 V Cables	
	Average	Minimum	Average	Minimum
20	—	—	20	18
18	30	27	20	18
16	30	27	20	18
14	30	27	30	27
12	30	27	30	27

Note: Alternate insulation thickness 15 mils average, 13 mils minimum at any point for PVC plus 4 mils at any point on Nylon.

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Table 6.23
Insulation thickness of hoistway cables – mm

600 V Cables			300 V Cables	
Size AWG	mm Average	Minimum	mm Average	Minimum
20	–	–	0.50	0.45
18	0.76	0.68	0.50	0.45
16	0.76	0.68	0.50	0.45
14	0.76	0.68	0.76	0.68
12	0.76	0.68	0.76	0.68

Note: Alternate insulation thickness 0.38 mm average, 0.34 mm minimum at any point for PVC plus 0.10 mm at any point on Nylon.

Table 6.24
Jacket thickness of hoistway cables – mils

Core diameter (inch)	Jacket thickness (mils)	
	Average	Minimum
0 – 0.424	20	16
0.425 – 0.699	30	24
0.700 – 0.999	35	28
1.000 – 1.500	40	32
1.501 and larger	45	36

Table 6.25
Jacket thickness of hoistway cables – mm

Core diameter (mm)	Jacket thickness (mm)	
	Average	Minimum
0 – 10.7	0.50	0.40
10.8 – 17.7	0.76	0.61
17.8 – 25.4	0.88	0.70
25.5 – 38.1	1.01	0.81
38.2 and larger	1.14	0.91

CONDUCTOR(S)

7 Metal

Section 7 effective July 2, 1998

7.1 Except as noted in 7.2, all conductors shall be of soft-annealed copper complying with ASTM B 3-90 No. 27 – 36 AWG (14.2 – 5.0 mils or 0.36 – 0.127 mm) copper strands that are uncoated or have a coating of tin complying with ASTM B 33-91 or a tin/lead coating complying with ASTM B 189-90 are acceptable in products whose temperature rating does not exceed 150°C (302°F). Uncoated or tin/lead-coated or tin-coated solid copper conductors and uncoated or tin/lead-coated or tin-coated copper strands whose diameter is at least 0.015 inch or 0.38 mm are acceptable in products whose temperature rating does not exceed 200°C (392°F).

7.2 Type XF, XFF, SF-1, SF-2, SFF-1, and SFF-2 fixture wires may employ a nickel-base alloy complying with ASTM B 160-93 and having a tensile strength of $65,000 \pm 15,000$ lbf/in² or 448 ± 103 MN/m² or $44,816 \pm 10,342$ N/cm² or 45.7 ± 10.5 kgf/mm², an elongation of at least 35 percent, and a nominal volume resistivity of 66 ohm-cmil/ft at 20°C (68°F) or 0.110 ohm-mm²/m at 20°C (68°F). Flexible cords employing Class 2.24A insulation may employ uncoated copper or copper with a coating of nickel complying with ASTM B 355-84, a coating of silver complying with ASTM B 298-93, a tin/lead coating complying with ASTM B 189-90 or a coating of another metal or alloy (evaluation required). Type PF, PFF, PGF, and PGFF fixture wire may employ uncoated copper; tin, silver, or nickel-coated copper; or a nickel-base alloy.

7.2 effective July 2, 1998

7.3 The conductors of all wires, cords and cables shall be continuous. See Continuity of Conductors, Section 10.

8 Sizes

Section 8 effective July 2, 1998

8.1 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. For a solid conductor, the American Wire Gauge number signifies a definite diameter and cross-sectional area. For a stranded conductor, the gauge number signifies that the sum of the cross-sectional areas of the individual wires is equivalent to the cross-sectional area of a solid conductor of the same gauge number.

8.2 The individual wires used in making up a stranded conductor are usually drawn to some definite diameter, which may or may not be the diameter corresponding to any particular AWG number.

8.3 Each of the circuit conductors in Type TPT and TST tinsel cords shall be No. 27 AWG. The circuit conductor in Type XTW and CXTW decorative-lighting cord or wire shall be No. 22, 20, or 18 AWG. The circuit conductors in Types SP-1, SPT-1, and SPE-1 shall be No. 20 or 18 AWG. The circuit conductors of clock cord shall be No. 20 AWG. Otherwise, no circuit or grounding conductor shall be smaller than No. 18 AWG.

8.3 revised February 6, 2001

8.4 Except as noted in (a) – (e) of this paragraph, the grounding conductor or conductors (see 5.1) and all of the circuit conductors of a flexible cord shall be of the same AWG size:

- a) Type SRD, SRDE, and SRDT cable in the No. 8 – 4 AWG sizes may contain either:

No Text on This Page

1. Two or three 8's and one 10, two or three 6's and one 8, or two or three 4's and one 6. In each case, the small conductor shall be the one with the grounded-conductor identification specified in 65.4.1 or 65.6.1, or
 2. Two 8's and two 10's, two 6's and two 8's, or two 4's and two 6's. In each case, one of the small conductors shall bear the grounded-conductor identification specified in 65.4.1 or 65.6.1 and the other small conductor shall be a grounding conductor and shall bear the identification specified in 67.1.
- b) For flexible cord or cable with conductor sizes 8 AWG and larger, the grounding conductor may be reduced by not more than two AWG sizes from the largest circuit conductor (eg, No. 8 AWG circuit conductor cord may have a minimum No. 10 AWG grounding conductor).
- c) Type E, EO, ETP, or ETT elevator cable may employ No. 20 – 2 AWG circuit conductors in the same cable. The circuit conductors in any layer may be of the same AWG size or of any mixture of AWG sizes. In addition, one or more twisted pairs of conductors that are no smaller than No. 20 AWG and are for use in telephone, audio, or higher-frequency communications circuits, and/or one or more coaxial cables may be included in any layer, or the cable may consist entirely of twisted pairs. Each twisted-pair used for telephone, audio, or higher-frequency communications circuits shall be insulated as indicated in 45.1.1 and covered with a shield as specified in 39.2– 39.6 and covered with a jacket having a wall of 60°C Class 1.2 CP, NBR/PVC, neoprene, or SBR/NR or of 60°C Class 1.7 PVC thermoplastic at least 13 mils or 0.33 mm thick at any point or of other material such as nylon or polyester at least 2 mils or 0.05 mm thick at any point. For Type ETP, when pairs are used and the shields are not in contact with each other or the circuit conductors, the jacket over the shielded pairs is optional and webs shall be provided between the support members, between pairs, and adjacent conductors or groups. A coaxial cable shall consist of a center conductor, insulation, shield, and an overall covering consisting of nylon (see 22.1) not less than 0.002 inch or 0.05 mm thick at any point or of a 60°C Class 1.7 PVC jacket having an average thickness of at least 20 mils or 0.51 mm and a minimum thickness at any point of at least 18 mils or 0.46 mm. An optical-fiber member shall comply with 8.5 (see also 1.2, 1.4, 8.6, 46.1.1, and 75.1 (g) and (h)). For Type ETP the assembly shall consist of two or more insulated conductors or group(s) of insulated conductors, laid in parallel to form a flat cable. One or more web(s) may be provided, composed of the same material as the jacket. Support members may be provided and placed in the center of the group(s) or other suitable position(s) and composed of material as outlined in 46.2.1. When support members are used outside of the group construction, the insulation on the steel members is optional and web(s) shall be provided between the support members and adjacent conductors or groups, in accordance with Table 28.5.
- d) In a Type SEW, SOW, SEOW, SOOW, SEOOW, STW, STOOW, or STOW cord containing two No. 18, 17, 16, or 15 AWG circuit conductors, a grounding conductor is not required but, if a grounding conductor is provided and if it is larger in size than the circuit conductors, the insulation on the grounding conductor shall be of at least the thickness indicated for the grounding-conductor size in Table 16.3, shall comply with 67.1, and in the case of a Type SEW, SEOOW, or SEOW cord, shall be of the same material or same class of material as the insulation on the circuit conductors and, in the case of a Type SOOW, STW, or STOW cord, shall be either of the same material as the insulation on the circuit conductors or of an acceptable class of material covered for cords in this Standard of equal or higher temperature rating. For the overall diameters of such cords with one No. 14 AWG grounding conductor, see note ^b to Tables 40.1 and 40.2. For the jacket thicknesses of such cords with one No. 14 AWG grounding conductor, see note ^b to Table 28.1.

e) The conductors of all types of cables and cords shall use flexible stranding, except as detailed under specific constructions. Mixed AWG sizes of circuit conductors shall be permitted for cords containing five or more circuit conductors. For flexible cord or cable with conductor sizes 10 AWG and smaller, the grounding conductor shall be the same size as the largest circuit conductor, except for Types SRD, SRDT, and SRDE where a No. 12 AWG grounding conductor is acceptable for use with No. 10 AWG circuit conductors, and for the outdoor cords as mentioned in item (d) above.

8.4 revised April 13, 2000

8.5 An optical-fiber member shall consist of either of the following:

a) One or more glass fibers that are individually coated and tight buffered and then are jacketed in any thickness with Class 2.4 insulation material or 60°C Class 1.2 jacketing material or with 60°C Class 2.9 PVC insulation or class 1.7 jacketing material or a nylon covering having a minimum thickness of 2 mils.

b) One or more glass fibers that are individually coated, optionally tight buffered, and then enclosed with or without a gel in a loose buffer tube. A loose buffer tube shall be of any thickness of one of the insulation or jacketing materials mentioned in (a), or shall be enclosed in a jacket of one of these materials in any thickness. The construction of the glass fiber, of the coating, and of a tight buffer are not specified. The construction of a loose buffer tube that is covered by a jacket is not specified. The gel is not specified. The construction of a nonmetallic tape, wrap, or braid is not specified. Non-current-carrying metal or other electrically conductive parts may be included in an optical-fiber member but an optical-fiber member shall not have any electrical elements. An optical-fiber member may include one or more strength elements.

8.6 The optical energy that any optical fiber in a cable may carry is necessarily limited to the levels ruled by the Food and Drug Administration (FDA) of the US Department of Health and Human Services as not constituting any risk of eye or other injury to people. To help protect electrical and optical cable installers, users, and service personnel, and anyone who may handle an optical portion of the cable after installation, 74.1(h) specifies a tag, reel, or carton marking that limits the optical energy carried to the Class I laser-radiation levels described in 21 CFR Part 1040.

8.7 Fixture wires and Type CXTW decorative-lighting wire shall be constructed only in even AWG conductor sizes. Flexible cords are acceptable in odd or even AWG sizes as indicated in index Tables 6.5 – 6.18 and, except that the metal conductors shall comply with the diameter, cross-sectional area, and other requirements applicable to the odd AWG size and shall have an ampacity determined by interpolation (by cross-sectional area) between the ampacities of the next larger and smaller even AWG sizes of that type of cord, the insulation, jacket, fillers, and the like, in cords of odd conductor sizes shall comply with all the requirements applicable to that type of cord having the next smaller even AWG conductor size (for example, cord with No. 15 AWG conductors shall comply with the requirements for cord with No. 16 AWG conductors) except where specifically stated otherwise.

9 Size Verification

Section 9 title revised March 13, 2001

9.1 All solid and stranded circuit and grounding conductors are to be identified as a particular AWG size in the markings [see 69.1, 69.5, and 74.1(e)] required on or in the wire, cable, or cord and on the tag, reel, or carton. The size of a solid conductor shall be verified either by determination of the d-c resistance or, for a round solid conductor, by determination of the cross-sectional area by measuring the average diameter as described in 9.2. The size of a stranded conductor shall be verified either by determination of the d-c resistance or by determination of the cross-sectional area as described in 9.3. Determination of the conductor size by measurement of the direct-current resistance as described in D-C Resistance Test, Section 49A, is the referee method in all cases. The sizes of the various types of wire, cable, and cord are indicated in Tables 6.1 – 6.21.

Portion of 9.1 revised March 13, 2001

9.2 Where measured as the means of size verification by cross-sectional area (see 9.1), the average diameter of a round solid conductor shall not be smaller than the minimum diameter indicated as 0.99 x nominal for the size in Table 20.1 of UL 1581. The average diameter of the conductor is to be determined and compared with the minimum in Table 20.1 in the following manner:

- a) Measurements of the diameter of a round solid conductor are to be made over the metal-coated or uncoated conductor by means of a machinist's micrometer caliper having flat surfaces both on the anvil and on the end of the spindle. The measurements are to be made at a single point on the conductor. The micrometer is to be calibrated to read directly to at least 0.001 inch or 0.01 mm, with each division of a width that facilitates estimation of each measurement to at least 0.0001 inch or 0.001 mm. The maximum and minimum diameters at that point are each to be recorded to the nearest 0.0001 inch (0.1 mil) or 0.001 mm, added together, and divided by 2 without any rounding of the sum or resulting average.
- b) Each minimum indicated in Table 20.1 of UL 1581 is absolute. The unrounded average of the two diameter readings is therefore to be compared directly with the minimum indicated as 0.99 x nominal in the table. Where the average diameter is smaller than the minimum in the table, the cross-sectional area of the round solid conductor does not comply as being that of the marked AWG size.

Portion of 9.1 revised and redesignated as 9.2 March 13, 2001

9.3 Where measured as the means of size verification (see 9.1), the cross-sectional area of a stranded conductor shall not be smaller than the minimum area indicated as 0.98 x nominal for the size in Table 20.1 of UL 1581. The cross-sectional area of a stranded conductor is to be determined as the sum of the areas of its component round strands. However, where the sum of the strand areas does not comply, the conductor area is to be determined by the weight method outlined in Conductor Cross-Sectional Area by the Weight Method, Section 210 of UL 1581.

9.2 revised and redesignated as 9.3 March 13, 2001

10 Continuity of Conductors

Section 10 effective July 2, 1998

10.1 Each of the conductors of a wire, cord or cable shall be connected in series with an ac or dc source of voltage less than 30 volts and a means of indicating an unbroken circuit (a lamp, bell, buzzer, or equivalent).

10.2 Operation of the indicator shall be evidence of the continuity of the conductor under test.

11 Stranding

Section 11 effective July 2, 1998

11.1 A flexible cord or fixture wire shall employ conductors having strands of the sizes specified in Table 11.1. The nominal dimensions of the strands are shown in Table 20.5 of UL 1581. The direction of the lay of the strands is not specified.

Table 11.1
Conductor stranding

Table 11.1 revised February 6, 2001

Types of cord and fixture wire	Conductor	AWG size of individual strands	
		Minimum	Maximum
PF, PGF, RFH-2, TF, SF-1, SF-2, TFN, XF, and Hoistway Cables ^f	Solid or 7-strand	—	—
TPT and TST	Tinsel	See 11.3	
SRD, SRDE, and SRDT	Flexible stranding	36	20 ^a
Nos. 18 – 14 AWG (see last item for other sizes) of Type SJ, SJE, SJO, SJEOO, SJEO, SJOO, SJT, SJTO, SJTOO, S, SE, SO, SEO, SEOO, SOO, ST, STOO, STO, SJEW, SJOW, SJEOOW, SJEOW, SJOOW, SJTW, SJTOW, SJTOOW, SEW, SOW, SEOW, SEOOW, SOOW, STW, STOOOW, and STOW	Flexible stranding	36	30
No. 22 AWG Type XTW and CXTW cord and wire	b	b	b
E, EO, ETT, ETP, SP-3, SPE-3, SPT-3, and No. 20 and 18 AWG Type XTW and CXTW cords, CXTW wire, and Hoistway Cables	Flexible stranding	36	30
Clock, SP-1, NISP-1, SPE-1, NISPE-1, SP-2, NISP-2, SPE-2, NISPE-2, SPT-1W, SPT-1, NISPT-1, SPT-2, NISPT-2, SPT-2W, SV, SVE, SVEO, SVOO, SVO, SVT, SVTO, SVTOO, HPD, HSJ, HSJO, and HPN	Flexible stranding	36 ^e	34 ^c
SP-3, SPE-3, and SPT-3, in size Nos. 10 and 12 AWG, and all other types and sizes ^d	Flexible stranding	36	26

Table 11.1 Continued on Next Page

Table 11.1 Continued

Types of cord and fixture wire	Conductor	AWG size of individual strands	
		Minimum	Maximum
<p>^a Type SRD, SRDE, and SRDT range and dryer cable may employ concentric stranding consisting of 19 strands of solid copper wire. Strands larger than No. 20 AWG are acceptable in the Nos. 6 and 4 AWG sizes of the cable employing 19-strand concentric conductors.</p> <p>^b The temper, number, size, and length of lay of the strands are to be judged based on the performance of the finished wire or cord in the abrasion and flexing tests described in 61.1 and 62.1.</p> <p>^c Type SP-2, NISP-2, SPE-2, NISPE-2, SPT-2 (but not Type SPT-2W), NISPT-2, may employ No. 30 AWG strands if the marking specified in 74.3 is provided.</p> <p>^d No. 23 and 25 AWG strands, respectively, may be employed in No. 2 and 4 AWG sizes of Type S, SE, SO, SEO, SEOO, ST, STO, STOO, SEW, SOW, SEOW, SEOOW, SOO, SOOW, STW, STOW, and STOOW cables, in accordance with the stranding requirements in 11.2.</p> <p>^e No. 20 AWG Types SP-1, SPT-1, and SPE-1 may employ a minimum strand size of No. 40 AWG.</p> <p>^f Hoistway Cable may also employ flexible stranding.</p>			

11.2 A flexible conductor, other than a tinsel conductor, shall be bunch stranded or rope-lay stranded except that the conductors of Type SRD, SRDE, and SRDT cables may be concentric stranded, and the conductors of Type S, SE, SO, SEO, SOO, SEOO, STO, STOO, ST, SEW, SOW, SEOW, SOOW, SEOOW, STOW, STOOW, and STW cords in No. 6 AWG and larger sizes shall be rope-lay stranded. The length of lay of the strands of a No. 18 AWG or larger conductor shall be in accordance with Table 11.2 or 11.3, except that the length of lay of the strands of a 7-strand fixture wire shall not be more than 48 times the diameter of an individual strand. The length of lay of the strands of a No. 20 AWG conductor shall not be more than 1.25 inches or 32 mm. The maximum acceptable length of lay of the strands of a No. 24 or 22 AWG conductor is to be based on the performance of the finished Type XTW and CXTW cord or wire in the abrasion and flexing tests described in 61.1 and 62.1.

Revised 11.2 effective October 13, 2000

11.3 Each conductor in a Type TPT or TST tinsel cord shall be one of the styles indicated in (a) – (f). The resistance of each individual conductor, measured straight (not twisted) at a temperature of $23.0 \pm 3.0^{\circ}\text{C}$ ($73.4 \pm 5.4^{\circ}\text{F}$), shall not be more than 8 ohms per 100 ft or 5.25 ohms per 20 m.

- a) An assembly of 18 strands, which shall consist of three groups having a rope lay, each group consisting of six strands, and each strand consisting of a flattened No. 39 AWG annealed copper wire wrapped around a core of No. 30 two-ply cotton thread, or equivalent fibrous material.
- b) An assembly of six strands, which shall have a rope lay around a center core of No. 10 three-ply cotton thread, or equivalent. Each strand shall consist of two flattened No. 37 AWG annealed copper wires wrapped around a core of No. 20 three-ply cotton thread, or equivalent.
- c) An assembly of seven strands, in the form of six strands having a rope lay about the seventh. Each strand consists of two flattened No. 38 AWG annealed copper wires wrapped concentrically around a No. 270 denier fortisan thread.
- d) An assembly of 18 strands consisting of six groups having a rope lay and each group consisting of three strands. Each strand consists of a flattened No. 39 AWG annealed copper wire wrapped around a core of No. 50 two-ply cotton thread, or equivalent.

e) An assembly of seven strands, in the form of six strands having a rope lay about the seventh. Each strand consists of two flattened No. 37 AWG cadmium copper wires wrapped concentrically around a core of No. 250 denier polyester fiber thread, or equivalent.

f) An assembly of seven or more strands, each consisting of a flattened copper wire no larger than No. 35 AWG and no smaller than No. 39 AWG, and having a total cross-sectional area of no less than 198 cmil or 0.100 mm (No. 27 AWG). The construction and arrangement of the strands is not specified, but the finished cord shall be acceptable for the purpose, as determined by an investigation that includes a flexibility test.

11.3 revised February 6, 2001

11.4 A No. 20 AWG or smaller flexible cord having tinsel conductors not complying with 11.3 (a) – (f) or having a stranded copper construction may be used as shaver cord without any type–letter designation if it is acceptable for the purpose as determined by an evaluation that includes a flexibility test.

Table 11.2
Maximum acceptable length of lay of conductor strands or stranded members in inches

Table 11.2 revised March 13, 2001

Bunch stranding				Bunch, rope-lay ^b or concentric-lay stranding in Type SRD, SRDE and SRDT cords	Members of rope-lay of stranded assemblies ^b in flexible cords ^a	Bunch or rope-lay stranding in Type HPN cord
AWG size of conductor	Flexible cords ^a	Types SFF-1, SFF-2, PFF, PGFF, and PTFE	All others			
18	1.25	1.00	2.00	–	1.75	1.00
17	1.25	–	–	–	1.75	1.00
16	1.50	1.25	2.00	–	2.25	1.25
15	1.50	–	–	–	2.25	–
14	1.75	1.62	2.00	–	2.50	1.62
12	2.00	–	2.00	–	3.00	2.00
10	2.50	–	2.50	2.50	3.00	–
8	2.75	–	–	3.00	3.00	–
6	–	–	–	3.50	3.50	–
4	–	–	–	4.00	4.50	–
2	–	–	–	c	5.50	–

^a Other than Type HPN, SRD, SRDE, and SRDT cords.

^b The length of the lay of individual strands comprising each concentric-stranded member in a rope-lay conductor shall neither be less than 8 nor more than 16 times the overall diameter of the member. The length of lay of the individual strands comprising each bunch-stranded member in a rope-lay conductor shall not be more than 30 times the overall diameter of the member.

^cFor bunch stranding 16 times the diameter of the conductor.

Table 11.3
Maximum acceptable length of lay of conductor strands or stranded members in millimeters

Table 11.3 revised March 13, 2001

AWG size of conductor	Bunch stranding			Bunch, rope-lay ^b or concentric-lay stranding in Type SRD, SRDE, and SRDT cords	Members of rope-lay of stranded assemblies ^b in flexible cords ^a	Bunch or rope-lay stranding in Type HPN cord
	Flexible cords ^a	Types SFF-1, SFF-2, PFF, PGFF, and PTFE	All others			
18	32	25	51	—	44	25
17	32	—	—	—	44	25
16	38	32	51	—	57	32
15	38	—	—	—	57	—
14	44	41	51	—	64	41
12	51	—	51	—	76	51
10	64	—	64	64	76	—
8	70	—	—	76	76	—
6	—	—	—	89	89	—
4	—	—	—	102	114	—
2	—	—	—	—	140	—

^a Other than Type HPN, SRD, SRDE, and SRDT cords.

^b The length of the lay of individual strands comprising each concentric-stranded member in a rope-lay conductor shall neither be less than 8 nor more than 16 times the overall diameter of the member. The length of lay of the individual strands comprising each bunch-stranded member in a rope-lay conductor shall not be more than 30 times the overall diameter of the member.

^cFor bunch stranding 16 times the diameter of the conductor.

12 Metal Coating

Section 12 effective July 2, 1998

12.1 If the insulation adjacent to a conductor of copper or of a copper-base alloy is of a material that corrodes unprotected copper in the test described in 500.1 of UL 1581, and if a protective separator is not provided, the solid conductor and each of the individual strands of a stranded conductor shall be

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separately covered with a coating of tin complying with ASTM B 33-91, of a tin/lead alloy complying with ASTM B 298-87, or of another metal or alloy (evaluation required). In a Type SF-1, SF-2, SFF-1, or SFF-2 silicone-rubber-insulated fixture wire, the conductor of each of the individual wires of the conductor, if stranded, shall be tinned or acceptably metal-coated in any case, and no separator is required.

12.2 If the insulation adjacent to a conductor is not of a material that corrodes unprotected copper in the test in 500.1 of UL 1581, and regardless of whether a separator is provided, the wire or all of the individual wires of the conductor, if stranded, may be metal-coated. If so coated, the metal used for the coating shall comply with 7.2 and the solid conductor or each individual strand shall be acceptably and separately metal-coated.

13 Separator

Section 13 effective July 2, 1998

13.1 If the insulation adjacent to an untinned or uncoated conductor is of a material that corrodes unprotected copper in the test described in 500.1 of UL 1581, a protective separator shall be provided between the conductor and the insulation.

13.2 A separator when provided, is not required to cover the conductor completely unless it is required to pass the conductor corrosion test specified in 500.1 of UL 1581. It shall be of a color contrasting to that of a conductor, except clear or green or green/yellow shall not be used. The separator shall consist of:

- a) A close spiralling of fine fibrous yarn, paper, cellophane, or polyester tape;
- b) A braid of fine fibrous yarn; or
- c) A longitudinally applied wrap of paper, cellophane, or polyester.

13.2 revised April 13, 2000

14 Joints

Section 14 effective July 2, 1998

14.1 A joint in a solid conductor or in one of the individual wires of a stranded conductor shall be made in a workmanlike manner and shall not affect the diameter of the configuration of the conductor or the individual wire. A joint shall not be made in a stranded conductor as a whole, but, in a rope-lay stranded conductor, a stranded member (primary group) may be considered equivalent to a solid wire and, as such, is acceptable spliced as a unit. These joints are not to be any closer together than two lay lengths.

CONDUCTOR INSULATION

15 Material and Application

Section 15 effective July 2, 1998

15.1 A conductor shall be insulated for its entire length with the insulation specified for type in index Tables 6.1 – 6.21. For flexible cords, elevator cables, and hoistway cables, the insulation classes referenced in Tables 6.5 to 6.21 are listed in Table 15.1, and their properties are given in Table 15.2 of this Standard. For other wire types covered by this Standard, class references are to UL 1581. Thermoplastic insulation shall not be used under a jacket of thermoset material. The insulation shall be applied directly to the surface of the conductor or to any separator, shall cover the conductor or any separator completely, and shall not have any defects that are visible with normal or corrected vision without magnification.

Table 15.1
Classes of insulation materials for flexible cords, elevator cables, and hoistway cables

Class Number	Temperature rating (°C)	Material Type
2.4	60	SBR/NR, EP
2.5	90	CPE, CP, NBR/PVC
2.5A	90	EP
2.9	60	PVC
2.11	105	PVC
2.13	90	XL
2.14	105	XL
2.15	90	Neoprene
2.16	105	CP, CPE
2.17	90	Neoprene
2.20	105	TPE
2.22	90	PVC
2.23A	105	EP
2.24	150, 200	FEP
2.25	60	Neoprene, CP, NBR/PVC
2.26	75	LDPE
2.28	90	TPE
2.29	75	PVC
2.30	75	EP, SBR/NR

Legend	
CP	Chlorosulfonated Polyethylene
SBR/NR	Styrene-butadiene rubber/natural rubber or blend thereof
NBR/PVC	Crosslinked compound with acrylonitrile butadiene rubber and PVC
Neoprene	Polychloroprene
CPE	Chlorinated Polyethylene
EP	Ethylene Propylene Rubber
PVC	Polyvinyl Chloride
TPE	Thermoplastic Elastomer
FEP	Fluorinated Ethylene Propylene
LDPE	Low Density Polyethylene
XL	Crosslinked Synthetic Polymer

Table 15.2
Insulation properties

Table 15.2 revised April 13, 2000

Class	Physical properties initial		Air oven aging test				Oil immersion test ⁺			
	min.				Min. % of before aging requirement				Min. % of before aging requirement	
	Elong. %	Tensile strength lb/in ²	Oven temp (°C ±2)	Time d	Elong. %	Tensile str., %	Oil temp. (°C±2)	Time h	Elong.%	Tensile str., %
2.4	200	500	70	7	70	70	NA‡			
2.5	200	1200	110	10	50	50	NA‡	18*	60*	60*
2.5A	200	500	110	10	50	50	NA‡			
2.9	100	1500	100	7	65	85	NA‡			
2.11	100	1500	136	7	65	85	NA‡			
2.13	150	1500	121	7	45	70	NA‡			
2.14	150	1500	136	7	45	70	NA‡			
2.15	200	1200	110	10	50	50	NA‡	18*	60*	60*
2.16	200	1200	136	7	50	50	NA‡	18*	60*	60*
2.17	200	500	100	10	50	50	NA‡			
2.20	200	800	136	7	75	75	NA‡			
2.22	100	1500	121	7	65	85	NA‡			
2.23A	200	500	136	7	50	50	NA‡			
2.24	200	2500	232	7	75	75	NA			
2.25	200	1200	70	7	65	75	NA‡			
2.26	350	1400	100	2	75	NA	NA‡			
2.28	200	800	121	7	75	75	NA‡			
2.29	100	1500	100	10	65	85	NA‡			
2.30	200	600	100	10	50	50	NA‡			

‡ An oil-resistant insulation may be incorporated in a finished jacketed cord by subjecting the insulation to the same oil test specified in Table 27.2 for the jacket being used. Cords having both insulations and jacket materials meeting the oil resistant test shall be marked accordingly.

* Required for HPN only.

+ Oil tests are required on products with an "OO" in the type designation.

15.2 The insulation may be applied simultaneously in more than one color/layer provided that all layers are not separable and are of the same base compound (differ only in color). The thickness of each individual layer is not specified.

15.3 If a flexible cord or cable employs a grounding conductor (see 68.1), the insulation on that conductor, except as noted for certain parallel cords in 16.3.3.2 and 16.3.3.3, shall be of the same thickness as the insulation on the other conductors.

15.4 The insulation on a grounding conductor, in the case of a Type SPE-1, NISPE-1, SPE-2, NISPE-2, SRDE, SVE, SJE, SJEW, SE, SEW, SVEO, SJEO, SJEOW, SJEOO, SJEOOW, SEO, SEOW, SEOO, or SEOOOW cord, shall be of the same material as the insulation on the other conductors. In the case of any other cord or cable in which a grounding conductor is acceptable and is used, the insulation on a grounding conductor shall be of:

- a) The same material or same class of material as the insulation on the other conductors or
- b) A class of insulation material that is covered in this Standard and is of a kind (thermoplastic or thermoset) complying with 15.1 and of a temperature rating equal to or higher than the temperature rating of the insulation on the other conductors.

Revised 15.4 effective April 13, 1999

15.5 Insulation and jacket material of a kind not covered in this Standard for the intended use shall be investigated in accordance with 15.6. Insulation and jacket material of a kind covered by this Standard, but not in compliance with the short-term aging retention requirements, may also be investigated in accordance with 15.6.

15.6 Insulation and jacket materials that are generically different from those named in the index tables in Index Tables, Section 6, or that do not comply with the applicable short-term tests, are acceptable if the materials, thicknesses, and temperature ratings of the materials are applicable to the intended use. The material shall be evaluated for the requested temperature rating as described in Long-Term Aging, Section 481 of UL 1581. Investigation of the electrical, mechanical, and physical characteristics of the construction using the new material shall show the new material to be comparable in performance to the materials indicated for the application in Index Tables, Section 6. Crushing, impact, abrasion, deformation, heat shock, dielectric withstand, insulation resistance, and other tests may be part of the evaluation.

16 Thicknesses of Insulation

Section 16 effective July 2, 1998

16.1 General

16.1.1 The thickness of the insulation on an individual conductor shall be as specified in Tables 6.1 – 6.21 for the particular type and size of wire or flexible cord. The thicknesses for hard-service and extra-hard-service cords are summarized in Tables 16.2 and 16.3, the thicknesses for parallel cords are summarized in Tables 16.4 – 16.7, and the thicknesses for Type CXTW cord and wire are summarized in Table 16.8.

16.2 Thermoset and thermoplastic

16.2.1 The minimum acceptable thickness at any point of thermoset or thermoplastic, conductor insulation, corresponding to any specified minimum acceptable average thickness, shall be as indicated in Table 16.1 when measured as described in Thicknesses of Insulation on Flexible Cord and on Fixture Wire, Section 250 of UL 1581.

Table 16.1
Insulation thickness

Mils		mm	
Specified minimum acceptable average thickness	Minimum acceptable thickness at any point	Specified minimum acceptable average thickness	Minimum acceptable thickness at any point
15.0	13.0	0.38	0.33
20.0	18.0	0.51	0.46
23.0	21.0	0.58	0.53
30.0	27.0	0.76	0.69
45.0	40.0	1.14	1.02
60.0	54.0	1.52	1.37

16.3 Parallel Cord Types SP-1, NISP-1, SP-2, NISP-2, SP-3, SPE-1, NISPE-1, SPE-2, NISPE-2, SPE-3, SPT-1, NISPT-1, SPT-2, NISPT-2, SPT-1W, SPT-2W, SPT-3, HPN, TPT, Shaver, and Clock Cord

16.3.1 General

16.3.1.1 Type SP-1, NISP-1, SP-2, NISP-2, SP-3, SPE-1, NISPE-1, SPE-2, NISPE-2, SPE-3, SPT-1, NISPT-1, SPT-2, NISPT-2, SPT-1W, SPT-2W, SPT-3, HPN, TPT, shaver, and clock cord shall be of the parallel construction illustrated in the applicable Figure 16.1, 16.2, 16.3, 16.4, or 16.5 with dimensions as specified in the corresponding applicable Table 16.4, 16.5, 16.6, or 16.7. The nonintegral type involves the use of a separate jacket and conductor insulation that may or may not be of a different compound. The integral type is a combination of conductor insulation and jacket involving the use of a single layer of insulation that is a single compound. In Figures 16.3 – 16.5, which illustrate cords of the integral construction, a straight dotted line is drawn vertically through the web between conductors to indicate the theoretical line of tearing, but it is to be understood that a cord of this type does not necessarily tear apart exactly at the center. As indicated in Figure 16.5 and Table 16.7, some shaver cord is not intended for tearing.

Revised 16.3.1.1 effective April 13, 1999

16.3.1.2 Type SP-1, NISP-1, SP-2, NISP-2, SPE-1, NISPE-1, SPE-2, NISPE-2, SPT-1, NISPT-1, SPT-2, or NISPT-2 cords in the construction with three circuit conductors and without a grounding conductor may be acceptable for restricted use in a particular application if they are constructed in accordance with 16.3.2.1 and 16.3.3.1 and if they are marked as specified in 75.2. See Figures 16.1 and 16.3 and Tables 16.4 and 16.5

Revised 16.3.1.2 effective April 13, 1999

Table 16.2
Thicknesses of conductor insulation in hard-service cords

Type(s) of cord	Circuit conductor size(s)	Minimum acceptable average thickness		Minimum acceptable thickness at any point ^a	
		Mils	mm	Mils	mm
SJ, SJOO, SJO, SJOOW, and SJOW	18 – 12 AWG 10	30.0	0.76	27.0	0.69
		45.0	1.14	40.0	1.02
SJE, SJEO, SJEOO, SJEW, SJEOW, and SJEOOW	18 – 12 10	30.0	0.76	27.0	0.69
		45.0	1.14	40.0	1.02
SJT, SJTOO, SJTO, SJTW, SJTOOW, and SJTOW	18 – 12 10	30.0	0.76	27.0	0.69
		45.0	1.14	40.0	1.02

^a 80% of minimum average acceptable only at the line of contact between conductors.

Table 16.3
Thicknesses of conductor insulation in extra-hard service cords

Type(s) of cord	Circuit conductor size(s)	Minimum acceptable average thickness		Minimum acceptable thickness at any point ^a	
		Mils	mm	Mils	mm
S, SOO, SO, SOOW, and SOW	18 – 15 AWG	30.0	0.76	27.0	0.69
	14 – 10	45.0	1.14	40.0	1.02
	8 – 2	60.0	1.52	54.0	1.37
SE, SEO, SEOO, SEW, SEOW, and SEOWW	18 – 15	30.0	0.76	27.0	0.69
	14 – 10	45.0	1.14	40.0	1.02
	8 – 2	60.0	1.52	54.0	1.37
ST, STOO, STO, STW, STOWW, and STOW	18 – 15	30.0	0.76	27.0	0.69
	14 – 10	30.0	0.76	27.0	0.69
		45.0	1.14	40.0	1.02
8 – 2	45.0	1.14	40.0	1.02	
		60.0	1.52	54.0	1.37

^a 80% of minimum average acceptable only at the line of contact between conductors

16.3.2 Nonintegral construction

16.3.2.1 The jacket shall be made integral with the web or webs, which shall extend through the assembly between the two or three separately insulated circuit conductors. See 27.1, Figure 16.1, and Table 16.4.

16.3.2.1 revised April 13, 2000

Table 16.4

Thickness of insulation and jacket and distance between insulated conductors in Types NISP-1, NISP-2, NISPE-1, NISPE-2 and NISPT-2 with three circuit conductors without a grounding conductor, and with two circuit conductors with or without a grounding conductor

Table 16.4 revised April 13, 2000

Types of cord	Minimum acceptable average thickness of insulation A ^a		Minimum acceptable thickness at any point of insulation B ^a		Minimum acceptable average thickness of jacket C ^a		Minimum acceptable thickness at any point of jacket D ^a		Minimum acceptable distance between insulated conductors E ^a	
	Mils	mm	Mils	mm	Mils	mm	Mils	mm	Mils	mm
NISPT-1, NISP-1, NISPE-1	15.0	0.38	13.0	0.33	15.0	0.38	13.0	0.33	15.0	0.38
NISPT-2, NISP-2, NISPE-2	30.0	0.76	27.0	0.69	15.0	0.38	13.0	0.33	20.0	0.51

^a Dimensions A – E are illustrated in Figure 16.1.

Table 16.5

Thickness of insulation and jacket and distance between copper conductors in integral Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2 with three circuit conductors and without a grounding conductor

Types of cord	AWG size of conductors	Nominal away from tear areas (vertical dashed lines through webs in Figure 16.3) and outside point Figure 16.2) A ^a		Minimum acceptable at any point before separation measured outside Point P or X (defined in Figure 16.2) B ^a		Minimum acceptable at any point after separation C ^a		Minimum acceptable distance between copper conductors D ^a	
		Mils	mm	Mils	mm	Mils	mm	Mils	mm
SP-1, SPE-1, SPT-1	18	30.0	0.76	27.0	0.69	13.0	0.33	45.0	1.14
SP-2, SPE-2 SPT-2	18 – 16	45.0	1.14	40.0	1.02	27.0	0.69	80.0	2.03

^a Dimensions A – D are illustrated in Figure 16.3. Dimensions A is included for information only; it is not a requirement.

Table 16.6
Thicknesses of insulation and jacket and distance between copper conductors in integral Types SP-1, SP-2, SP-3, SPE-1, SPE-2, SPE-3, SPT-1, SPT-2, SPT-3, and HPN with two circuit conductors with or without a grounding conductor and integral Types SPT-1, SPT-2W with two circuit conductors and without a grounding conductor

Types of cords	Size of conductors	Nominal away from (vertical dashed line or lines through web or webs in Figure 16.4) and outside Point P or X (defined in Figure 16.2)		Minimum acceptable at any point before separation measured outside Point P or X (defined in Figure 16.2)		Minimum acceptable at any point after separation C ^a		Minimum acceptable distance between copper conductors D ^a				Thicknesses of jacket over grounding conductor insulation before separation			
		Mils	mm	Mils	mm	Mils	mm	Mils	mm	Mils	mm	Mils	mm	Mils	mm
SP-1, SPE-1, SPT-1W, and SPT-1	20 – 18 AWG	30.0	0.76	27.0	0.68	13.0	0.33	27.0	0.68	45.0	1.14	15	0.38	13	0.33
SP-2, SPE-2, SPT-2, SPT-2W, and HPN	18 – 16	45.0	1.14	40.0	1.01	27.0	0.68	40.0	1.01	80.0	2.03	15	0.38	13	0.33
SP-3, SPE-3, and SPT-3	18 – 16	60.0	1.52	54.0	1.37	40.0	1.01	54.0	1.37	110.0	2.79	15	0.38	13	0.33
HPN	15, 14	60.0	1.52	54.0	1.37	27.0	0.68	40.0	1.01	80.0	2.03	15	0.38	13	0.33
SP-3, SPE-3, and SPT-3	14	80.0	2.03	72.0	1.83	40.0	1.01	54.0	1.37	110.0	2.79	15	0.38	13	0.33
SP-3, SPE-3, SPT-3 and HPN	12	95.0	2.41	86.0	2.18	40.0	1.01	54.0	1.37	110.0	2.79	15	0.38	13	0.33

Table 16.6 Continued on Next Page

Table 16.6 Continued

Types of cords	Size of conductors	Nominal away from tear area(s) (vertical dashed line or lines through web or webs in Figure 16.4) and outside Point P or X (defined in Figure 16.2)		Minimum acceptable at any point before separation measured outside Point P or X (defined in Figure 16.2)		Minimum acceptable at any point after separation		Minimum acceptable distance between copper conductors				Thicknesses of jacket over grounding conductor insulation before separation			
		Mils	mm	Mils	mm	Mils	mm	Mils	mm	With grounding conductor	Without grounding conductor	Mils	mm	Mils	mm
SP-3, SPE-3, and SPT-3	10	110.0	2.79	99.0	2.51	40.0	1.01	54.0	1.37	110.0	2.79	15	0.38	13	0.33

^a Dimensions A – F are illustrated in Figure 16.4. Dimension A is included for information only; it is not a requirement

Table 16.7
Thicknesses of insulation and distance between copper conductors in integral parallel Types TPT, XTW, shaver, and clock cords with two circuit conductors and without a grounding conductor

Revised Table 16.7 effective October 13, 2000

Types of cord	AWG size of conductors	Insulation						Minimum acceptable distance between copper conductors $D^a = 1.5 \times A$ mils	
		Nominal away from tear area (vertical dashed lines through webs in Figure 16.5) and outside Point P or X (defined in Figure 16.2) A^a		Minimum acceptable at any point before separation measured outside Point P or X (defined in Figure 16.2) $B^a = 0.9 \times A$ mils		Minimum acceptable at any point after separation C^a			
		Mils	mm	Mils	mm	Mils	mm	Mils	mm
XTW ^c	22, 20, 18	30.0	0.76	27.0	0.69	13.0	0.33	45.0	1.14
TPT, shaver cord	27	30.0	0.76	27.0	0.69	13.0 ^b	0.33 ^b	45.0	1.14
Clock cord	20	30.0	0.76	27.0	0.69	13.0	0.33	45.0	1.14

^a Dimensions A – D are illustrated in Figure 16.5. Dimension A is included for information only; it is not a requirement.
^b Inapplicable in the case of shaver cord not having valleys. The conductors of such cord are not intended to be separated. See Figure 16.5.
^c Type XTW cords having more than 2 conductors have the same dimensional requirements with dimension "D" existing between each conductor (see Figure 16.6 for a 3-conductor design).

Table 16.8
Thicknesses of conductor insulation in Type CXTW cord (twisted pair) and in Type CXTW wire

Type	AWG size of circuit conductor(s)	Minimum acceptable average thickness	Minimum acceptable thickness at any point
CXTW cord and wire	22, 20, 18	Mils	
		30.0	27.0
CXTW cord and wire	22, 20, 18	mm	
		0.76	0.69

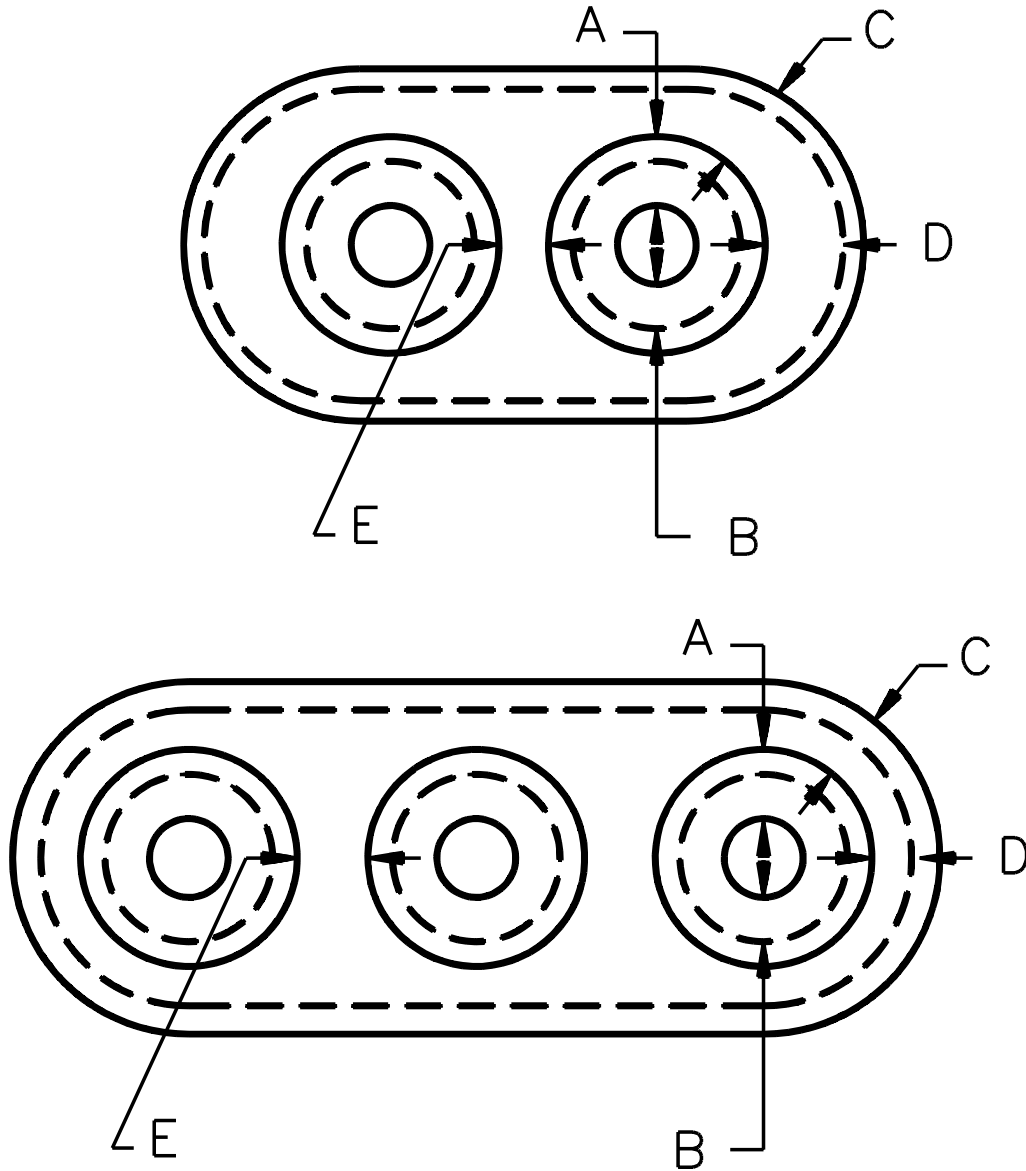
16.3.3 Integral construction

16.3.3.1 The construction of a cord of the integral type shall enable the integrally insulated circuit conductors and any grounding conductor (individually insulated) to be separated readily for any desired distance when slit at the end and intentionally torn apart. The construction shall also keep the integrally insulated circuit conductors and any grounding conductor (individually insulated) from being separated readily by any other manipulation.

16.3.3.2 Type SP-1, SP-2, SPE-1, SPE-2, SPT-1, SPT-2, SP-3, SPE-3, SPT-3, or HPN cord with a grounding conductor shall employ the construction with two integrally insulated circuit conductors to which a centrally located, nonintegrally insulated grounding conductor of the same AWG size as the two circuit conductors is added. As illustrated in Figure 16.4, the integral circuit-conductor insulation shall be extended to provide a jacket of at least 15 mils or 0.38 mm average thickness and at least 13 mils or 0.33 mm minimum thickness at any point over the nonintegral insulation on the grounding conductor in Type SP-1, SPE-1, SPT-1, SP-2, SPE-2, SPT-2, SP-3, SPE-3, SPT-3, and HPN cord.

Figure 16.1
Nonintegral parallel cord types NISP-1, NISP-2, NISPE-1, NISPE-2, NISPT-1 and NISPT-2 with two or three circuit conductors without a grounding conductor, or with two circuit conductors with a grounding conductor

Figure 16.1 revised April 13, 2000

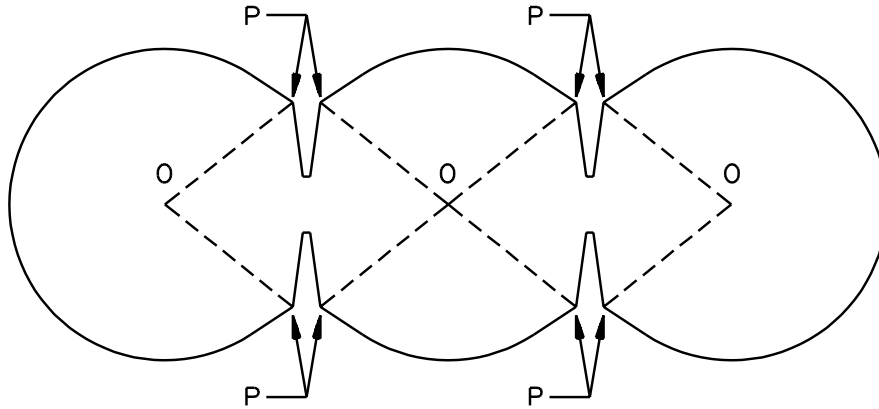


SB0636-1

See Table 16.4 for dimensions A – E.

See 16.3.1.2 for restrictions on cords with three circuit conductors.

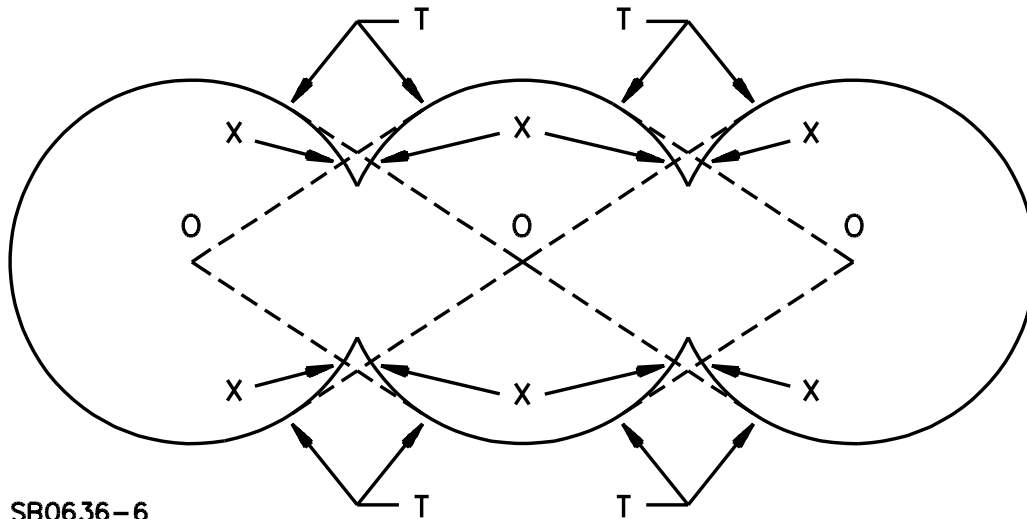
Figure 16.2
Definition of regions of valley slopes on which thickness measurements are not to be made in integral parallel cords and cables



SB0636-5

Constructions with a cross section having a definite Point P at the outer end of each valley slope

OP in each case is a straight line from the center O of a conductor to P on the same segment of the cross section. Thickness measurements are not to be made on any valley slope.

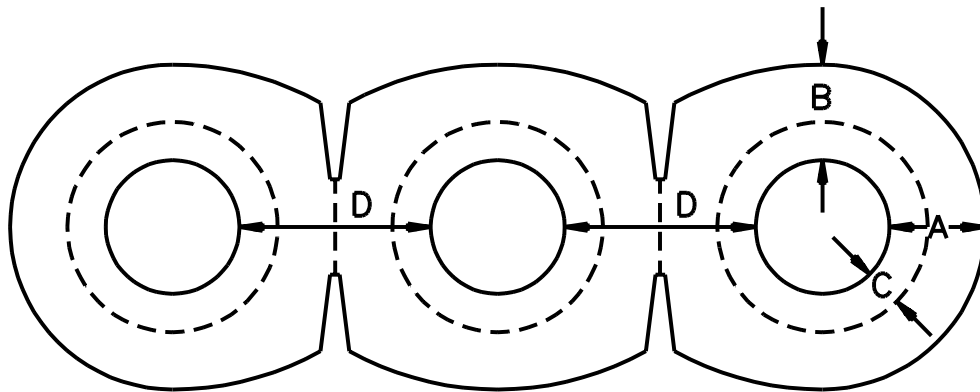


SB0636-6

Constructions with a cross section not having a definite Point to mark the outer end of each valley slope

OT in each case is a straight line from the center O of a conductor to T, the point of tangency, on the adjacent segment of the cross section. Thickness measurements are not to be made deeper on a valley slope than point X, which is the intersection of the line OT with the valley slope. Thickness measurements are to be made on each slope segment TX.

Figure 16.3
Integral parallel cord Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2 with three circuit
conductors and without a grounding conductor



SB0636-2

See Table 16.5 for dimensions A – D.

See 16.3.1.2 for restrictions on cords with three circuit conductors.

16.3.3.3 The grounding conductor mentioned in 16.3.3.2 shall have insulation of at least 15 mils or 0.38 mm average and at least 13 mils or 0.33 mm minimum at any point of a compound having a green outer surface with or without one or more straight or helical unbroken yellow stripes that occupy a total width of 5 – 70 percent of the calculated circumference of the finished conductor and no less individual width than 5 percent of the calculated circumference of the finished outer surface (the width is to be measured perpendicular to each stripe not necessarily around the conductor circumference).

16.3.3.4 In Type SPE-1, SPE-2, or SPE-3 cord, the green grounding-conductor insulation with or without one or more yellow stripes (see 16.3.3.3) shall be as specified for the circuit conductors.

16.3.3.5 In Type SP-1, SP-2, SPT-1, SPT-2, SP-3, or SPT-3 cord, the green grounding conductor insulation with or without one or more yellow stripes (see 16.3.3.3) shall be as specified for the circuit conductors or shall be of a class of material covered in this Standard of equal or higher temperature rating.

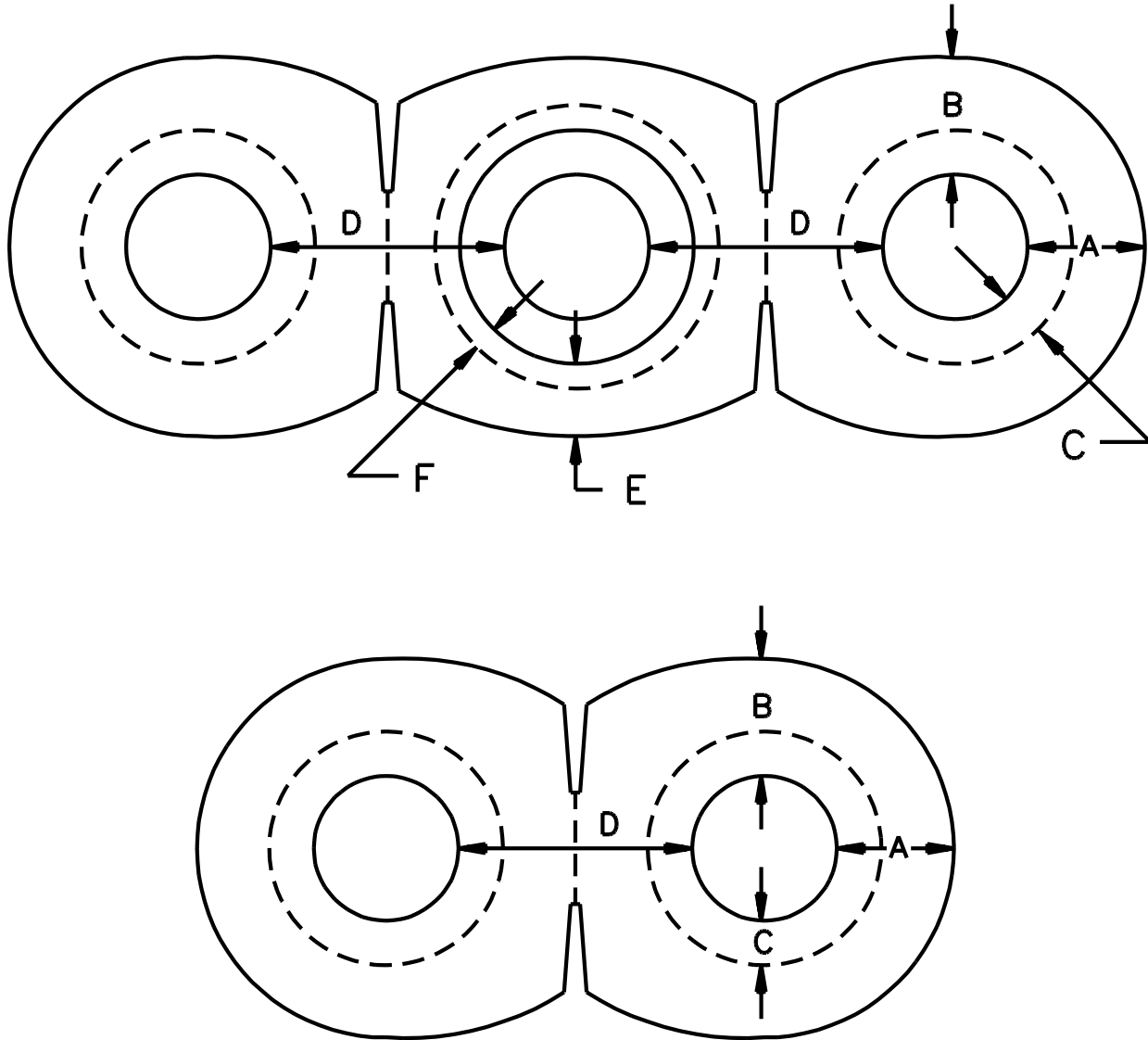
16.3.3.6 In Type HPN cord, a thermoset compound that is covered in this Standard and is rated for at least the temperature rating for the cord shall be employed as the insulation on the grounding conductor. See also 15.1.

16.3.3.7 Before assembly into the flexible cord, the insulation on any grounding conductor used shall withstand the application of a 3000-V spark test made as described in 900.1 – 900.12 of UL 1581.

16.3.3.8 The green grounding conductor with or without one or more yellow stripes shall be separable from two insulated circuit conductors in a manner that enables the green or green and yellow to be visible throughout the torn section. The means of providing for that separation is not specified.

Figure 16.4
Integral parallel cord Types SP-1, SP-2, SP-3, SPE-1, SPE-2, SPE-3, SPT-1 SPT-2, SPT-3, and HPN
with two circuit conductors with or without grounding conductor and Types SPT-2W and
SPT-1W with two circuit conductors and without a grounding conductor

Figure 16.4 title revised October 13, 1998



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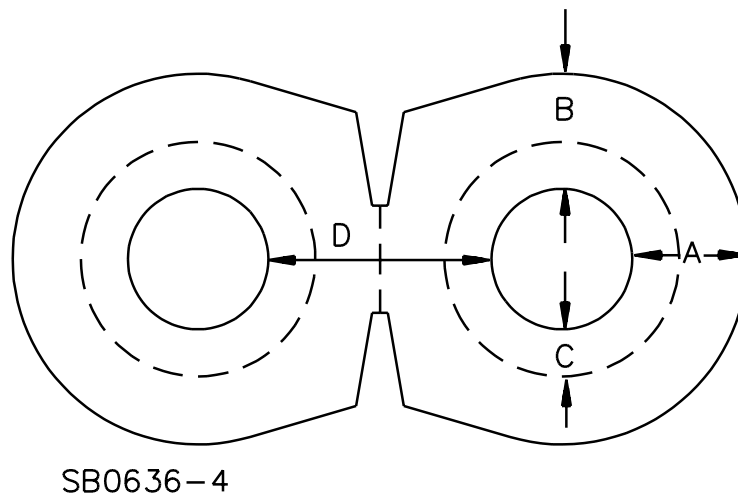
See Table 16.6 for dimensions A – F.

See 16.3.3.3 for thickness of the grounding-conductor insulation.

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Figure 16.5
Integral parallel cord Types TPT, XTW, shaver and clock with two circuit conductors and without a grounding conductor

Figure 16.5 revised October 13, 1998



Shaver cord (see note ^b to Table 16.7) is acceptable with valleys but valleys are not required and may be replaced with shallow grooves intended only for appearance.

16.4 Three-conductor integral Types SRD, SRDE, and SRDT range and dryer cables

16.4.1 The construction and dimensions of the cable shall be as indicated in Figure 16.6. The thickness (see A in Figure 16.6) of the complete insulation shall not be less than 0.100 inch or 2.54 mm at any point outside the point P or X (defined in Figure 16.2) in the groove or valley between the conductors. The thickness B of the web (the distance between copper conductors) shall not be less than 0.110 inch or 2.79 mm at any point. The thickness C of the insulation on any conductor at any point after separation shall not be less than 0.041 inch or 1.04 mm. The center conductor shall be used as the grounded circuit conductor (see marking requirement in Section 65) if the center conductor is smaller (see 8.4) than the other two conductors.

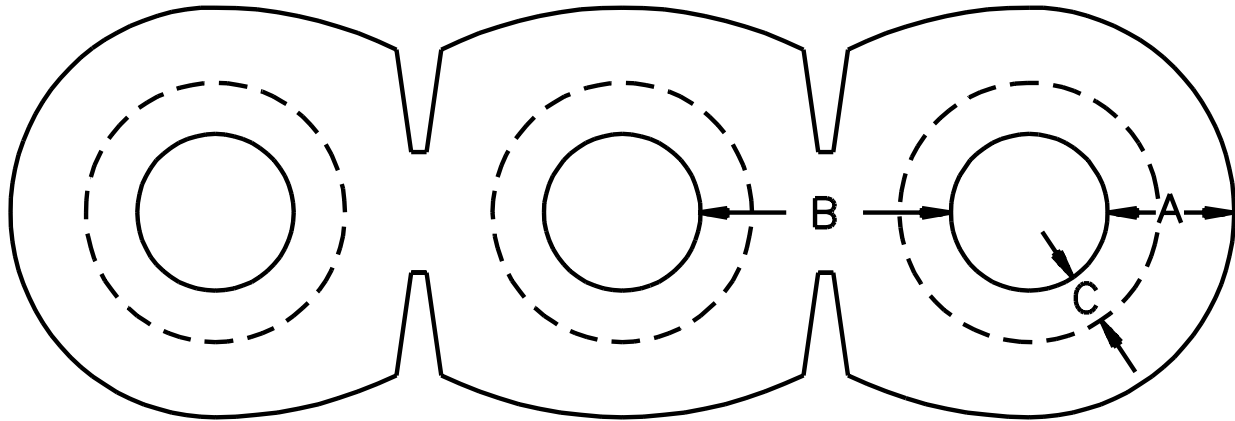
16.4.1 revised April 13, 2000

17 Tightness of Insulation

17.1 The insulation on each individual circuit conductor of an integral, parallel cord other than tinsel cord, and range and dryer cables – that is, the insulation in clock cord and in Type XTW, SP-1, SPE-1, SP-2, SPE-2, SPT-1W, SPT-1, SPT-2W, SPT-2, SP-3, SPE-3, SPT-3, and HPN cords shall be applied tightly, whether or not a separator is used to reduce slipping of the circuit conductor in the insulation or in any separator and to reduce slipping of any separator in the insulation when a 12-inch or 305-mm specimen of finished cord is subjected for 30 s to a longitudinal pull of 8 lbf or 35.6 N or 3.63 kgf applied between the two circuit conductors, at opposite ends of the specimen. This requirement is not applicable to any green or green and yellow grounding conductor that may be used in a Type SP-1, SPE-1, SPT-1, SP2, SPE-2, SPT-2, SP-3, SPE-3, SPT-3, or HPN cord. The test is to be made as described in Test for Tightness of Circuit-Conductor Insulation in Integral Parallel Cord Other Than Tinsel Cord, Section 1280, of UL 1581.

Revised 17.1 effective April 13, 1999

Figure 16.6
Dimensions of a 3-conductor integral Type SRD, SRDE, or SRDT cable



SB0607-1

17.2 The insulation on the conductor of a Type CXTW wire and on each individual conductor of a Type CXTW cord shall be applied tightly, whether or not a separator is used, to reduce slipping of the conductor in the insulation or in any separator and to reduce slipping of any separator in the insulation when a 6-inch or 150-mm specimen of the finished wire is subjected for 60 s to a longitudinal pull of 4 lbf or 18 N or 1.81 kgf applied vertically between the conductor and the insulation. The test is to be made as described in Test for Tightness of Conductor Insulation in Decorative-Lighting Cords and Wires, Section 1270, of UL 1581.

17.2 effective July 2, 1998

FIBROUS COVERINGS

18 General

18.1 A fibrous covering, if specified in Tables 6.1 – 6.21 as a part of any type of fixture wire or over the insulation of a flexible cord, shall be a tape, braid, or wrap that complies with 19.1 – 21.6. If the fibrous covering is optional as specified in Tables 6.1 – 6.21, requirements are not specified.

18.1 revised April 13, 2000

19 Tapes

Section 19 effective July 2, 1998

19.1 Tape shall not be the final outer covering of a fixture wire or flexible cord, and shall not be employed in place of the cotton braid immediately over the conductor assembly of an elevator cable, but is acceptable otherwise as a fibrous covering.

19.2 Except as noted in 19.3, tape, if used, shall be woven rubber-filled cotton cloth that is:

- a) Treated on one or both sides,
- b) Not less than 0.010 inch or 0.25 mm thick, and
- c) Of any width.

It shall be applied helically directly to the surface of the insulation with successive convolutions overlapping one another not less than 1/8 inch or 3 mm.

19.2 effective July 2, 1998

19.3 Material other than rubber-filled cotton-cloth tape is acceptable if evaluation shows it to be at least equivalent to the tape mentioned in 19.2.

19.4 The thickness of the tape is to be determined by removing it from the insulation and measuring it by means of a dead-weight dial micrometer having a presser foot 0.250 ± 0.010 inch or 6.4 ± 0.2 mm in diameter and exerting a total of 3.0 ± 0.1 ozf or 85 ± 3 gf or 0.84 ± 0.02 N on the tape – the load being applied by means of a weight. The entire surface of the presser foot is to be in contact with the tape during each measurement.

20 Braids

Section 20 effective July 2, 1998

20.1 General

20.1.1 A braid employed as a covering on an individual conductor or as an outer covering over an assembly of two or more individual conductors shall be of a close weave, shall cover the conductor or conductors over which it is applied, and shall be fabricated on a machine having the same number of ends per carrier throughout. Each end shall consist of the same kind (that is, soft or glazed), size, and ply of yarn. The angle of weave with reference to the axis of the conductor or cord, respectively, shall result in the threads in the braid not rupturing when the finished conductor or cord (except elevator cable – see 45.2.1– 45.4.1) is tightly wrapped around itself for six complete turns at room temperature.

20.1.2 A silk braid is acceptable where rayon is indicated in Tables 6.1 – 6.21. A rayon braid or a combination cotton and rayon braid is acceptable where cotton is indicated. A cotton braid or a combination cotton and rayon braid is acceptable where rayon is indicated. A braid of other synthetic textile yarn is acceptable on a fixture wire if evaluation shows it to be applicable to the particular use.

20.1.3 The braid on an individual conductor shall be applied directly to the surface of the insulation and, except as noted in 20.1.4, shall be of cotton. The application of a braid over rubber insulation may be either before or after the vulcanization of the rubber compound.

20.1.4 A rayon braid is acceptable in place of a cotton braid on Type FFH-2 fixture wire with rubber insulation (no covering is required on Type FFH-2 wire with XLPE insulation). A spun-rayon braid is acceptable in place of a cotton braid on Type RFH-2 fixture wire and on the individual conductors of Type PD flexible cord.

20.2 Cotton braids

20.2.1 A cotton braid on an individual conductor, except a saturated or lacquered braid on a rubber-insulated fixture wire, shall comply with the requirements in 20.2.1 – 20.2.7.

20.2.2 The braid over the insulation on the conductor of a fixture wire shall be applied with a lay angle of not less than 45° if the diameter over the insulation is no larger than 0.100 inch or 2.5 mm, and not less than 50° if the diameter over the insulation is larger than 0.100 inch or 2.5 mm. For a flexible cord and an elevator cable, each optional and required braid on an insulated conductor, over an assembly, and overall shall be applied at an angle of 35 – 60°.

20.2.3 The size, ply, and number of ends of yarn and the length of lay shall result in the percent coverage Q in each direction being not less than 76, when computed by means of whichever of the following formulas is applicable

$$Q = \frac{100 N E T_{in}}{\sin A}$$

in which:

Q is the percent coverage in one direction,

N is the number of picks per inch,

E is the number of ends per pick,

T is the diameter of one end of yarn in inches, and A is the lay angle;

$$Q = \frac{NET_{mm}}{25.4 \sin A}$$

in which:

N is the number of picks per centimeter,

E is the number of ends per pick,

T is the diameter of one end of yarn in millimeters, and

A is the lay angle.

20.2.4 The number of picks per inch N or picks per centimeter N is to be measured by means of a standard braid counter at three places that are at least 2 inches or 50 mm apart in any 12-inch or 300-mm section in the center 3 ft or 1 m of a 5-ft or 1500-mm specimen of the braid-covered wire. The outer surface of a specimen having a saturated braid is to be wiped with a cloth wet with an organic solvent. The average of the three determinations is to be taken as the number of picks per inch or picks per centimeter for that specimen. Values of yarn diameter T are shown in Table 20.1.

Table 20.1
Yarn diameter

Size and ply of yarn			Yarn diameter T	
			inch	mm
12/1	25/2	26/2	0.01074	0.2728
14/1	30/2		0.00986	0.2504
36/2			0.00875	0.2223
20/1	40/2		0.00830	0.2108
25/1	26/1	50/2	0.00725	0.1842
30/1	60/2		0.00673	0.1709
36/1			0.00619	0.1572

20.2.5 The lay angle A is to be determined by means of whichever of the following formulas is applicable

$$\tan A = N = \frac{\pi N(2T_{in} + D_{in})}{K}$$

in which:

N is the number of picks per inch,

T is the diameter of one end of yarn in inches,

D is the nominal (calculated) diameter in inches over the insulation as indicated in Table 20.2, and

K is the number of carriers in one direction; or

$$\tan A = \frac{\pi N(2T_{\text{mm}} + D_{\text{mm}})}{25.4 K}$$

in which:

N is the number of picks per centimeter,

T is the diameter of one end of yarn in millimeters,

D is the nominal (calculated) diameter in millimeters over the insulation as indicated in Table 20.2, and

K is the number of carriers in one direction.

Table 20.2
Nominal diameter over the insulation

AWG Size of Conductor	Stranding	Insulation Thickness		Nominal Diameter D	
		Mils	mm	Mils	mm
20	Stranded	23	0.58	0.086	2.18
18	Solid	15	0.38	0.070	1.78
18	Stranded	15	0.38	0.078	1.98
18	Stranded	20	0.51	0.092	2.34
18	Stranded	23	0.58	0.094	2.39
18	Solid	30	0.76	0.100	2.54
18	Stranded	30	0.76	0.108	2.74
16	Stranded	20	0.51	0.101	2.57
16	Solid	30	0.76	0.111	2.82
16	Stranded	30	0.76	0.120	3.05
14	Stranded	45	1.14	0.168	4.27

20.2.6 The minimum acceptable number of picks per unit width for the most commonly used braids that are woven on a 16-carrier braider is given in Table 20.3 (picks per inch) or in Table 20.4 (picks per centimeter). A braid complying with either table has acceptable coverage and an acceptable braid angle. Braids are not limited to those covered by the tables, but other braids are required to comply with the requirements in 20.2.2– 20.2.5.

20.2.6 revised April 13, 2000

20.2.7 The values in Table 20.3 were computed by means of whichever of the following formulas is applicable

$$\text{Picks per inch} = N = \sqrt{\left[\frac{Q}{100 ET_{in}}\right]^2 - \left[\frac{K}{\pi(2T_{in} + D_{in})}\right]^2}$$

or

$$\text{Picks per centimeter} = N = 25.4 \sqrt{\left[\frac{Q}{100 ET_{mm}}\right]^2 - \left[\frac{K}{\pi(2T_{mm} + D_{mm})}\right]^2}$$

except that, if the formula produced a value which resulted in a braid angle less than the acceptable minimum, the value was recomputed by means of whichever of the following formulas is applicable

$$\text{Picks per inch} = N = \frac{K \tan A}{\pi(2T_{in} + D_{in})}$$

or

$$\text{Picks per centimeter} = N = \frac{25.4 K \tan A}{\pi(2T_{mm} + D_{mm})}$$

in which:

A is the minimum acceptable lay angle.

Table 20.3
Commonly used 16-carrier cotton braids – nonmetric dimensions

Size and ply of yarn	Number of ends	Size of conductor, thicknesses of insulation, and minimum acceptable number of picks per inch							
		No. 20 AWG 23 Mils	No. 18 AWG 15 Mils	No. 18 AWG 20 Mils	No. 18 AWG 23 Mils	No. 18 AWG 30 Mils	No. 16 AWG 20 Mils	No. 16 AWG 30 Mils	No. 14 AWG 45 Mils
12/1, 25/2, or 26/2	2	23.7	26.3	–	27.7	30.3	–	31.1	33.0
14/1 or 30/2	2	30.3	30.1	22.8	22.4	33.8	–	34.6	–
	3	–	–	–	–	22.1	–	20.3	22.3
36/2	3	24.6	24.6	–	22.9	22.4	–	23.2	25.9
20/1 or 40/2	2	24.8	38.5	23.5	39.6	41.7	25.8	42.4	–
	3	24.8	24.8	–	23.0	24.0	–	25.1	27.6
25/1, 26/1, or 50/2	3	25.4	25.4	–	25.9	29.2	–	30.2	32.4
	4	–	–	–	–	22.9	–	21.0	–
30/1 or 60/2	3	27.6	27.6	–	29.2	32.3	–	33.2	–
	4	–	25.6	–	23.7	23.1	–	22.0	–
36/1	4	25.9	25.9	–	24.0	–	–	–	–

Table 20.4
Commonly used 16-carrier braids – metric dimensions

Table 20.4 revised January 19, 1998

Size and ply of yarn	Number of ends	Size of conductor, thickness of insulation, and minimum acceptable number of picks per centimeter							
		No. 20 AWG 0.58 mm	No. 18 AWG 0.38 mm	No. 18 AWG 0.51 mm	No. 18 AWG 0.58 mm	No. 18 AWG 0.76 mm	No. 16 AWG 0.51 mm	No. 16 AWG 0.76 mm	No. 14 AWG 1.14 mm
12/1, 25/2, or 26/2	2	9.3	10.4	–	10.9	11.9	–	12.3	13.0
14/1 or 30/2	2	11.9	11.9	9.0	8.8	13.3	–	13.6	–
	3	–	–	–	–	8.7	–	8.0	8.8
36/2	3	9.7	9.7	–	9.0	8.8	–	9.1	10.2
20/1 or 40/2	2	9.8	15.2	9.3	15.6	16.4	10.2	16.7	–
	3	9.8	9.8	–	9.1	9.5	–	9.9	10.9
25/1, 26/1, or 50/2	3	10.0	10.0	–	10.2	11.5	–	11.9	12.8
	4	–	–	–	–	9.0	–	8.3	–
30/1 or 60/2	3	10.9	10.9	–	11.5	12.7	–	13.1	–
	4	–	10.1	–	9.3	9.1	–	8.7	–

Table 20.4 Continued on Next Page

Table 20.4 Continued

Size and ply of yarn	Number of ends	Size of conductor, thickness of insulation, and minimum acceptable number of picks per centimeter							
		No. 20 AWG 0.58 mm	No. 18 AWG 0.38 mm	No. 18 AWG 0.51 mm	No. 18 AWG 0.58 mm	No. 18 AWG 0.76 mm	No. 16 AWG 0.51 mm	No. 16 AWG 0.76 mm	No. 14 AWG 1.14 mm
36/1	4	10.2	10.2	—	9.5	—	—	—	—

20.3 Saturation of braids

20.3.1 A braid used as the final outer covering of a wire or cord intended for use in damp places shall be saturated with a moisture-resistant compound which may be of any desired color. A coating of lacquer is acceptable in place of a saturating compound.

20.3.2 The requirement in 20.3.1 applies to:

- a) The braids on the individual conductors of a cord that is intended for use in damp places but does not have an overall braid, and
- b) A braid over a multiple-conductor assembly in a cord that is intended for use in damp places but does not have an overall braid.

20.3.3 In addition to the saturating compound, a finishing compound is acceptable on the surface of an outer braid and, to give a neat appearance, is to be wiped to remove any excess of finishing compound.

21 Wraps

Section 21 effective July 2, 1998

21.1 A fibrous covering in the form of a wrap shall not be used as an outer covering on any flexible cord or on any fixture wire employing flexible stranding, but, if saturated and finished to the degree necessary to render the finished wire moisture-resistant, a cotton wrap covering is acceptable on Type RFH-2 fixture wires with rubber insulation. No covering is required on Type RFH-2 wire with XLPE insulation.

21.2 A wrap covering on a conductor shall be composed of cotton yarn of a size and ply not less than 14/1 or 30/2, shall be closely laid, shall provide the coverage specified in 21.4 and 21.5, and shall not rupture when the conductor is tightly wrapped around itself for six complete turns at room temperature. See also 21.6.

21.3 A cotton wrap covering shall be constructed to result in the tangent of the angle between the yarn and the axis of the finished wire being 0.649 (corresponding to an angle of 33°) or more.

21.4 The size, number of ends, and length of lay of the yarn shall result in the wrap covering 80 percent or more of the surface of the insulation to which it is applied when computed by means of the formula

$$C = \frac{100 ET}{L \sin A}$$

in which:

C is the percent coverage,

E is the number of ends of yarn in the ribbon,

T is 0.0096 inch or 0.2438 mm for 14/1 or 30/2 cotton size and ply,

L is the length of lay in inches or millimeters (measured), and

A is the angle between the yarn and the axis of the wire.

21.5 The mean circumference P of the wrap need not actually be measured in determining the percent coverage provided by a cotton wrap. For general uniformity, the value of P is to be computed by means of the formula

$$P = \pi(T - D)$$

in which:

P is $(L \tan A)$ in inches or millimeters,

T is the constant for the yarn size employed as indicated in 21.4, and

D is the nominal diameter over the insulation (that is, under the wrap) as indicated in Table 20.2.

The length of lay is to be measured, using a specimen of the wire about 20 inches or 500 mm long. When computed in this manner, the percent coverage is required not to be less than 80, with no minus tolerance.

21.5 revised April 13, 2000

21.6 Binder threads of a fibrous material shall be helically applied to the wrap and in the opposite direction to the lay of the yarn in the wrap. The binder threads shall be uniformly spaced and shall consist of material having a strength and elasticity and a manner of application that together make the completed wire capable of withstanding the mandrel test described in 20.1.1 without breaking the binder threads.

NYLON JACKET

22 General

Section 22 effective July 2, 1998

22.1 A nylon jacket over an insulated individual conductor of a Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SJ, SJE, SJO, SJEO, SJEOO, SJOO, SJT, SJTO, SJTOO, SEW, SEOW, SEOOO, SOW, SOOO, STW, STOW, STOOO, SJEW, SJOW, SJEOO, SJOOO, SJTOO, SJTOO, SJTOO, SV, SVE, SVO, SVOO, SVT, SVTO, or SVTOO flexible cord and a nylon jacket over the insulation on a Type TFN or TFFN fixture wire, coaxial-cable member of an elevator cable, or Type SPT-1 cord shall not show any cracks when flexed at room temperature on a mandrel after specimens of the insulated and jacketed conductor have been aged in a full-draft circulating-air oven. The test is to be conducted as described in Cracking of Nylon Covering on Coaxial-Cable Members of Elevator Cables or of Nylon Jacket on Types TFN, TFFN, and SPT-1 and of Insulated Conductors in Service Cords, Test, Section 1540 of UL 1581.

LENGTH OF LAY OF TWISTED CONDUCTORS

23 General

Section 23 effective July 2, 1998

23.1 The length of lay of the conductors in Type CXTW cord shall not be more than 30 times the diameter over the insulation on one of the individual conductors. For any other type of cord (except elevator cable – see 45.3.1) having a twisted conductor assembly, the length of lay of the twisted conductors shall not be greater than indicated in Table 23.1 (inches) or in Table 23.2 (millimeters). In the service cords having a breather tube as indicated in note ^a to Tables 40.1 and 40.2, the breather tube is to have the same direction and length of lay as the twisted conductors.

Table 23.1
Maximum acceptable length of lay of twisted conductors in inches

Table 23.1 revised February 6, 2001

AWG size of conductors	Number of conductors and maximum acceptable length of lay ^a				
	2	3	4	5	6 ^a
27 ^b , 18 ^b	1-3/8	–	–	–	–
17 ^b	1-1/2	–	–	–	–
18	2	2-1/4 ^c	2-1/2	3	3-1/2
17 ^e	2 ^e	2-1/4 ^{c,e}	2-1/2 ^e	–	–
16 ^b	2-1/4	2-1/2 ^c	2-3/4	3-1/2	4-1/4
15	2-1/4 ^e	2-1/2 ^{c,e}	2-3/4 ^e	–	–
14	2-1/2	3-1/4	3-3/4	4-3/4	5-1/2
12	3	3-1/2	4-1/4	5-1/2	6-1/2
10	3-1/2	4-1/4	4-3/4	6	7
8 ^d	4-1/2	5	6	a	a
6 ^d		6	7	a	a
4 ^d	6	7	8-1/2	a	a

Table 23.1 Continued on Next Page

Table 23.1 Continued

AWG size of conductors	Number of conductors and maximum acceptable length of lay ^a				
	2	3	4	5	6 ^a
2 ^d	7	8	10	a	a

^a For low-leakage cords with any number and size of conductors, for 5- and 6-conductor No. 8 – 2 AWG cords, and for cords with more than 6 conductors, the maximum acceptable length of lay is 15 times the calculated overall diameter of the assembly but, in a multiple-layer cord, the length of lay of the conductors in each of the inner layers is not specified (governed by the construction of the cabling machine).

^b Applicable only to the acceptable AWG sizes of 2-conductor Type TST, SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum acceptable length of lay of 1-3/4 in applies to 3-conductor No. 18 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum length of lay of 2 in applies to 3-conductor No. 17 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum length of lay of 1-1/2 inches applies to 2-conductor No. 16 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords.

^c 3-1/4 inches for a No. 18, 17, 16, or 15 AWG Type S, SE, SEOO, SEO, SO, SOO, ST, STOO, STO, SEW, SEOOW, SEOW, SOW, SOOW, STW, STOOW, or STOW cord having one No. 14 AWG grounding conductor in accordance with 8.4(d).

^d If all of the conductors of a 3- or 4-conductor cable are not of the same size (see 8.4), the length of lay is to be based on the largest wire size.

^e Applicable only to Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SJ, SJE, SJEO, SJEOO, SJO, SJOO, SJT, SJTOO, SJTO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, STOOW, SJEW, SJEOW, SJEOOW, SJOW, SJOOW, SJTW, SJTOOW, and SJTOW cords.

Table 23.2
Maximum acceptable length of lay of twisted conductors in millimeters

Table 23.2 revised February 6, 2001

AWG size of conductors	Number of conductors and maximum acceptable length of lay ^a				
	2	3	4	5	6 ^a
27 ^b , 18 ^b	35	–	–	–	–
17 ^b	38	–	–	–	–
18	51	57 ^c	64	76	89
17 ^e	51 ^e	57 ^{c, e}	64 ^e	–	–
16 ^b	57	64 ^c	70	89	108
15 ^e	57 ^e	64 ^{c, e}	70 ^e	–	–
14	64	83	95	121	140
12	76	89	108	140	165
10	89	108	121	152	178
8 ^d	114	127	152	a	a
6 ^d	127	152	178	a	a
4 ^d	152	178	216	a	a
2 ^d	178	203	254	a	a

Table 23.2 Continued on Next Page

Table 23.2 Continued

AWG size of conductors	Number of conductors and maximum acceptable length of lay ^a				
	2	3	4	5	6 ^a
<p>^a For low-leakage cords with any number and size of conductors, for 5- and 6-conductor Nos. 8 – 2 AWG cords, and for cords with more than 6 conductors, the maximum acceptable length of lay is 15 times the calculated overall diameter of the assembly but, in a multiple-layer cord, the length of lay of the conductors in each of the inner layers is not specified (governed by the construction of the cabling machine).</p> <p>^b Applicable only to the acceptable AWG sizes of 2-conductor Type TST, SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum acceptable length of lay of 44 mm applies to 3-conductor No. 18 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum acceptable length of lay of 51 mm applies to 3-conductor No. 17 AWG and No. 16 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords. A maximum acceptable length of lay of 38 mm applies to 2-conductor No. 16 AWG Type SV, SVE, SVEO, SVO, SVOO, SVT, SVTOO, and SVTO cords.</p> <p>^c 83 mm for a No. 18, 17, 16, or 15 AWG Type S, SE, SEO, SEOO, SO, SOO, ST, STOO, STO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOOW, or STOW cord having one No. 14 AWG grounding conductor in accordance with 8.4(d).</p> <p>^d If all of the conductors of a 3- or 4-conductor cable are not of the same size (see 8.4), the length of lay is to be based on the largest wire size.</p> <p>^e Applicable only to Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SJ, SJE, SJEO, SJEOO, SJO, SJOO, SJT, SJTOO, SJTO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, STOOW, SJEW, SJEOW, SJEOOW, SJOW, SJOOW, SJTW, SJTOOW, and SJTOW cords.</p>					

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FILLERS

24 General

Section 24 effective July 2, 1998

24.1 Fillers, if used in a flexible cord, shall be twisted with the conductors to make the conductor assembly have a circular cross section.

24.2 If fillers are employed in a flexible cord, although not required, they shall comply with the requirement in 24.1.

BREATHER TUBES

25 General

Section 25 effective July 2, 1998

25.1 Types STW, STOW, STOOW, SJTW, SJTOW, SJTOOW, SEW, SEOW, SEOOW, SJOW, SJOOW, SJEW, SJEOW, SJEOWW, SOW, and SOOW flexible cords having conductors of sizes No, 10, 12, 14, 16, or 18 AWG may have a breather tube incorporated in their construction.

25.1 revised April 13, 2000

25.2 The flexible cords mentioned in 25.1 with a breather tube shall comply with all of the requirements for the standard construction of these cords, except that the length of lay shall comply with the lay specified for such cords with an additional conductor; the average overall diameter of these cords shall comply with the overall diameters specified for such cords with an additional circuit conductor.

25.2 revised April 13, 2000

25.3 The breather tube shall not crack when specimens of the finished cords are subjected to the cold bend and mechanical strength tests specified for these cords.

SUPPORT MEMBERS

26 General

Section 26 effective July 2, 1998

26.1 When required, a supporting member may be incorporated in the center of the flexible cord assembly. The supporting member may be of nonmetallic material, fibrous material, or steel.

26.2 When steel is used, the support member shall consist of a flexible, stranded steel that is insulated with the same grade thickness of insulation as used on the circuit conductors. An optional braid, constructed in accordance with 20.2.1 may be used over the insulation.

26.3 The overall jacket shall be marked to show that a steel support member is present (see 69.6).

OUTER JACKET

27 General

Section 27 effective July 2, 1998

27.1 If a nonintegral jacket is required for a flexible cord in Tables 6.5 – 6.19, or for elevator cable in Table 6.20, or hoistway cable in Table 6.21, the conductor assembly of the cord shall be completely covered and well centered in a jacket of the specified class of material. Material classes are listed in Table 27.1 and their properties are given in Table 27.2 of this Standard. These do not refer to classes in UL 1581. For materials other than those shown in Table 27.1, see 15.6. The jacket shall be applied directly to the core (conductor assembly plus any braid, wrap, or serving applied over the twisted conductors) and shall fill the spaces around the conductors and any fillers. If applied in more than one layer of the same class, adjacent layers shall not be readily separable when the total jacket thickness is less than 95 mils or 2.41 mm. Jackets with a total thickness of 60 mils or 1.52 mm and greater may have a reinforcement consisting of an open weave or the like placed between adjacent layers of the same class which shall not be readily separable. Jackets with a total thickness of 95 mils or 2.41 mm and greater may or may not consist of separable adjacent layers of the same class. If separable, the outside layer must be at least 50% if the total thickness measured. The finished cord shall be full and round (having a circular cross section) and shall not show depressions because of unfilled valleys between the individual twisted conductors. The method of application of the jacket shall result in the finished cord being flexible and not easily kinked.

Table 27.1
Classes of jacket materials for flexible cords and cables, elevator cables and hoistway cables

Table 27.1 revised January 19, 1998

Class number	Temperature rating (°C)	Material type
1.2	60	SBR/NR, EP, NBR/PVC, Neoprene, CP
1.3	90	Neoprene
1.7	60	PVC
1.8	105	PVC
1.10	90	CP, CPE, NBR/PVC, EP
1.14	105	TPE
1.16	90	PVC
1.17	105	CP, CPE
1.18	90	TPE
1.19	75	PVC
1.20	75	EP, NBR/PVC, SBR/NR, Neoprene, CP
Legend		
CP	Chlorosulfonated Polyethylene	
SBR/NR	Styrene-butadiene rubber/natural rubber or blend thereof	
NBR/PVC	Crosslinked compound with acrylonitrile butadiene rubber and PVC	
Neoprene	Polychloroprene	
CPE	Chlorinated Polyethylene	
EP	Ethylene Propylene Rubber	
PVC	Polyvinyl Chloride	
TPE	Thermoplastic Elastomer	

Table 27.2
Jacket properties

Table 27.2 revised October 13, 1998

Class	Physical properties initial		Air oven aging test				Oil immersion test†			
	min.				Min. % of before aging requirement				Min. % of before aging requirement	
	Elong. %	Tensile strength lbs/in ²	Oven temp (°C±2)	Time d	Elong.%	Tensile str., %	Oil temp. (C°±2)	Timeh	Elong.%	Tensilestr., %
1.2	200*	1200	70	7	70	75	121	18	60	60
1.3	200	1200	110	10	50	50	121	18	60	60
1.7	100	1500	100	7	45	85	60	168	75	75
1.8	100	1500	136	7	45	85	60	168	75	75
1.10	200	1200	110	10	50	50	121	18	60	60
1.14	200	1200	136	7	75	75	60	168	75	75
1.16	100	1500	121	7	45	85	60	168	75	75
1.17	200	1200	136	7	65	70	121	18	60	60
1.18	300	1200	121	7	80	80	60	168	75	75
1.19	100	1500	100	10	65**	70	60	168	75	75
1.20	200	1200	100	10	50	50	121	18	60	60

* The elongation requirements for Class 1.2 jackets on coiled Types SVO, SJO, and SO cords shall be 150%.

† Oil tests are only required on Type EO, ETT, ETP, HPN, or products with and "O" or "OO" in the type designation.

** The requirement is 45 for die cut specimens.

28 Thicknesses of Jacket

Section 28 effective July 2, 1998

28.1 The thicknesses of the jacket on Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, and STOOW cords shall not be less than indicated in the applicable Table 28.1, 28.2, or 28.3. The thicknesses of the jacket on 5 or 6 conductor Type SJ, SJE, SJEO, SJEOO, SJO, SJOO, SJT, SJTO, SJTOO, SJEW, SJEOW, SJEOOW, SJOW, SJOOOW, SJTW, SJTOW, SJTOOW cords with mixed conductor sizes shall not be less than indicated in Table 28.3A. Measurements are to be made as described in Thickness of Jacket on Flexible Cord, Fixture Wire, and Elevator Cable, Section 280, of UL 1581.

28.1 effective July 2, 1998

Table 28.1
Thicknesses of jackets on Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SEW, SEOW, SEOWW, SOW, SOOW, STW, STOW, and STOOW cords containing 2 – 6 No. 18 – 14 AWG conductors or 2 – 5 No. 12 – 2 AWG conductors

Table 28.1 revised October 13, 1998

AWG size of conductors	Total number of circuit and grounding conductors	Minimum acceptable thickness			
		Average		At any point	
		Mils	mm	Mils	mm
18 – 16, 15 ^a	2 – 4 ^b	60.0	1.52	48.0	1.22
18 – 16, 15 ^c	5 – 6	80.0	2.03	64.0	1.63
14	2 – 4	80.0	2.03	64.0	1.63
14	5 – 6	95.0	2.41	76.0	1.93
12 – 10	2 – 5	95.0	2.41	76.0	1.93
8 ^d	2 – 3	110.0	2.79	88.0	2.24
8 ^d	4	125.0	3.18	100.0	2.54
8 ^e	5	125.0	3.18	100.0	2.54
6 ^d	2 – 3	125.0	3.18	100.0	2.54
6 ^d	4	140.0	3.56	112.0	2.84
6 ^e	5	140.0	3.56	112.0	2.84
4 ^d	2 – 3	140.0	3.56	112.0	2.84
4 ^d	4	155.0	3.94	124.0	3.15
4 ^e	5	155.0	3.94	124.0	3.15
2 ^d	2 – 3	155.0	3.94	124.0	3.15
2 ^d	4	170.0	4.32	136.0	3.45
2 ^e	5	170.0	4.32	136.0	3.45

^a Only for cords with or without one grounding conductor that is of the same size as the circuit conductors.

^b The jacket thicknesses may be an average of 60 mils or 1.52 mm and a minimum at any point of 48 mils or 1.22 mm for a "w" cord having two No. 18, 17, 16, or 15 AWG circuit conductors and one No. 14 AWG grounding conductor.

^c Only for cords with or without one or more grounding conductors that are of the same size as the circuit conductors.

^d Only for cords with or without one grounding conductor that:

- 1) Is of the same size as the circuit conductors or
- 2) As indicated in 8.4(b), is two AWG sizes smaller than the circuit conductors.

^e Only for cords with or without one or more grounding conductors that:

- 1) Are of the same size as the circuit conductors or
- 2) As indicated in 8.4(b), are two AWG sizes smaller than the circuit conductors.

Table 28.2

Thicknesses of jacket on Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, and STOOW cords containing more conductors (of 10 AWG and smaller) than covered in Table 28.1, or mixed conductor sizes

Calculated diameter under jacket		Minimum:			
		Average thickness		Thickness at any point	
inch	mm	Mils	mm	Mils	mm
0 – 0.500	0 – 12.70	80	2.03	64	1.63
0.501 – 0.750	12.73 – 19.05	95	2.41	76	1.93
0.751 – 1.000	19.08 – 25.40	110	2.79	88	2.24
1.001 – 1.500	25.43 – 38.10	125	3.18	100	2.54
1.500 – 2.000	38.10 – 50.80	140	3.56	112	2.84
2.001 and larger	50.81 and larger	To be determined by investigation			

Table 28.3

Thicknesses of jacket on Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO, SEW, SEOW, SEOOW, SOW, SOOW, STW, STOW, and STOOW cords containing 6 or more No. 8 – 2 AWG conductors^a

Calculated diameter under jacket		Minimum acceptable			
		Average thickness		Thickness at any point	
inch	mm	Mils	mm	Mils	mm
0.751 – 1.000	19.08 – 25.40	140	3.56	112	2.84
1.001 – 1.250	25.43 – 31.75	155	3.94	124	3.15
1.251 – 1.500	31.78 – 38.10	170	4.32	136	3.45
1.501 – 1.750	38.13 – 44.45	190	4.83	152	3.86
1.751 – 2.000	44.48 – 50.80	205	5.21	164	4.17
2.001 – 2.250	50.83 – 57.15	220	5.59	176	4.47
2.251 – 2.500	57.18 – 63.50	235	5.97	188	4.78
2.501 – 2.750	63.53 – 69.85	250	6.35	200	5.08
2.751 – 3.000	69.88 – 76.20	265	6.73	212	5.38
3.001 – 3.250	76.23 – 82.55	280	7.11	224	5.69
3.251 – 3.500	82.58 – 88.90	295	7.49	236	5.99
3.501 – 3.950	88.93 – 100.33	310	7.87	248	6.30
3.951 – 4.450	100.36 – 113.03	330	8.38	364	6.71
4.451 – 5.000	113.06 – 127.00	345	8.76	276	7.01

^a As indicated in 8.4(b), any grounding conductor or conductors may be of the same size as the circuit conductors or two AWG sizes smaller than the circuit conductors.

28.2 The thickness of the jacket on Type EO elevator cable shall not be less than indicated in Table 28.4. The thickness of the jacket on Type ETT and ETP elevator cable shall not be less than indicated in Table 28.5. Measurements are to be made as described in Thickness of Jacket on Flexible Cord, Fixture Wire, and Elevator Cable, Section 280, of UL 1581.

28.3 The nylon jacket on Types TFN and TFFN fixture wire shall not be less than 4 mils or 0.10 mm thick at any point. Measurements are to be made as described in 280.1 – 280.3 of UL 1581.

Table 28.3A

Thickness of Jackets on Types SJ, SJO, SJOO, SJE, SJEO, SJEOO, SJT, SJTO, SJTOO, SJOW, SJOOW, SJEW, SJEOW, SJEOOW, SJTW, SJTOW, SJTOOW Containing Mixed Conductor Sizes

Table 28.3A added January 19, 1998

Calculated diameter under jacket		Minimum			
		Average thickness		Thickness at any point	
mm	inch	mm	mils	mm	mils
0 – 8.89	0 – 0.350	0.76	30	0.61	24
8.90 – 11.4	0.351 – 0.450	1.14	45	0.91	36
11.5 – 14.0	0.451 – 0.550	1.52	60	1.22	48
14.1 – 22.9	0.551 – 0.900	2.03	80	1.62	64
23.0 – 31.7	0.901 – 1.25	2.41	95	1.93	76
31.8 – 38.1	1.26 – 1.50	2.79	110	2.23	88
38.1 – 50.8	1.51 – 2.00	3.17	125	2.54	100

Table 28.4

Thicknesses of jacket on Type EO elevator cables

Core diameter ^a		Minimum:			
		Average thickness		Thickness at any point	
inch	mm	Mils	mm	Mils	mm
0 – 0.500	0 – 12.70	80	2.03	72	1.83
>0.500 – 0.750	≤12.70 – 19.05	95	2.41	86	2.18
>0.750 – 1.000	≤19.05 – 25.40	110	2.79	100	2.54
≥1.000 – 1.500	≤25.40 – 38.10	125	3.18	115	2.92
>1.500 – 2.000	≤38.10 – 50.80	140	3.56	126	3.20

^a The core diameter is the calculated diameter of the conductor assembly, including the cotton braid under the jacket.

Table 28.5

Thicknesses of jacket on Type ETT and ETP elevator cable and minimum thickness of mandatory web(s) on Type ETP elevator cable

Table 28.5 revised April 13, 2000

Core diameter ^a		Minimum:			
		Average thickness		Thickness at any point	
inch	mm	Mils	mm	Mils	mm
0 – 0.250	0 – 6.3	35	0.89	28	0.71
0 – 0.500	0 – 12.70	45	1.14	40	1.01
0.501 – 1.000	12.71 – 25.40	60	1.52	54	1.37
1.001 and larger	25.41 and larger	80	2.03	72	1.83

^a The core diameter is the calculated diameter of the conductor assembly, including the cotton braid under the jacket.

^b The core diameter is the calculated diameter of the conductor assembly, including the cotton braid under the jacket.

Note:

For type ETP the core diameter for a group construction shall be determined by measuring the diameter of the largest group including the braid if present. For a non-group construction, the core diameter shall be determined by measuring the diameter of the largest conductor in the cable.

INDIVIDUAL CORDS

29 Clock Cord and Decorative-Lighting Cords

Revised Section 29 effective October 13, 2000

29.1 Type XTW is the designation for the parallel variety of 2-6 conductor decorative-lighting cord, which is to be made only in the Nos. 22, 20, and 18 AWG sizes. Type CXTW is the designation for the twisted-pair variety of 2-conductor decorative-lighting cord, which is to be made only in the Nos. 22, 20, and 18 AWG sizes with a length of lay in accordance with 23.1. The constructions in any case shall be as indicated in Table 6.6. In accordance with 65.1.1, the usual polarity identification (grounded conductor) is not required for any type of decorative-lighting cord except 2-conductor Type XTW cord. Clock cord shall be No. 20 AWG parallel only, with insulation thicknesses in accordance with Table 16.7.

30 Insulating and Jacketing Compounds

Section 30 effective July 2, 1998

30.1 Table 30.1 shows the insulating and jacketing compounds used in vacuum-cleaner and service cords rated 60°C (140°F) and higher.

Table 30.1
Class numbers of circuit-conductor insulation and of jacketing compounds

Type of cord	60°C (140°F) compounds ^a		75°C (167°F) compounds ^a		90°C (194°F) compounds ^a		105°C (221°F) compounds ^a	
	Insulation	Jacket	Insulation	Jacket	Insulation	Jacket	Insulation	Jacket
SV	2.4	1.2	2.30	1.20	2.5, 2.5A, 2.17	1.3, 1.10	2.16, 2.23A	—
SVE, SVEO	—	—	—	—	2.28	1.18	2.20	1.14
SVO, SVOO	2.4	1.2	2.30	1.20	2.5, 2.5A	1.3, 1.10	—	—
SVT, SVTO, SVTOO	2.9	1.7	2.29	1.19	2.22	1.16	2.11	1.8
SJE, SJEO, SJEOO, SJEW, SJEOW, SJEOOW	—	—	—	—	2.28	1.18	2.20	1.14
SJ, SJO, SJOW, SJOO, SJOOW	2.4	1.2	2.30	1.20	2.5, 2.5A, 2.15, 2.17	1.3, 1.10	2.16, 2.23A	1.17
SJT, SJTO, SJTOO, SJTW, SJTOW, SJTOOW	2.9, 2.24, 2.26	1.7	2.24, 2.26, 2.29	1.19	2.22, 2.24	1.16	2.11, 2.24	1.8

Table 30.1 Continued on Next Page

Table 30.1 Continued

Type of cord	60°C (140°F) compounds ^a		75°C (167°F) compounds ^a		90°C (194°F) compounds ^a		105°C (221°F) compounds ^a	
	Insulation	Jacket	Insulation	Jacket	Insulation	Jacket	Insulation	Jacket
SE, SEO, SEOO	—	—	—	—	2.28	1.16, 1.18	2.20	1.14
S, SO, SOW, SOO, SOOW	2.4	1.2	2.30	1.20	2.5, 2.5A, 2.15, 2.17	1.3, 1.10	2.16, 2.23A	1.17
ST, STO, STOW	2.9, 2.24, 2.26	1.7	2.24, 2.26, 2.29	1.19	2.22, 2.24	1.16	2.11, 2.24	1.8
STOO, STOOW	2.9	1.7	2.29	1.19	2.22	1.16	2.11	1.8

^a The physical requirements for individual materials are given in Tables 15.2 and 27.2 of this Standard.

31 Resistance of Nonintegral Jacket

Section 31 effective July 2, 1998

31.1 A nonintegral jacket of thermoplastic or thermosetting material shall exhibit 100 megohms or more of resistance when a specimen of the complete, finished cord is tested for a period of 1 minute as indicated in 1340.1 of UL 1581. The purpose of this requirement is to qualify a separable jacket as insulation to enable the cord to be used on or with double-insulated equipment.

32 Outdoor Service Cords

Section 32 effective July 2, 1998

32.1 CORD FOR USE WITH RECREATIONAL VEHICLES – A flexible cord that is intended for use in a cord set or power-supply cord for recreational vehicles shall be a Type SOOW, SOW, STOOW, STOW, STW, SEOOW, SEOW, or SEW cord that complies with the requirements for outdoor use in 32.4 – 32.13 and has two insulated No. 14, 12, or 10 AWG circuit conductors and one insulated grounding conductor of the same size as the circuit conductors. For use in the marking specified for the cord surface in 75.2, a current rating of 15 A shall apply to this cord having No. 14 AWG circuit conductors, a current rating of 20 A shall apply to this cord having No. 12 AWG circuit conductors, and a current rating of 30 A shall apply to this cord having No. 10 AWG circuit conductors. The outer surface of the insulation on the grounding conductor shall be green with or without one or more straight or helical unbroken yellow stripes that are of even or varying width and occupy a total width of 5 – 70 percent of the calculated circumference of the insulated conductor and no less individual width than 5 percent of the calculated circumference of the insulated conductor.

32.2 CORD FOR USE WITH MOBILE HOMES AND RECREATIONAL VEHICLES – A flexible cord that is intended for use in a power-supply cord for mobile homes and recreational vehicles shall be a Type SOOW, SOW, STOOW, STOW, STW, SEOOW, SEOW, or SEW cord that complies with the requirements for outdoor use in 32.4 – 32.13 and either has three insulated No. 8 AWG circuit conductors and one insulated grounding conductor of the same size as the circuit conductors or has three insulated No. 6 AWG circuit conductors and one insulated No. 6 or 8 AWG grounding conductor. For use in the marking specified for the cord surface in 75.1, a current rating of 40 A shall apply to this cord having No. 8 AWG circuit conductors and a current rating of 50 A shall apply to this cord having No. 6 AWG circuit conductors. The outer surface of the insulation on the grounding conductor shall be green with or without

one or more straight or helical unbroken yellow stripes that are of even or varying width and occupy a total width of 5 – 70 percent of the calculated circumference of the insulated conductor and no less individual width than 5 percent of the calculated circumference of the insulated conductor.

32.3 CORD FOR OTHER OUTDOOR POWER-SUPPLY CORDS AND CORD SETS – A flexible cord that is intended for use in an outdoor cord set (see 76.2 and 76.3) or power-supply cord that is not for mobile homes and/or recreational vehicles shall be one of the following varieties of service cord:

a) **EXTRA-HARD-SERVICE CORDS** – A Type SOOW, SOW, STOOW, STOW, STW, SEOOW, SEOW, or SEW cord that complies with the requirements for outdoor use in 32.4 – 32.13 and has two or more insulated No. 18 - 2 AWG circuit conductors with or without one insulated grounding conductor of the same size as the circuit conductors (provision is made in 8.4(d) for a larger grounding conductor in certain cords). The outer surface of the insulation on the grounding conductor shall be green with or without one or more straight or helical unbroken yellow stripes that are of even or varying width and occupy a total width of 5 – 70 percent of the calculated circumference of the insulated conductor and no less individual width than 5 percent of the calculated circumference of the insulated conductor.

b) **HARD-SERVICE CORDS** – A Type SJOOW, SJOW, SJTOOW, SJTOW, SJTW, SJEOOW, SJEOW, or SJEW cord that complies with the requirements for outdoor use in 32.4 – 32.13 and has 2 – 5 insulated No. 18 – 10 AWG circuit conductors with or without one insulated grounding conductor of the same size as the circuit conductors. The outer surface of the insulation on the grounding conductor shall be green with or without one or more straight or helical unbroken yellow stripes that are of even or varying width and occupy a total width of 5 – 70 percent of the calculated circumference of the insulated conductor and no less individual width than 5 percent of the calculated circumference of the insulated conductor.

32.4 INSULATION RESISTANCE IN WATER AT 15.6°C (60°F) – Before assembly into an outdoor service cord, the individual insulated conductors (circuit and grounding) insulated with PVC, TPE, or a thermoset material shall be capable of exhibiting an insulation resistance of at least the value indicated in Table 32.1 for the cord type. Specimens of the insulated conductors are to be tested in tap water at room temperature as described in Insulation-Resistance Test in Water, Section 920, of UL 1581 after a 6-h or longer period of immersion. When measurements are taken at temperatures other than 15.6° C (60° F), the readings shall be adjusted by the appropriate multiplying factor discussed in 33.1. Immediately before the insulation-resistance reading is taken on a specimen, the a-c potential indicated in Table 51.1 for the dielectric voltage-withstand test is to be applied to the insulation for 60 s followed by earth grounding of the conductor.

Table 32.1
Short-time room-temperature insulation resistance of insulated circuit and grounding conductors
for outdoor service cords

AWG size of conductors	Insulation on conductors for Type STOOW, STOW, STW, SEOOW, SEOW, and SEW cords	Insulation on conductors for Type SJTOOW, SJTOW, SJTW, SJEOOW, SJEOW, and SJEW cords	Insulation on conductors for Type SOOW and SOW cords	Insulation on conductors for Type SJOOW and SJOW cords
Minimum acceptable insulation resistance in megohms based on 1000 conductor feet in water at 60.0°F (15.6°C)				
18	170	170	690	690
17	160	160	645	645
16	150	150	590	590
15	140	140	560	560
14	160	120	655	475
12	130	95	540	395
10	110	110	460	460
8	110	–	460	–
6	96	–	375	–
4	80	–	310	–
2	65	–	260	–
Minimum acceptable insulation resistance in megohms based on a conductor Kilometer (G(Ωm) in water at 60.0°F (15.6°C)				
18	52	53	210	210
17	50	50	200	200
16	45	45	180	180
15	43	43	170	170
14	49	36	200	145
12	40	30	165	120
10	34	34	140	140
8	34	–	140	–
6	29	–	115	–
4	24	–	95	–
2	20	–	80	–

32.5 JACKET: SUNLIGHT RESISTANCE – The jacket on an outdoor service cord shall be considered acceptable for sunlight-resistant use if the ratio of the average tensile strength and ultimate elongation of five conditioned specimens of the jacket to the average tensile strength and ultimate elongation of five unaged specimens is 0.80 or more when specimens of the jacket from the finished cord are tested after exposure as described in Carbon-Arc and Xenon-Arc Tests, Section 1200, of UL 1581 to 720 h of carbon-arc or xenon-arc radiation and water spray (in 20-min cycles consisting of radiation for 17 min without water and 3 min with water).

32.6 JACKET: COLD BEND – The jacket on an outdoor service cord shall not crack on its inner or outer surface when specimens of the complete, finished cord are conditioned in the following sequence and then wound onto a mandrel of the diameter and for the number of turns indicated in Table 58.1. The cord and mandrel are to be at the indicated low temperature during the winding. The winding is to be conducted as described in Cold Bend, Test, Section 580 of UL 1581, with the surface of the specimen that was closest to the arc(s) being outermost.

- a) Exposure as described in Carbon-Arc and Xenon-Arc Tests, Section 1200, of UL 1581 to 720 h of carbon-arc or xenon-arc radiation and water spray in 20-min cycles consisting of radiation for 17 min without water and 3 min with water.
- b) Rest for 16 – 96 h in still air at room temperature.
- c) Cooling for 4 h in air at a temperature of $-30.0 \pm 2.0^{\circ}\text{C}$ ($-22.0 \pm 3.6^{\circ}\text{F}$).

32.7 CORD: COLD BEND – The jacket on and the thermoplastic or thermoset circuit- and grounding-conductor insulation in an outdoor service cord shall not crack on the inner or outer surfaces when specimens of the complete, finished cord that have been cooled for 4 h in air at a temperature of $-40.0 \pm 2.0^{\circ}\text{C}$ ($-40.0 \pm 3.6^{\circ}\text{F}$), $-50.0 \pm 2.0^{\circ}\text{C}$ ($-58.0 \pm 3.6^{\circ}\text{F}$), $-60.0 \pm 2.0^{\circ}\text{C}$ ($-76.0 \pm 3.6^{\circ}\text{F}$), or $-70.0 \pm 2.0^{\circ}\text{C}$ ($-94.0 \pm 3.6^{\circ}\text{F}$) are wound onto a mandrel of the diameter and for the number of turns indicated in Table 58.1. The winding is to be conducted as described in Cold Bend, Test, Section 580 of UL 1581. See 76.1 regarding marking or not marking the cord with its low-temperature rating.

32.8 THERMOSET AND TPE INSULATIONS: INCREASE IN RELATIVE PERMITTIVITY – Individual thermoset- and TPE-insulated conductors (circuit and grounding) removed from finished outdoor service cord shall exhibit a 1-day to 14-day increase in relative permittivity not exceeding 10.0 percent [$100(r_{14} - r_1)/r_1 \leq 10.0$], and a 7-day to 14-day increase in relative permittivity not exceeding 3.0 percent [$100(r_{14} - r_7)/r_7 \leq 3.0$]. The test is to be conducted as described in Capacitance and Relative Permittivity, Test, Section 1020 of UL 1581, with specimens of the insulated conductors measured for capacitance individually at 24 hours, 7 days, and 14 days during continuous immersion in tap water that is maintained at a temperature of $50.0 \pm 1.0^{\circ}\text{C}$ ($122.0 \pm 1.8^{\circ}\text{F}$). The capacitances at each of these times are to be averaged for use in calculating r at 1, 7, and 14 days and then determining the increases in r for 1 – 14 days and for 7 – 14 days.

32.9 THERMOSET AND TPE INSULATION: STABILITY FACTOR OR STABILITY-FACTOR DIFFERENCE – Before assembly into an outdoor service cord, individual thermoset- and TPE-insulated conductors (circuit and grounding) shall be capable of exhibiting either a 14-d stability factor not exceeding 1.0 or a 14-d minus 1-d stability-factor difference not exceeding 0.5. Specimens of the insulated conductors are to be tested during continuous immersion in tap water that is maintained at a temperature of $50.0 \pm 1.0^{\circ}\text{C}$ ($122.0 \pm 1.8^{\circ}\text{F}$). The test is to be conducted as described in Stability Factor, Test, Section 1000 of UL 1581.

32.10 PVC INSULATION: LONG-TIME INSULATION RESISTANCE IN WATER AT 50°C – Throughout an extended, continuous immersion in tap water at $50.0 \pm 1.0^{\circ}\text{C}$ ($122.0 \pm 1.8^{\circ}\text{F}$), no specimen of PVC-insulated circuit or grounding conductor removed from finished outdoor service cord shall have any measured weekly reading of insulation resistance below that indicated in Table 32.2. The immersion shall be for 12 weeks if, throughout the final 6 weeks of the immersion, the individual measured readings of insulation resistance are equal to or higher than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer. The immersion shall be for 24 – 36 weeks if the individual measured readings of insulation resistance are higher than indicated in Table 32.2 but are less than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.

32.11 For every continuous period of 3 weeks during the latter half of the 12-week or 24 – 36-week immersion, a smooth curve drawn covering the entire immersion period and showing the average of the measured readings of insulation resistance shall not decrease at a rate exceeding:

- a) 4 percent per week if and while the individual insulation-resistance readings are at least either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.
- b) 2 percent per week if and while the individual insulation-resistance readings are higher than the value indicated in Table 32.2 but are less than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.

32.12 Each insulated conductor taken from the finished cord is to be immersed in tap water at room temperature and then subjected to the a-c potential indicated in Table 51.1 for 60 s followed by earth grounding of the conductor. The specimens are then to be immersed in the hot water with weekly readings of insulation resistance taken as described in Insulation-Resistance Test in Water, Section 920 of UL 1581. At all times other than while readings of the insulation resistance are being taken, an essentially sinusoidal rms potential at 48 – 62 Hz is to be applied to the insulation: 600 V for a conductor from an extra-hard-service cord, and 300 V for a conductor from a hard-service cord. Insulation for which the curve of insulation resistance shows a rate of decrease greater than the 4 or 2 percent indicated in 32.8 may be kept immersed for additional 1-week periods. If none of the additional individual weekly insulation-resistance readings is lower than indicated in Table 32.2, such insulation may be judged on the results shown by the curve for every continuous period of 3 weeks during the final 12 weeks of the immersion.

Table 32.2
Long-time elevated-temperature insulation resistance of PVC-insulated circuit and grounding conductors from outdoor service cords

AWG size of conductors	Insulation on conductors from Type STOOW, STOW, and STW cords	Insulation on conductors from Type SJTOOW, SJTOW, and SJTW cords
Minimum acceptable insulation resistance in megohms based on 1000 conductor feet in water at 50.0°C (122°F)		
18	0.112	0.112
17	0.095	0.095
16	0.098	0.098
15	0.084	0.084
14	0.108	0.082
12	0.092	0.066
10	0.075	0.075
8	0.075	–
6	0.062	–
4	0.052	–
2	0.043	–
Minimum acceptable insulation resistance in megohms based on a conductor Kilometer (G(Ωm) in water at 60.0°F (15.6°C)		
18	0.034	0.034
17	0.030	0.030
16	0.030	0.033

Table 32.2 Continued on Next Page

Table 32.2 Continued

AWG size of conductors	Insulation on conductors from Type STOOW, STOW, and STW cords	Insulation on conductors from Type SJTOOW, SJTOW, and SJTW cords
15	0.026	0.026
14	0.033	0.025
12	0.028	0.020
10	0.023	0.023
8	0.023	—
6	0.019	—
4	0.016	—
2	0.013	—

32.13 THERMOSET JACKETS: SWELLING AND BLISTERING IN WATER AT 50°C – The thermoset jacket on a Type SOOW, SOW, SJOOW, or SJOW cord shall not increase (swell) more than 20.0 percent in average diameter and shall not blister when a specimen of the finished cord is immersed continuously for 336 h (14 d) in tap water that is maintained at a temperature of 50.0 ±1.0°C (122.0 ±1.8°F). The test is to be conducted as described in Swelling and Blistering in Water, Test, Section 1043 of UL 1581.

33 Adjusting Insulation Resistance to 15.6°C (60°F)

Section 33 effective July 2, 1998

33.1 If the temperature at which readings are taken is other than 15.6°C (60°F) the readings are to be multiplied by the applicable multiplying factor from Table 33.1. If the compound does not fit any of the resistivity coefficients given in Table 33.1, the applicable multiplying factor shall be determined in accordance with Test Procedure for Determining the Multiplying-Factor Column for Adjusting Insulation Resistance, Section 34.

33.1 revised April 13, 2000

Table 33.1
Multiplying factor M^a for adjusting insulation resistance to 60.0°F (15.6°C)

Table 33.1 revised May 18, 1998

Temperature		Resistivity coefficient C for 1.0°F (0.55°C)									
°F	°C	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
40	4.4	0.55	0.46	0.38	0.31	0.26	0.22	0.18	0.15	0.12	0.10
41	5.0	0.57	0.48	0.40	0.33	0.28	0.23	0.19	0.16	0.14	0.12
42	5.6	0.59	0.49	0.42	0.35	0.30	0.25	0.21	0.18	0.15	0.13
43	6.1	0.60	0.51	0.44	0.37	0.32	0.27	0.23	0.20	0.17	0.15
44	6.7	0.62	0.53	0.46	0.39	0.34	0.29	0.25	0.22	0.19	0.16
45	7.2	0.64	0.56	0.48	0.42	0.36	0.32	0.28	0.24	0.21	0.18
46	7.8	0.66	0.58	0.50	0.44	0.39	0.34	0.30	0.26	0.23	0.20
47	8.3	0.68	0.60	0.53	0.47	0.42	0.37	0.33	0.29	0.26	0.23
48	8.9	0.70	0.62	0.56	0.50	0.44	0.40	0.36	0.32	0.29	0.26
49	9.4	0.72	0.65	0.59	0.53	0.48	0.42	0.39	0.35	0.32	0.29
50	10.0	0.74	0.68	0.61	0.56	0.51	0.46	0.42	0.39	0.35	0.32

Table 33.1 Continued on Next Page

Table 33.1 Continued

Temperature		Resistivity coefficient C for 1.0°F (0.55°C)									
°F	°C	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
51	10.6	0.77	0.70	0.64	0.59	0.54	0.50	0.46	0.42	0.39	0.36
52	11.1	0.79	0.73	0.68	0.63	0.58	0.54	0.50	0.47	0.43	0.40
53	11.7	0.81	0.76	0.71	0.67	0.62	0.58	0.55	0.51	0.48	0.45
54	12.2	0.84	0.79	0.75	0.70	0.67	0.63	0.60	0.56	0.54	0.51
55	12.8	0.86	0.82	0.78	0.75	0.71	0.68	0.65	0.62	0.59	0.57
56	13.3	0.89	0.86	0.82	0.79	0.76	0.74	0.71	0.68	0.66	0.64
57	13.9	0.92	0.89	0.86	0.84	0.82	0.79	0.77	0.75	0.73	0.71
58	14.4	0.94	0.93	0.91	0.89	0.87	0.86	0.84	0.83	0.81	0.80
59	15.0	0.97	0.95	0.94	0.95	0.94	0.93	0.92	0.91	0.90	0.89
60	15.6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
61	16.1	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
62	16.7	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.25
63	17.2	1.09	1.12	1.16	1.19	1.23	1.26	1.30	1.33	1.37	1.40
64	17.8	1.13	1.17	1.22	1.26	1.31	1.36	1.41	1.46	1.52	1.57
65	18.3	1.16	1.22	1.28	1.34	1.40	1.47	1.54	1.61	1.69	1.76
66	18.9	1.19	1.27	1.34	1.42	1.50	1.59	1.68	1.77	1.87	1.97
67	19.4	1.23	1.32	1.41	1.50	1.61	1.71	1.83	1.95	2.08	2.21
68	20.0	1.27	1.37	1.48	1.59	1.72	1.85	1.99	2.14	2.20	2.48
69	20.6	1.30	1.42	1.55	1.69	1.84	2.00	2.17	2.36	2.56	2.77
70	21.1	1.34	1.48	1.63	1.79	1.97	2.16	2.37	2.59	2.84	3.11
71	21.7	1.38	1.54	1.71	1.90	2.10	2.33	2.58	2.85	3.15	3.48
72	22.2	1.43	1.60	1.80	2.01	2.25	2.52	2.81	3.14	3.50	3.90
73	22.8	1.47	1.67	1.89	2.13	2.41	2.72	3.07	3.45	3.88	4.36
74	23.3	1.51	1.73	1.98	2.26	2.58	2.94	3.34	3.80	4.31	4.89
75	23.9	1.56	1.80	2.08	2.40	2.76	3.17	3.64	4.18	4.78	5.47
76	24.4	1.60	1.87	2.18	2.54	2.95	3.43	3.97	4.59	5.31	6.13
77	25.0	1.65	1.95	2.29	2.69	3.16	3.70	4.33	5.05	5.90	6.87
78	25.6	1.70	2.03	2.41	2.85	3.38	4.00	4.72	5.56	6.54	7.69
79	26.1	1.75	2.11	2.53	3.03	3.62	4.32	5.14	6.12	7.26	8.61
80	26.7	1.81	2.19	2.65	3.21	3.87	4.66	5.60	6.73	8.06	9.65
81	27.2	1.86	2.28	2.79	3.40	4.14	5.03	6.11	7.40	8.95	10.8
82	27.8	1.92	2.37	2.93	3.60	4.43	5.44	6.66	8.14	9.93	12.1
83	28.3	1.97	2.46	3.07	3.82	4.74	5.87	7.26	8.95	11.0	13.6
84	28.9	2.03	2.56	3.23	4.05	5.07	6.34	7.91	9.85	12.2	15.2
85	29.4	2.09	2.67	3.39	4.29	5.43	6.85	8.62	10.8	13.6	17.0

Table 33.1 Continued on Next Page

Table 33.1 Continued

Temperature		Resistivity coefficient C for 1.0°F (0.55°C)									
°F	°C	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12
^a Calculated from the formula $M = C^{(t - 60)}$ in which: <i>C is determined as described in Section 34, and</i> <i>t is the temperature of the cable in °F</i>											

34 Test Procedure for Determining the Multiplying-Factor Column for Adjusting Insulation Resistance

Section 34 effective July 2, 1998

34.1 Two samples, conveniently of a No. 14, 12, or 10 AWG solid conductor with a 45-mil or 1.14-mm wall of insulation, are to be selected as representative of the insulation under consideration. The samples are to be of a length (at least 200 ft or 60 m) that yields insulation-resistance values that are stable within the calibrated range of the measuring instrument at the lowest water-bath temperature.

34.2 The two samples are to be immersed in a water bath equipped with heating, cooling, and circulating facilities. The ends of the samples are to extend at least 2 ft or 600 mm above the surface of the water to reduce electrical leakage. The samples are to be left in the water at room temperature for 16 h before adjusting the bath temperature to 50.0°F (10.0°C) or before transferring the samples to a 50.0°F (10.0°C) bath.

34.3 The d-c resistance of the metal conductor is to be measured at applicable intervals of time until the temperature remains unchanged for at least 5 min. The insulation is then to be considered as being at the temperature of the bath indicated on the bath thermometer.

34.4 Each of the two samples is to be exposed to successive water temperatures of 50.0, 61.0, 72.0, 82.0, and 95.0°F (10.0, 16.1, 22.2, 27.8, and 35.0°C) and returning, 82.0, 72.0, 61.0, and 50.0°F (27.8, 22.2, 16.1, and 10.0°C). Insulation-resistance readings are to be taken at each temperature after equilibrium is established.

34.5 The two sets of readings (four readings in all) taken at the same temperature are to be averaged for the two samples. These four average values and the average of the single readings at 95.0°F (35.0°C) are to be plotted on semilog paper. A continuous curve (usually a straight line) is to be drawn through the five points. The value of insulation resistance at 60.0°F (15.6°C) is then to be read from the graph.

34.6 The resistivity coefficient C for a 1.0°F (0.55°C) change in temperature is to be calculated to two decimal places by dividing the insulation resistance at 60.0°F (15.6°C) read from the graph by the insulation resistance at 61.0°F (16.1°C). C heads the column of multiplying factors M that applies to the particular insulation.

35 Type SPT-2W, SPT-1W, XTW, and CXTW Cords for Decorative Lighting

Section 35 effective July 2, 1998

35.1 INSULATION RESISTANCE IN WATER AT 15.6°C (60°F) – The PVC insulation on Type CXTW wire and in Type SPT-2W, SPT-1W, XTW, and CXTW cords shall be capable of exhibiting an insulation resistance of at least the value indicated for each conductor (conductors unseparated in the case of a parallel cord) in Table 35.1. Specimens are to be tested in tap water at room temperature as described in

Insulation-Resistance Test in Water, Section 920, of UL 1581 after a 6-h or longer period of immersion. When measurements are taken at temperatures other than 15.6°C (60°F), the readings shall be adjusted by the appropriate multiplying factor discussed in Adjusting Insulation Resistance to 15.6°C (60°F), Section 33. Immediately before the insulation-resistance reading is taken on a specimen, an essentially sinusoidal potential of 1250 V at 48 - 62 Hz is to be applied to the insulation followed by earth grounding of the conductor(s).

Table 35.1
Short-time room-temperature insulation resistance of PVC-insulated conductors of Type CXTW wire and Type XTW, SPT-2W, SPT-1W, and CXTW cords

Table 35.1 revised April 13, 2000

AWG size of conductors	Insulation on unseparated parallel Type XTW cord	Insulation on unseparated integral 2-conductor Type SPT-2W cord	Insulation on individual insulated conductors before assembly into nonintegral 2-conductor Type SPT-2W cord	Insulation on unseparated integral 2-conductor Type SPT-1W cord	Insulation on individual insulated conductors before assembly into nonintegral 2-conductor Type SPT-1W cord	Insulation on individual insulated conductors before assembly into Type CXTW cord and before designation as Type CXTW wire
	Each conductor measured separately	Each conductor measured separately	Each conductor measured separately	Each conductor measured separately	Each conductor measured separately	Each conductor measured separately
22	190	-	-	-	-	225
20	215	-	-	215	-	195
18	-	215	165	175	105	150
16	-	190	145	-	-	-
14	-	-	-	-	-	-
12	-	-	-	-	-	-
Minimum acceptable insulation resistance in megohms based on 1000 conductor feet in water at 60.0°F (15.6°C)						
22	58	-	-	-	-	70
20	66	-	-	-	-	61
18	-	66	50	54	33	47
16	-	58	44	-	-	-
14	-	-	-	-	-	-
12	-	-	-	-	-	-
Minimum acceptable insulation resistance in megohms based on a conductor kilometer (G·m) in water at 60.0°F (15.6°C)						

Table 35.2
Long-time elevated-temperature insulation resistance of PVC-insulated conductors of Type CXTW wire and Type XTW, SPT-2W, SPT-1W, and CXTW cords

Table 35.2 revised April 13, 2000

AWG size of conductors	Insulation on unseparated parallel Type XTW cord Each conductor measured separately	Insulation on unseparated integral 2-conductor Type SPT-2W cord Each conductor measured separately	Insulation on individual insulated conductors before assembly into nonintegral 2-conductor Type SPT-2W cord	Insulation on unseparated integral 2-conductor Type SPT-1W cord Each conductor measured separately	Insulation on individual insulated conductors before assembly into nonintegral 2-conductor Type SPT-1W cord	Insulation on individual insulated conductors before assembly into Type CXTW cord and before designation as Type CXTW wire
	Minimum acceptable insulation resistance in megohms based on 1000 conductor feet in water at 50.0°C (122°F)					
22	0.114	-	-	-	-	0.135
20	0.129	-	-	-	-	0.115
18	-	0.129	0.097	0.105	0.064	0.090
16	-	0.114	0.086	-	-	-
14	-	-	-	-	-	-
12	-	-	-	-	-	-
	Minimum acceptable insulation resistance in megohms based on a conductor kilometer (G·m) in water at 50.0°C (122°F)					
22	0.040	-	-	-	-	0.042
20	0.046	-	-	-	-	0.037
18	-	0.046	0.033	0.033	0.020	0.028
16	-	0.040	0.029	-	-	-
14	-	-	-	-	-	-
12	-	-	-	-	-	-

35.2 SUNLIGHT RESISTANCE – Type CXTW wire and Type SPT-2W, SPT-1W, XTW, and CXTW cords shall be considered acceptable for sunlight-resistant use if the ratio of the average tensile strength and ultimate elongation of five conditioned specimens of the PVC to the average tensile strength and ultimate elongation of five unaged specimens of the PVC is 0.80 or more when specimens of the finished wire, the finished parallel cord, the jacket removed from the finished nonintegral cord, or the individual insulated conductors removed from the finished twisted cord are tested after exposure as described in Carbon-Arc and Xenon-Arc Tests, Section 1200 of UL 1581 to 720 h of carbon-arc or xenon-arc radiation and water spray.

35.3 COLD BEND AFTER SUNLIGHT CONDITIONING– The PVC in Type CXTW wire and in Type SPT-2W, SPT-1W, XTW, and CXTW cords shall not crack on its inner or outer surface when specimens of the complete, finished wire or cord are conditioned in the following sequence and then are wound onto a mandrel of the diameter and for the number of turns indicated in Table 58.1. The wire or cord and the mandrel are to be at the indicated low temperature during the winding. The winding is to be conducted as described in Cold Bend, Test, Section 580 of UL 1581, with the surface of each specimen that was closest to the arcs being outermost.

- a) Exposure as described in Carbon-Arc and Xenon-Arc Tests, Section 1200 of UL 1581 to 720 h of carbon-arc radiation and water spray in 20-min cycles consisting of radiation for 17 min without water and 3 min with water.
- b) Rest for 16 – 96 h in still air at room temperature.
- c) Cooling for 4 h in air at a temperature of $-30.0 \pm 2.0^{\circ}\text{C}$ ($-22.0 \pm 3.6^{\circ}\text{F}$).

35.3 revised April 13, 2000

35.4 COLD BEND – The PVC in Type CXTW wire and in Type SPT-2W, SPT-1W, XTW, and CXTW cords shall not crack on its inner or outer surface when specimens of the complete, finished wire or cord that have been cooled for 4 h in air at the low temperature of indicated in Table 58.2 are wound onto a mandrel of the diameter and for the number of turns indicated in Table 58.1. The winding is to be conducted as described in Cold Bend, Test, Section 580 of UL 1581. See 78.1 regarding marking or not marking the cord with its low-temperature rating.

35.5 LONG-TIME INSULATION RESISTANCE IN WATER AT 50°C – Throughout an extended, continuous immersion in tap water at $50.0 \pm 1.0^{\circ}\text{C}$ ($122.0 \pm 1.8^{\circ}\text{F}$), no specimen of PVC-insulated conductor of finished Type CXTW wire and finished Type SPT-2W, SPT-1W, XTW, and CXTW cords shall have any measured weekly reading of insulation resistance below that indicated for each conductor (conductors unseparated in the case of parallel cord) in Table 35.2. The immersion shall be for 12 weeks if, throughout the final 6 weeks of the immersion, the individual measured readings of insulation resistance are equal to or higher than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer. The immersion shall be for 24 – 36 weeks if the individual measured readings of insulation resistance are higher than indicated in Table 35.2 but are less than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.

35.6 For every continuous period of 3 weeks during the latter half of the 12-week or 24 – 36-week immersion, a smooth curve drawn covering the entire immersion period and showing the average of the measured readings of insulation resistance shall not decrease at a rate exceeding:

- a) 4 percent per week if and while the individual insulation-resistance readings are at least either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.

- b) 2 percent per week if and while the individual insulation-resistance readings are higher than the value indicated in Table 35.2 but are less than either 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer.

35.7 Each specimen is to be immersed in tap water at room temperature and then subjected to an essentially sinusoidal rms potential of 1500 V at 48 – 62 Hz for 60 s followed by earth grounding of the conductor(s). The specimens are then to be immersed in the hot water with weekly readings of insulation resistance taken as described in Insulation-Resistance Test in Water, Section 920 of UL 1581. At all times other than while readings of the insulation resistance are being taken, an essentially sinusoidal potential of 125 V at 48 – 62 Hz is to be applied to the insulation. Insulation for which the curve of insulation resistance shows a rate of decrease greater than the 4 or 2 percent indicated in 39.6 may be kept immersed for additional 1-week periods. If none of the additional individual weekly insulation-resistance readings is lower than indicated in Table 35.2, such insulation may be judged on the results shown by the curve for every continuous period of 3 weeks during the final 12 weeks of the immersion.

36 Outdoor Cords for Landscape Lighting

Section 36 deleted April 13, 2000

36.1 Deleted April 13, 2000

36.2 Deleted April 13, 2000

37 Low-Leakage-Current Service Cords

Section 37 effective July 2, 1998

37.1 A Type ST, STOO, STO, SJT, SJTOO, SJTO, STW, STOOW, STOW, SJTW, SJTOOW, or SJTOW cord that is intended for use as a low-leakage-current cord in a power-supply cord or cord set for earth-grounded direct-patient-contact medical and dental equipment shall contain two circuit conductors and one grounding conductor, with all conductors having either Class 2.24 FEP or Class 2.26 PE insulation. The finished cord shall comply with both of the a-c leakage-current tests described in A-C Leakage-Current Tests of Low-Leakage-Current Service Cords, Section 1320 of UL 1581 and shall be surface-marked as indicated in 78.1.

38 Fixture Wire Resistant to -50°C (-58°F)

Section 38 effective July 2, 1998

38.1 A fixture wire of any type is to be considered resistant to a temperature of -50°C (-58°F) if the finished wire shows no cracks after the cold-bend test in 580.1 of UL 1581 at a temperature of $-50.0 \pm 2.0^{\circ}\text{C}$ ($-58.0 \pm 3.6^{\circ}\text{F}$) using a mandrel of the diameter indicated in Table 58.1 and the number of turns indicated in Table 58.1. Such a cord is to be marked “ -50 C ” or “minus 50 C” in accordance with 72.1.

39 Shielded Service and Vacuum-Cleaner Cords

Section 39 effective July 2, 1998

39.1 A Type S, SE, SO, SOO, SEO, SEOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJEO, SJEOO, SJT, SJTO, SJTOO, SEW, SOW, SOOW, SEOW, SEOOW, STW, STOW, STOOW, SJEW, SJOW, SJOOW, SJEOW, SJEOOW, SJTW, SJTOW, SJTOOW, SV, SVE, SVO, SVOO, SVEO, SVEOO, SVT, SVTO, or SVTOO which contains one or more shields shall be surface marked “shielded” in accordance with 80.1.

39.2 A shield is acceptable over one or more of the circuit conductors or over the entire assembly under the jacket.

39.3 The shield shall be a braid of copper wires, copper wires, wrapped shield, a metallized polyester tape, with a drain wire or a metal tape with or without drain wire.

39.4 A braided or wrapped shield shall have a minimum coverage of 85% and shall be composed of No. 36 or No. 34 AWG copper wires for flexible cords with conductors of No. 10 AWG and smaller, and of No. 32 or No. 30 AWG for flexible cords with conductors larger than No. 10 AWG. For thermoset constructions, the copper wires shall be coated with tin, lead, or lead alloy, unless a separator is used. The coverage shall be determined by using the following formula, as applicable:

a) For braids

$$\% \text{ coverage} = 100 (2F - F^2)$$

where

$$F = \frac{NCd}{2L \sin a}$$

N = number of wires per carrier

C = number of carriers

d = diameter of individual wires, in or mm

L = lay of wires, in or mm

a = angle of braid with axis of underlying core, having a tangent of angle equal to

$$\pi \frac{D + 2d}{L}$$

D = diameter of core under shield, in or mm

b) for wraps

$$\% \text{ coverage} = 100 \times F$$

where

$$F = \frac{NCd}{L \sin a}$$

N = number of wires per carrier

C = number of carriers

d = diameter of individual wrap wires, in or mm

L = lay of wires, in or mm

a = angle of wrap with axis of underlying core, having a tangent of angle equal to

$$\pi \frac{D + d}{L}$$

D = diameter of core under wrap, in or mm

In computing D, (the diameter of the conductor assembly under the braid or wrap having insulated conductors of the same size), the diameter of one of the insulated conductors shall be multiplied by the factor given in Table 39.1. The diameter of an individual insulated conductor shall be determined by using the nominal diameter of the conductor and the average thickness of the insulation and the covering over the insulation, if one is used, as specified in this Standard.

39.4 revised May 18, 1998

Table 39.1

Multiplying factors for the calculation of the diameter of the conductor assembly under the braid

Table 39.1 revised April 13, 2000

Number of conductors	Multiplying factor	Number of conductors	Multiplying factor
2 (without fillers)	1.64	11	4.00
2 (with fillers)	2.00	12	4.15
3	2.15	13	4.24
4	2.41	14	4.41
5	2.70	15	4.55
6	3.00	16	4.70
7	3.00	17	4.86
8	3.31	18	5.00
9	3.61	19	5.00
10	3.93		

39.5 A laminated tape of polyester film and aluminum foil shall be applied longitudinally or helically so that it has at least a 0.062 in (1.58 mm) overlap. The total thickness of the tape shall be 0.0015 in (0.038 mm) minimum for flexible cords with conductors of No. 10 AWG and smaller and 0.0025 in (0.0635 mm) for flexible cords with conductors of No. 8 AWG and larger. The minimum size of drain wire shall be No. 22 AWG (seven-strand) tinned copper for flexible cords with conductors of No. 14 AWG and smaller, of No. 20 AWG (seven-strand minimum) tinned copper for flexible cords with conductors of No. 12 and 10 AWG, and of No. 18 AWG (seven-strand minimum) tinned copper for flexible cords with conductors of No. 8 AWG and larger. The drain wire shall be in contact with the aluminum foil.

39.5 revised May 18, 1998

39.6 Shielded flexible cords shall comply with all of the requirements for such cords without the shield, except that the overall diameters shall comply with the overall diameters in Tables 40.1 or 40.2, plus the additional increase afforded by the shield.

39.7 Flexible cords and cables employing shield(s) of different materials or constructions than those described in the 39.1 – 39.6 shall be examined and tested in accordance with Flexing Test, Section 63.

40 Overall Diameter

Section 40 effective July 2, 1998

40.1 The average overall diameter of finished vacuum-cleaner and service cords and of round, jacketed heater cords shall not be smaller or larger than indicated in Tables 40.1 and 40.2. The tabulated diameters do not apply to cords with mixed AWG conductor sizes, service cords of a construction that includes a spacer between conductors (low-leakage-current cords), a shield, or any other element or elements that necessarily enlarge the finished cord. See note ^a to Tables 40.1 and 40.2 for service cords with a breather tube. See note ^f to Tables 40.1 and 40.2 for retractile cords.

40.1 revised April 13, 2000

40.2 To determine whether or not a flexible cord complies with the requirement in 40.1, measurements of overall diameter are to be made at five points, at intervals of approximately 6 inches or 150 mm on a 3-ft or 1-m length of finished cord. Measurements are to be made with a machinist's micrometer caliper or dead-weight dial micrometer as described in 280.1 of UL 1581. The average of the five measurements is to be taken as the overall diameter of the cord.

40.2 revised April 13, 2000

Table 40.1

Acceptable range ^{d,e,f} in inches of the average overall diameter of round, jacketed heater cords and of vacuum-cleaner and service cords

Table 40.1 revised February 6, 2001

Types of cord	AWG size of circuit and grounding conductors	2 circuit conductors without a grounding conductor	3 circuit conductors or 2 circuit conductors and either a breather tube ^a or one grounding conductor	4 circuit conductors or 3 circuit conductors and one grounding conductor or 3 circuit conductors and a breather tube ^a or 2 circuit conductors, a breather tube ^a , and one grounding conductor	5 circuit conductors or 4 circuit conductors and one grounding conductor or 3 circuit conductors, a breather tube ^a , and one grounding conductor
HSJ, HSJO	18	0.285 – 0.330	0.300 – 0.345	0.330 – 0.380	–
	16	0.305 – 0.350	0.325– 0.375	0.355 – 0.405	–
	14	0.395 – 0.445	0.420– 0.470	0.460 – 0.515	–
	12	0.435 – 0.485	0.460– 0.515	0.510 – 0.570	–
SV, SVE, SVEO, SVOO, SVO, SVT, SVTOO, SVTO	18	0.220 – 0.255	0.230 – 0.265	–	–
	17	0.235 – 0.270	0.250 – 0.285	–	–
	16	0.245 – 0.280	0.260 – 0.295	–	–
SJ, SJE, SJOO, SJO, SJEO, SJEOO, SJT, SJTO, SJTOO, SJEW, SJOOW, SJOW, SJEOW, SJEOOW, SJTW, SJTOW, SJTOOW	18	0.280 – 0.315	0.300 – 0.335 ^a	0.325 – 0.365 ^a	
	17	0.290 – 0.325	0.310– 0.345 ^a	0.340 – 0.380 ^a	
	16	0.305 – 0.340	0.325 – 0.360 ^a	0.350 – 0.395 ^a	
	15	0.315 – 0.350	0.335 – 0.375 ^a	0.370 – 0.415 ^a	
	14	0.335 – 0.375	0.360– 0.395 ^a	0.390 – 0.435 ^a	
	12	0.405 – 0.455	0.425 – 0.475 ^a	0.465 – 0.520 ^a	
	10	0.540 – 0.605	0.565 – 0.635 ^a	0.625 – 0.700 ^a	
S, SE, SOO, SEO, SEOO, ST, STOO, STO, SEW, SOOW, SOW, SEOW, SEOOOW, STW, STOOOW, STOW	18	0.340 – 0.385	0.360 – 0.400 ^{a,b}	0.385 – 0.430 ^a	0.460 – 0.510 ^a
	17	0.350 – 0.390	0.370 – 0.415 ^{a,b}	0.400 – 0.445 ^a	0.465 – 0.520 ^a
	16	0.365 – 0.410	0.385– 0.430 ^{a,b}	0.410 – 0.460 ^a	0.490 – 0.550 ^a
	15	0.475 – 0.530	0.500 – 0.560 ^{a,b}	0.540 – 0.610 ^a	0.615 – 0.690 ^a
	14	0.495 – 0.550	0.520 – 0.575 ^a	0.560 – 0.620 ^a	0.630 – 0.705 ^a

Table 40.1 Continued on Next Page

Table 40.1 Continued

Types of cord	AWG size of circuit and grounding conductors	2 circuit conductors without a grounding conductor	3 circuit conductors or 2 circuit conductors and either a breather tube ^a or one grounding conductor	4 circuit conductors or 3 circuit conductors and one grounding conductor or 3 circuit conductors and a breather tube ^a or 2 circuit conductors, a breather tube ^a , and one grounding conductor	5 circuit conductors or 4 circuit conductors and one grounding conductor or 3 circuit conductors, a breather tube ^a , and one grounding conductor
S, SE, SOO, SEO, SEOO, ST, STOO, STO, SEW, SOOW, SOW, SEOW, SEOOW, STW, STOOW, STOW	12	0.565 – 0.625	0.590 – 0.655 ^a	0.640 – 0.710 ^a	0.700 – 0.770 ^a
	10	0.615 – 0.685	0.650 – 0.720 ^a	0.700 – 0.775 ^a	0.760 – 0.840 ^a
	8	0.780 – 0.880	0.830 – 0.930 ^a	0.925 – 1.050 ^a	1.000 – 1.150 ^a
	6	0.920 – 1.050	0.970 – 1.100 ^a	1.050 – 1.200 ^{a,c}	1.180 – 1.330 ^a
	4	1.060 – 1.210	1.130 – 1.280 ^a	1.250 – 1.450 ^a	–
	2	1.210 – 1.400	1.300 – 1.500 ^a	1.450 – 1.650 ^a	–

Table 40.1 Continued on Next Page

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Table 40.1 Continued

Types of cord	AWG size of circuit and grounding conductors	2 circuit conductors without a grounding conductor	3 circuit conductors or 2 circuit conductors and either a breather tube ^a or one grounding conductor	4 circuit conductors or 3 circuit conductors and one grounding conductor or 3 circuit conductors and a breather tube ^a or 2 circuit conductors, a breather tube ^a , and one grounding conductor	5 circuit conductors or 4 circuit conductors and one grounding conductor or 3 circuit conductors, a breather tube ^a , and one grounding conductor
^a A breather tube is acceptable in nonretractile service cords with 2 or 3 circuit conductors with or without one grounding conductor. Dimensionally, a breather tube is to be counted as replacing an insulated conductor.					
^b The values are as follows for Type S, SE, SEOO, SOO, SO, SEO, ST, STOO, STO, SEW, SEOW, SOOW, SOW, SEOW, STW, STOO, and STOW cords that have No. 18 – 16 AWG circuit conductors and have one No. 14 AWG ground conductor:					
			Size of circuit conductor <hr style="width: 50%; margin: auto;"/>	Acceptable average overall cord diameter <hr style="width: 50%; margin: auto;"/>	
			18 AWG	0.395 – 0.450 inch	
			17	0.405 – 0.465	
			16	0.420 – 0.470	
			15	0.535 – 0.600	
^c The values are 0.985 – 1.135 inch for Type S, SE, SOO, SO, SEO, SEOO, ST, STOO, STO, SEW, SOOW, SOW, SEOW, SEOW, STW, STOO, and STOW cords that have three No. 6 AWG circuit conductors and, as indicated in 8.4(b), have one No. 8 AWG grounding conductor. Values will be added for the other constructions covered in 8.4(b) (the larger extra-hard-service cords are acceptable with one or more grounding conductors that are two AWG sizes smaller than the circuit conductors) as the need for manufacture of these cords becomes apparent.					
^d Where values are not shown, the diameter of such construction are not specified.					
^e The tabulated diameters do not apply to a cord that is intended for applications in which either:					
a) A fitting is molded onto each end of the cord or					
b) A fitting is molded onto one end of the cord and a means of strain relief is molded on toward the other end of the cord.					
For such applications, each production and shipping length of the finished cord shall be tag-marked or otherwise labeled to the following effect:					
Small- or large-diameter cord in process.					
Not for general use.					
For use only in cord sets and/or detachable power-supply cords having a fitting molded onto each end of the cord or a fitting molded onto one end of the cord and a means of strain relief molded on toward the other end of the cord.					
^f For retractile vacuum cleaner and service cords, only the minimum values apply. The maximum values are not specified.					

Table 40.2

Acceptable range ^{d,e,f} in millimeters of the average overall diameter of round, jacketed heater cords and of vacuum-cleaner and service cords

Table 40.2 revised February 6, 2001

Types of cord	AWG size of circuit and grounding conductors	2 circuit conductors without a grounding conductor	3 circuit conductors or 2 circuit conductors and either a breather tube ^a or one grounding conductor	4 circuit conductors or 3 circuit conductors and one grounding conductor or 3 circuit conductors and a breather tube ^a or 2 circuit conductors, a breather tube ^a , and one grounding conductor	5 circuit conductors or 4 circuit conductors and one grounding conductor or 3 circuit conductors, a breather tube ^a , and one grounding conductor
HSJ, HSJO	18	7.24 – 8.38	7.62 – 8.76	9.38 – 9.65	–
	16	7.75 – 8.89	8.26 – 9.52	9.02 – 10.29	–
	14	10.03 – 11.30	10.67 – 11.94	11.68 – 13.08	–
	12	11.05 – 12.32	11.68 – 13.08	12.95 – 14.48	–
SV, SVE, SVEO, SVOO, SVO, SVT, SVTOO, SVTO	18	5.59 – 6.48	5.84 – 6.73	–	–
	17	5.97 – 6.86	6.35 – 7.24	–	–
	16	6.22 – 7.11	6.60 – 7.49	–	–
SJ, SJE, SJOO, SJO, SJEO, SJEOO, SJT, SJTO, SJTOO, SJEW, SJOOW, SJOW, SJEOW, SJEOOW, SJTW, SJTOW, SJTOOW	18	7.11 – 8.00	7.62 – 8.51 ^a	8.26 – 9.27 ^a	–
	17	7.37 – 8.26	7.87 – 8.76 ^a	8.64 – 9.65 ^a	–
	16	7.75 – 8.64	8.26 – 9.14 ^a	8.89 – 10.03 ^a	–
	15	8.00 – 8.89	8.51 – 9.52 ^a	9.40 – 10.54 ^a	–
	14	8.51 – 9.52	9.14 – 10.03 ^a	9.91 – 11.05 ^a	–
	12	10.29 – 11.56	10.80 – 12.06 ^a	11.81 – 13.21 ^a	–
	10	13.72 – 15.37	14.35 – 16.13 ^a	15.88 – 17.78 ^a	–
S, SE, SOO, SEO, SEOO, ST, STOO, STO, SEW, SOOW, SOW, SEOW, SEOOW, STW, STOOW, STOW	18	8.64 – 9.78	9.14 – 10.16 ^{a,b}	9.78 – 10.92 ^a	11.68 – 12.95 ^a
	17	8.89 – 9.91	9.40 – 10.54 ^{a,b}	10.16 – 11.30 ^a	11.81 – 13.21 ^a
	16	9.27 – 10.41	9.78 – 10.92 ^{a,b}	10.41 – 11.68 ^a	12.45 – 13.97 ^a
	15	12.07 – 13.46	12.70 – 14.22 ^{a,b}	13.72 – 15.49 ^a	15.62 – 17.53 ^a
	14	12.57 – 13.97	13.21 – 14.60 ^a	14.22 – 15.75 ^a	16.00 – 17.91 ^a

Table 40.2 Continued on Next Page

Table 40.2 Continued

Types of cord	AWG size of circuit and grounding conductors	2 circuit conductors without a grounding conductor	3 circuit conductors or 2 circuit conductors and either a breather tube ^a or one grounding conductor	4 circuit conductors or 3 circuit conductors and one grounding conductor or 3 circuit conductors and a breather tube ^a or 2 circuit conductors, a breather tube ^a , and one grounding conductor	5 circuit conductors or 4 circuit conductors and one grounding conductor or 3 circuit conductors, a breather tube ^a , and one grounding conductor
S, SE, SOO, SEO, SEOO, ST, STOO, STO, SEW, SOOW, SOW, SEOW, SEOOW, STW, STOOW, STOW	12	14.35 – 15.88	14.99 – 16.64 ^a	16.26 – 18.03 ^a	17.78 – 19.56 ^a
	10	15.62 – 17.40	16.51 – 18.29 ^a	17.78 – 19.68 ^a	19.30 – 21.34 ^a
	8	19.81 – 22.35	21.08 – 23.62 ^a	23.50 – 26.67 ^a	25.40 – 29.21 ^a
	6	23.37 – 26.67	24.64 – 27.94 ^a	26.67 – 30.48 ^{a,c}	29.97 – 33.78 ^a
	4	26.92 – 30.73	28.70 – 32.51 ^a	31.75 – 36.85 ^a	–
	2	30.73 – 35.56	33.12 – 38.10 ^a	36.83 – 41.91 ^a	–

^a A breather tube is acceptable in nonretractile service cords with 2 or 3 circuit conductors with or without one grounding conductor. Dimensionally, a breather tube is to be counted as replacing an insulated conductor.

^b The values are as follows for Type S, SE, SEOO, SO, SEO, ST, STOO, STO, SEW, SEOOW, SOOW, SOW, SEO, STW, STOOW, and STOW cords that have No. 18 – 15 AWG circuit conductors and have one No. 14 AWG ground conductor:

Size of circuit conductor	Acceptable average overall cord diameter
18 AWG	10.03 – 11.43 mm
17	10.29 – 11.81
16	10.67 – 11.94
15	13.59 – 15.24

^c The values are 25.02 – 28.83 mm for Type S, SE, SOO, SO, SEO, SEOO, ST, STOO, STO, SOOW, SOW, SEOW, SEOOW, STW, STOOW, and STOW cords that have three No. 6 AWG circuit conductors and, as indicated in 8.4(b), have one No. 8 AWG grounding conductor. Values will be added for the other constructions covered in 8.4(b) (the larger extra-hard-service cords are acceptable with one or more grounding conductors that are two AWG sizes smaller than the circuit conductors) as the need for manufacture of these cords becomes apparent.

^d Where values are not shown, the diameter of such construction are not specified.

^e The tabulated diameters do not apply to a cord that is intended for applications in which either:

- a) A fitting is molded onto each end of the cord or
- b) A fitting is molded onto one end of the cord and a means of strain relief is molded on toward the other end of the cord.

For such applications, each production and shipping length of the finished cord shall be tag-marked or otherwise labeled to the following effect:

Small- or large-diameter cord in process.

Not for general use.

For use only in cord sets and/or detachable power-supply cords having a fitting molded onto each end of the cord or a fitting molded onto one end of the cord and a means of strain relief molded on toward the other end of the cord.

^f For retractile vacuum cleaner and service cords, only the minimum values apply. The maximum values are not specified.

41 Mechanical Strength

Section 41 effective July 2, 1998

41.1 The mechanical strength of a jacketed cord of the vacuum-cleaner or service type shall result in no circuit or grounding conductor breaking when a force, as specified in Table 41.1, is applied along the longitudinal axis of the finished cord for 1 min. A freely hanging weight or a mechanical-strength-testing machine capable of applying a constant force is to be used in conducting this test. The length of finished cord used in this test is to result in a section of approximately 3 ft or 1 m of the cord being between the clamps.

Table 41.1
Mechanical strength of vacuum-cleaner and service cords^a

Table 41.1 revised April 13, 2000

Type of cord	Size of conductors	Minimum acceptable force ^b at breaking point		
		lbf	N	kgf
SV, SVE, SVEO, SVO, SVOO, SVT, SVTO, SVTOO, SJ, SJE, SJO, SJEO, SJEOO, SJOO, SJT, SJTO, SJTOO, S, SE, SOO, SO, SEO, SEOO, ST, STOO, STO, SJEW, SJOW, SJEOW, SJEOOW, SJOOW, SJTW, SJTOW, SJTOOW, SEW, SOOW, SOW, SEOW, SEOOW, STW, STOOW, STOW	18 AWG	150	667	68.1
	17	170	756	77.1
^a The following cords need not be tested: <ol style="list-style-type: none"> 1. Cords having circuit conductors larger than No. 17 AWG. 2. Cords having a total number of conductors (circuit plus any grounding) greater than 3. 				

42 VW-1 (Vertical-Specimen) and FT1 Flame Test

42.1 Finished Type CXTW and XTW, finished fixture wire that is marked "VW-1", and finished flexible cord (including elevator cable) whose outer surface is marked "VW-1", "FT1", or both, as described in paragraph 79.1, shall be capable of complying with the VW-1 (Vertical-Specimen) Flame Test, Section 1080 of UL 1581 and shall also be capable of complying with the horizontal flame test referenced in 44.1. In the case of a flexible cord marked "VW-1" or a flexible cord marked "VW-1" and "FT1", the VW-1 test is to be made separately on the finished cord, on the circuit conductors from the finished cord (including any individual braid over the insulation) where the cord is other than the integral parallel type (that is, where the cord has a separable jacket), and on any grounding conductor (including any individual braid over the insulation) from the finished cord. In the case of a flexible cord marked "FT1" without also being marked "VW-1", the FT1 test is required only on the complete cord, not on any circuit or grounding conductor from the cord. In any case, a finished cord or wire that has a nylon jacket that is not required or has any other extra overall covering is to be VW-1 tested both with and without the extra covering. Where sufficient straight (non-coiled) length is not available, retractile cords are to be positioned for testing by pulling the specimen taut, without any unwinding, and then clamping the specimen in place.

42.1 revised February 6, 2001

43 Vertical Flame Test for Fixture Wires Other Than Types RFH-2 and FFH-2

43.1 A vertical specimen of finished Type XF, XFF, TF, TFF, TFN, TFFN, PF, PFF, PGF, PGFF, SF-1, SF-2, SFF-1, or SFF-2 fixture wire shall comply with the Vertical Flame Test, Section 1060 of UL 1581.

Revised 43.1 effective December 19, 1999

44 Horizontal-Specimen / FT2 Flame Test for Type CXTW Wire and All Flexible Cord Types

44.1 Each size of finished Type CXTW wire and each type and size of finished flexible cord (elevator cables are not included) shall be capable of complying with the Horizontal-Specimen / FT2 Flame Test, Section 1100 of UL 1581. Cord having a nylon jacket or other extra overall covering that is not required is to be tested both with and without the extra covering. Flat cord is to be tested with its flat surfaces vertical and with the gas flame applied to the center of one flat surface. Flat and round retractile cords are to be positioned for testing by pulling the specimen taut, without any unwinding, and then clamping the specimen in place. Flat retractile cords are to be positioned so that the gas flame is applied to a vertical flat surface of the cord.

Revised 44.1 effective December 19, 1999

44.2 Deleted effective December 19, 1999

45 Elevator Cables

Section 45 effective July 2, 1998

45.1 Conductor insulation

45.1.1 The thickness of insulation on elevator cables shall be as indicated in Table 45.1 (mils) or 45.2 (millimeters). See also 16.1.1 and 16.2.1.

Table 45.1
Thickness in mils of conductor insulation in elevator cables

Cable type	AWG size of conductor	Minimum acceptable average thickness	Minimum acceptable thickness at any point	Minimum acceptable thickness at line of contact
E and EO	20 – 16	20.0	18.0	16.0
	14 – 12 (300V)	30.0	27.0	24.0
	12, 10 (600 V)	45.0	40.0	36.0
	8 – 2	60.0	54.0	48.0
ETP, and ETT	20 – 16	20.0	18.0	–
	14 – 12 (300 V)	30.0	27.0	–
	12, 10 (600 V)	45.0	40.0	–
	8 – 2	60.0	54.0	–

Table 45.2
Thickness in millimeters of conductor insulation in elevator cables

Cable type	AWG size of conductor	Minimum acceptable average thickness	Minimum acceptable thickness at any point	Minimum acceptable thickness at line of contact
E and EO	20 – 16	0.51	0.46	0.41
	14 – 12 (300V)	0.76	0.69	0.61
	12, 10 (600 V)	1.14	1.02	0.91
	8 – 2	1.52	1.37	1.22
ETP, and ETT	20 – 16	0.51	0.46	–
	14 – 12 (300 V)	0.76	0.69	–
	12, 10 (600 V)	1.14	1.02	–
	8 – 2	1.52	1.37	–

45.2 Coverings on individual conductors

45.2.1 The braid on each individual conductor of Type E and EO cables shall be fibrous covering (see the last sentence of 18.1), and the braid on each individual conductor of Type ETT and ETP cables is optional (see the last sentence of 18.1). In either case, the braid is not required to be tested for flexibility (rupturing) by wrapping a specimen of the finished conductor around itself. Otherwise, the braid is required to comply with the requirements in 20.1.1 – 20.1.4. A cotton braid shall also comply with the requirements in 20.2.2 – 20.2.7, except that coverage in one direction is acceptable if it is less than 76 percent but shall not be less than 50 percent.

45.3 Length of lay of conductors

45.3.1 The individual finished, insulated conductors of an elevator cable shall be cabled together with a length of lay not greater than specified in Table 45.3. If the cable consists of a number of layers of conductors, the lay of successive layers shall be in opposite directions.

Table 45.3
Lay of conductors in elevator cables

Number of conductors	Maximum length of lay
2	30 times conductor diameter ^a
3	35 times conductor diameter ^a
4	40 times conductor diameter ^a
5 or more	15 times the calculated overall diameter of the assembly but, in a multiple-layer cable, the length of lay of the conductors in each of the inner layers is not specified (governed by the construction of the cabling machine).

^a "Conductor diameter" means the calculated diameter of one of the individual, finished, insulated conductors of which the cable is composed.

45.4 Overall braids

45.4.1 A cotton or rayon braid (see the last sentence of 18.1) shall be applied over the twisted conductor assembly of an elevator cable, except that in Type ETP cable a tape or braid is optional over each assembled group of conductors. Type E cable shall have a second braid or a rubber filled fibrous tape and a second braid. Each shall consist of the same size, ply, and kind. With the exception of Type E elevator cable, single ply yarn shall not be used in an outer braid. If a tape is used, it shall comply with

the requirements in 19.1 – 19.4. The outer braid or braids shall comply with the requirement in 20.1.1, except that they are not required to be tested for flexibility (rupturing) by wrapping a specimen of the finished cable around itself. The outer braid shall be saturated with a flame- and moisture-resistant compound which shall make the finished cable capable of complying with the flame test FT-1.

46 Conductor Assembly

Section 46 effective July 2, 1998

46.1 Types E, EO, and ETT

46.1.1 The conductors shall be cabled around a core composed of fibrous material, insulated steel wires, fibrous-covered insulated steel wires, or a combination of these materials. The insulation shall have an average thickness of at least 10 mils or 0.25 mm. If desired, suitable fillers may be cabled with the individual insulated conductors.

46.2 Type ETP

46.2.1 The assembly shall consist of two or more insulated conductors or groups of insulated conductors, laid in parallel to form a flat cable. One or more webs may be provided, composed of the same material as the jacket. Support members may be provided and placed in the center of the group(s) or other suitable position(s) and composed of materials as outlined in 46.1.1. When support members are used outside of the group construction, the insulation on steel members is optional and webs shall be provided between the support members and adjacent conductors or groups.

47 Optical-Fiber Members

Section 47 effective July 2, 1998

47.1 Each optical-fiber member shall be assembled into the cable as if it were an electrical conductor – that is, optical-fiber members shall be cabled with the same direction and length of lay as the electrical elements of the cable. In an elevator cable, a group of optical-fiber members that does not have an electrical conductor or conductors in the group may include one or more non-current-carrying, electrically conductive parts such as a metal strength element or a metal vapor barrier. The construction of these parts is not specified.

48 Test of Type HPN Cord for Arcing Caused by Flame

Section 48 effective July 2, 1998

48.1 Arcing shall not occur between the circuit conductors of finished Type HPN cord having two circuit conductors with or without a grounding conductor when the conductors in a horizontal length of the cord are energized by a 48 – 62 Hz essentially sinusoidal potential of 120 V rms while a test flame is applied to the cord for 2 min. The test is to be made as described in 1670.1 and 1670.2 of UL 1581.

49 Test of Type HPN Cord for Penetration of the Insulation by Arcing

Section 49 effective July 2, 1998

49.1 The insulation of Type HPN cord shall not be penetrated by 20 cycles of arcing between the ends of the strands of one circuit conductor that is broken but remains contained within the insulation. Each size of the cord shall be tested at rated current and voltage, and the test shall be completed on at least three specimens as described in 1680.1– 1680.11 of UL 1581.

49A Conductor Resistance

Section 49A added March 13, 2001

49A.1 D-C Resistance Test

49A.1.1 Where measured as the means of size verification (see 9.1), the direct-current resistance of any length of circuit and grounding conductor in ohms based on 1000 conductor feet or in ohms based on a conductor kilometer shall not be higher than the following maximum value for the marked size of the solid or stranded construction:

- a) TINSEL CONDUCTORS – See the maximum value in 11.3.
- b) SOLID AND STRANDED COPPER CONDUCTORS THAT ARE UNCOATED OR ARE COATED WITH TIN OR A TIN/LEAD ALLOY – See the maximum value in Table 49A.1, 49A.2, 49A.3, or 49A.4 as applicable. See 49A.1.4.
- c) SOLID AND STRANDED COPPER CONDUCTORS THAT ARE COATED WITH SILVER OR NICKEL FOR USE IN FLEXIBLE CORDS OR FIXTURE WIRES AS STATED IN 7.2 – Calculate the maximum value as described in 49A.1.2. See 49A.1.4.
- d) CONDUCTORS OF THE NICKEL-BASE ALLOY STATED IN 7.2 FOR USE IN FIXTURE WIRES – Calculate the maximum value as described in 49A.1.2.

See 49A.1.3 regarding measurements at other temperatures. All resistance measurements are to be conducted as described in D-C Conductor Resistance, Section 220 of UL 1581.

49A.1.2 For the silver-coated, nickel-coated, and nickel-base-alloy conductors referenced in 49A.1.1(c) and (d), the maximum resistance for the marked size of the solid or stranded construction is to be determined by multiplying the maximum resistance for uncoated copper of the same size and construction by the ratio of 100 percent IACS (International Annealed Copper Standard) to the percent conductivity of the conductor under consideration. For example, to determine the maximum resistance R at 25°C (77°F) of a solid 18 AWG conductor with a nickel coating of a thickness equal to 10 percent of the diameter over the conductor, note that Table 49A.4 assigns a value of 6.66 ohms per 1000 conductor feet or 21.84 ohms per conductor kilometer to the uncoated solid copper conductor and that ASTM B 355-95 assigns a conductivity of 88.0 percent to the Class 10 nickel-coated conductor.

$$R_{\text{max at } 25^{\circ}\text{C}} = 6.66 \times 100/88 = 7.57 \Omega \text{ per } 1000 \text{ conductor feet}$$

or

$$= 21.84 \times 100/88 = 24.82 \Omega \text{ per conductor kilometer}$$

49A.1.3 A conductor complies without temperature adjustment of the resistance values read where readings at a temperature higher than 20 or 25°C are below the value in the applicable table for 20 or 25°C. All other resistance readings at temperatures higher or lower than 20 or 25°C are to be adjusted to the resistance at 20 or 25°C by means of the applicable multiplying factor from Table 220.1 of UL 1581.

49A.1.4 The direct-current resistance of each circuit and grounding conductor in a finished cable or cord shall not exceed the single-conductor value referred to in 49A.1.1 and 49A.1.2. The resistance maximums are not to be raised to compensate for the increase in conductor length due to cabling. In the case of a conductor not complying, the cable or cord is to be disassembled and the resistance of the conductor is to be measured on an axial length of the conductor known to the accuracy specified in 220.6 of UL 1581 and at least 10 ft or 3 m long.

Table 49A.1
Maximum direct-current resistance of flexible-stranded copper conductors at 20°C (68°F)

AWG conductor size	Uncoated	Tin/lead coated or tin coated		
		36 – 30 AWG strands	29 – 24 AWG strands	23 – 10 AWG strands
Ohms per 1000 conductor feet				
22 ^a	16.9	18.1	17.9	17.5
20 ^a	10.6	11.4	11.2	11.0
18 ^a	6.66	7.15	7.07	6.93
17 ^a	5.27	5.66	5.60	5.48
16 ^a	4.18	4.49	4.44	4.35
14 ^a	2.62	2.82	2.79	2.73
12 ^a	1.65	1.77	1.75	1.72
10 ^a	1.04	1.12	1.10	1.08
8 ^a	0.653	0.702	0.694	0.680
6 ^b	0.419	0.450	0.445	0.436
4 ^b	0.264	0.283	0.280	0.274
2 ^b	0.166	0.178	0.176	0.173
Ohms per conductor kilometer				
22 ^a	55.4	59.4	58.7	57.5
20 ^a	34.8	37.2	36.9	36.1
18 ^a	21.8	23.4	23.2	22.7
17 ^a	17.3	18.5	18.4	18.0
16 ^a	13.7	14.7	14.6	14.3
14 ^a	8.59	9.24	9.15	8.96
12 ^a	5.41	5.82	5.75	5.64
10 ^a	3.41	3.66	3.62	3.54
8 ^a	2.14	2.30	2.28	2.23
6 ^b	1.37	1.48	1.46	1.43
4 ^b	0.866	0.928	0.918	0.899

Table 49A.1 Continued on Next Page

Table 49A.1 Continued

AWG conductor size	Uncoated	Tin/lead coated or tin coated		
		36 – 30 AWG strands	29 – 24 AWG strands	23 – 10 AWG strands
2 ^b	0.544	0.584	0.578	0.566
^a Single bunch.				
^b Rope lay.				

Table 49A.2
Maximum direct-current resistance of flexible-stranded copper conductors at 25°C (77°F)

AWG conductor size	Uncoated	Tin/lead coated or tin coated		
		36 – 30 AWG strands	29 – 24 AWG strands	23 – 10 AWG strands
Ohms per 1000 conductor feet				
22 ^a	17.2	18.5	18.3	17.9
20 ^a	10.8	11.6	11.5	11.2
18 ^a	6.79	7.29	7.21	7.06
17 ^a	5.37	5.77	5.71	5.59
16 ^a	4.26	4.58	4.53	4.44
14 ^a	2.67	2.87	2.84	2.78
12 ^a	1.68	1.81	1.79	1.75
10 ^a	1.06	1.14	1.13	1.10
8 ^a	0.666	0.715	0.708	0.693
6 ^b	0.427	0.459	0.454	0.445
4 ^b	0.269	0.289	0.286	0.280
2 ^b	0.169	0.182	0.180	0.176
Ohms per conductor kilometer				
22 ^a	56.5	60.5	59.9	58.6
20 ^a	35.5	38.0	37.6	36.8
18 ^a	22.3	23.9	23.7	23.2
17 ^a	17.6	18.9	18.7	18.3
16 ^a	14.0	15.0	14.9	14.5
14 ^a	8.76	9.42	9.33	9.13
12 ^a	5.52	5.93	5.87	5.75
10 ^a	3.48	3.73	3.69	3.61
8 ^a	2.18	2.35	2.32	2.27
6 ^b	1.40	1.51	1.49	1.46
4 ^b	0.883	0.947	0.936	0.917
2 ^b	0.555	0.595	0.589	0.577
^a Single bunch.				
^b Rope lay.				

Table 49A.3
Maximum direct-current resistance of solid and non-flexible stranded copper conductors at 20°C
(68°F)

AWG conductor size	Solid		Concentric or single bunch stranded			
	Uncoated	Tin/lead coated or tin coated	Uncoated	Tin/lead coated or tin coated		
				7 strands	19 strands	37 – 61 strands
Ohms per 1000 conductor feet						
20	10.4	10.8	10.6	11.2	11.4	–
18	6.53	6.79	6.66	7.07	7.15	–
16	4.10	4.26	4.18	4.44	4.44	–
14	2.57	2.68	2.62	2.73	2.79	2.82
12	1.62	1.68	1.65	1.72	1.75	1.75
10	–	–	1.04	1.08	1.08	1.10
8	–	–	0.653	–	0.680	0.694
6	–	–	0.411	–	0.421	0.437
4	–	–	0.259	–	0.269	0.275
2	–	–	0.163	–	–	–
Ohms per conductor kilometer						
20	34.02	35.37	34.77	36.85	37.24	–
18	21.42	22.27	21.84	23.20	23.45	–
16	13.45	13.99	13.71	14.57	14.57	–
14	8.44	8.78	8.59	8.95	9.14	9.24
12	5.31	5.53	5.41	5.64	5.76	5.76
10	–	–	3.41	3.55	3.55	3.62
8	–	–	2.14	–	2.23	2.28
6	–	–	1.35	–	1.38	1.43
4	–	–	0.85	–	0.882	0.901
2	–	–	0.53	–	–	–

Table 49A.4
Maximum direct-current resistance of solid and non-flexible stranded copper conductors at 25°C
(77°F)

AWG conductor size	Solid		Concentric or single bunch stranded			
	Uncoated	Tin/lead coated or tin coated	Uncoated	Tin/lead coated or tin coated		
				7 strands	19 strands	37 – 61 strands
Ohms per 1000 conductor feet						
20	10.6	11.0	10.8	11.5	11.6	–
18	6.66	6.92	6.79	7.21	7.29	–
16	4.18	4.35	4.26	4.53	4.53	–
14	2.62	2.73	2.67	2.78	2.84	2.87
12	1.65	1.72	1.68	1.75	1.79	1.79
10	–	–	1.06	1.10	1.10	1.13
8	–	–	0.666	–	0.693	0.708
6	–	–	0.419	–	0.429	0.445
4	–	–	0.264	–	0.274	0.280
2	–	–	0.166	–	–	–
Ohms per conductor kilometer						
20	34.69	36.07	35.45	37.58	37.98	–
18	21.84	22.71	22.27	23.66	23.91	–
16	13.71	14.26	13.98	14.86	14.86	–
14	8.61	8.95	8.76	9.13	9.32	9.43
12	5.42	5.63	5.52	5.75	5.87	5.87
10	–	–	3.48	3.62	3.62	3.69
8	–	–	2.18	–	2.27	2.321
6	–	–	1.38	–	1.41	1.461
4	–	–	0.86	–	0.899	0.918
2	–	–	0.54	–	–	–

DIELECTRIC TESTS

50 Fixture and Decorative-Lighting Wires– Spark Test

Section 50 effective July 2, 1998

50.1 The insulation on a finished fixture wire and the insulation on a finished CXTW wire shall be capable of withstanding without breakdown the application of a 50 - 4000 Hz essentially sinusoidal test potential (rms) as specified in Table 50.1. The test shall be made with the spark-testing equipment as described in Method, Section 900 of UL 1581 with 50.2 substituted for 900.12 of UL 1581.

50.1 revised April 13, 2000

Table 50.1
Spark-test potential for single conductors

Table 50.1 revised January 19, 1998

Type of wire	RMS test voltage
SF-1, SFF-1, XF, XFF	3000
RFH-2, FFH-2, SF-2, SFF-2, TF, TFF, PF, PFF, PGF, PGFF, TFN, TFFN, CXTW	6000

50.2 The conductor of the wire shall be earth-grounded during the spark test. If the conductor coming from the pay-off reel is bare, the conductor shall be earth-grounded at the pay-off reel or at another point at which continuous contact with the bare conductor, prior to the insulating process, is maintained but need not be tested for continuity or earth-grounded at the take-up reel. If the conductor coming from the pay-off reel is insulated, an earth-ground connection shall be made at both the pay-off and take-up reels except that, if the wire is tested for continuity and the conductor is of one integral length, the earth-ground connection need be made at only one point – at either the take-up or pay-off reel. In any case, each earth-ground connection shall be bonded directly to the earth ground in the spark tester.

51 Flexible Cords – Dielectric Voltage-Withstand and Spark Tests

Section 51 effective July 2, 1998

51.1 The insulation on the individual conductors of a flexible cord shall result in a full-length coil or reel of the finished cord being capable of withstanding without breakdown, for 1 min, the application of a 48 – 62 Hz essentially sinusoidal test potential (rms) between conductors as specified in Table 51.1. The test is to be made as described in Dielectric Voltage-Withstand Test for Cord Conductors, Section 800 of UL 1581.

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Table 51.1
RMS test potentials for insulated conductors of flexible cords

Table 51.1 revised February 6, 2001

Type of cord or cable	Voltage rating	AWG conductor size	Average thickness of insulation		Voltage-withstand test potential in volts ^a	Spark potential in volts ^{b,d}
			mils	mm		
TPT and shaver cords	300	27	30	0.76	1000	6000
TST	300	27	15	0.38	1000	3000
XTW	300	22, 20, 18 parallel	30	0.76	1250	6000
Clock cord	125	20 parallel	30	0.76	1250	5000
CXTW	300	22, 20, 18	30	0.76	1250	5000
C, PD	300	18 – 16	30	0.76	1500	6000
		14 – 10	45	1.14	1500	6000
SP-1, SPE-1, SPT-1W, and SPT-1	300	18	30	0.76	1500	6000 ^c
SP-2, SPE-2, SPT-2W, and SPT-2	300	18 – 16	45	1.14	1500	6000 ^c
SP-3, SPE-3, and SPE-3	300	18 – 14	Table 16.6		1500	6000 ^c
		12 – 10			2000	7500 ^c
NISP-1, NISPE-1, and NISPT-1	300	18	15	0.38	1500	3000
NISP-2, NISPE-2, and NISPT-2	300	18 – 16	30	0.76	1500	5000
SVOO, SVO, SVEO, SVTOO, SVTO, SV, SVE, and SVT	300	18, 17	15	0.38	1500	3000

Table 51.1 Continued on Next Page

Table 51.1 Continued

Type of cord or cable	Voltage rating	AWG conductor size	Average thickness of insulation		Voltage-withstand test potential in volts ^a	Spark potential in volts ^{b,d}
			mils	mm		
SJOO, SJO, SJ, SJEEO, SJEO, SJE, SJTOO, SJTO, SJT, SJOOW, SJOW, SJEOW, SJEOW, SJEOW, SJTOOW, SJTOW, and SJTW	300	18 – 12	30	0.76	2000	6000
		10	45	1.14	2000	7500
SOO, SO, SEOO, SEO, STOO, STO, S, SE, ST, SOOW, SOW, SEOW, SEOW, STOOW, STOW, SEW, and STW	600	18 – 16	30	0.76	2000	6000
		14 – 10	45	1.14	3000	7500
		8 – 2	60	1.52	4000	10,000
HSJO, HSJ, and HPD	300	18 – 15	30	0.76	1500	6000
		14 – 12	45	1.14	1500	7500
HPN	300	18 – 16	Table 16.6		1500	6000
		14			1500	7500
		12			2000	7500
SRD, SRDE, and SRDT	300	10 – 4	45	1.14	1500	6000
E, EO, ETT, ETP, and hoistway cable	300	20	20	0.51	1000	3000
		18 – 16	20	0.51	1500	3000
		14 – 12	30	0.76	1500	6000
		600	12 – 10	45	1.14	3000
		8 – 2	60	1.52	4000	10,000

^a For routine production dielectric voltage-withstanding testing, the time of application of the test potential may be 15 s instead of 1 min. See also note ^b.

^b For routine production testing, a spark test may be substituted for the dielectric voltage-withstand test between conductors if all of the individual conductors of each cord are tested at the potential indicated in this column in accordance with Method, Section 900 of UL 1581.

^c If a spark test is employed for routine production testing of 3-conductor Type SP-1, SPE-1, SPT-1, SP-2, SPE-2, SPT-2, SP-3, SPE-3, SPT-3 cord (see 16.3.3.2), the green conductor with or without one or more yellow stripes is not to be connected to either of the other conductors, to earth ground, or to any part of the electrical test circuit while the product is being run through the electrode.

Table 51.1 Continued

Type of cord or cable	Voltage rating	AWG conductor size	Average thickness of insulation		Voltage-withstand test potential in volts ^a	Spark potential in volts ^{b,d}
			mils	mm		
^d In lieu of the RMS values in this column, DC voltages of 3 times the RMS values may be substituted. See Spark Tests for Power-Limited Circuit Cable and for Cable for Power-Limited Fire-Alarm Circuits, Section 910 of UL 1581.						

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INSULATION-RESISTANCE TESTS

52 Thermoplastic-Insulated Fixture Wires

Section 52 effective July 2, 1998

52.1 Class 43 PVC conductor insulation and Class 12B (UL 1581) PVC conductor insulation shall make a finished insulated conductor have an insulation resistance of not less than 2.5 megohms based on 1000 conductor feet, or not less than 0.762 megohm based on a conductor kilometer, when tested in tap water at room temperature at the end of an immersion of not less than 6 h. The test is to be made as described in Insulation-Resistance Test in Water, Section 920 of UL 1581.

52.2 The temperature of the water in which the coil is immersed has a marked effect upon the insulation resistance, and readings are to be multiplied by the applicable multiplying factor M from Table 52.1, except that it is acceptable, if so requested, to use other values found by test to be applicable to a particular PVC compound.

52.3 Class 12A FEP and Class 12C (UL 1581) PTFE conductor insulation shall make a finished insulated conductor have an insulation resistance of not less than 1000 megohms based on 1000 conductor feet, or not less than 305 megohms based on a conductor kilometer, when tested in tap water at room temperature at the end of an immersion of not less than 6 h. The test is to be made as described in 920.1 – 920.6 of UL 1581. The temperature factors M in Table 52.1 do not apply. For FEP and PTFE, the temperature factor is 1.00 for any room temperature.

Table 52.1
Multiplying factor M for insulation resistance test for PVC insulated fixture wire

Temperature ^a		M
°F	°C	
50	10.0	0.79
51	10.6	0.81
52	11.1	0.82
53	11.7	0.84
54	12.2	0.86
55	12.8	0.88
56	13.3	0.90
57	13.9	0.92
58	14.4	0.95
59	15.0	0.97
60	15.6	1.00
61	16.1	1.03
62	16.7	1.06
63	17.2	1.10
64	17.8	1.14
65	18.3	1.19
66	18.9	1.23
67	19.4	1.27
68	20.0	1.33
69	20.6	1.39
70	21.1	1.46

Table 52.1 Continued on Next Page

Table 52.1 Continued

Temperature ^a		M
°F	°C	
71	21.7	1.56
72	22.2	1.67
73	22.8	1.78
74	23.3	1.91
75	23.9	2.06
76	24.4	2.23
77	25.0	2.39
78	25.6	2.56
79	26.1	3.03
80	26.7	3.21
81	27.2	3.40
82	27.8	3.60
83	28.3	3.82
84	28.9	4.05
85	29.4	4.30

^a The temperature of the water in which the coil or coils are immersed at the time that the insulation-resistance reading is taken is the basis for selection of the factor. If, because of hot or cold weather or local conditions, the temperature of the insulation to be tested differs by more than 5.0°F (2.8°C) from the temperature of the water in which the insulation is to be immersed, the test results after immersion for the number of hours indicated in 52.1 are not accurate unless one of the following is accomplished before insulation-resistance readings are taken:

a) The wire or cord is to be left in the water long enough to attain the same temperature in the water. The water and the wire or cord immersed in it are to be considered to be at the same temperature when three successive measurements of the d-c resistance of the conductor made at 30-min intervals by means of an acceptable Kelvin-bridge ohmmeter or its equivalent show no change.

The water is to be heated or cooled, as necessary, to within 5.0°F (2.8°C) of the temperature of the wire before the wire is immersed for the number of hours indicated in 52.1

53 Conductors from Indoor Service Flexible Cords and Hoistway Cables

53.1 The insulation resistance of the insulated conductors at 15.6°C (60°F) shall not be less than 2.5 M-ohms based on 1000 conductor feet, or 0.762 M-ohms based on a conductor kilometer, when tested immediately following the dielectric strength test in Flexible Cords – Dielectric Voltage-Withstand and Spark Tests, Section 51. See Outdoor Service Cord, Section 32, and Type SPT-2W, SPT-1W, XTW, and CXTW Cords for Decorative Lighting, Section 35, for values of insulation resistance for outdoor service cords. See Adjusting Insulation Resistance to 15.6°C (60°F), Section 33, for adjusting insulation resistance to 15.6°C (60°F).

53.1 revised October 13, 1998

54 Conductors Insulated with XLPO

Section 54 effective July 2, 1998

54.1 Class 38 (UL 1581) XLPO insulation shall make a finished insulated conductor have an insulation resistance of not less than 2500 megohms based on 1000 conductor feet, or not less than 762 megohms based on a conduct kilometer, when tested in tap water at room temperature at the end of an immersion of not less than 6 h. The test is to be made as described in 920.1 – 920.6 of UL 1581.

55 Silicone-Rubber-Insulated Conductors

Section 55 effective July 2, 1998

55.1 Class 22 (UL 1581) silicone-rubber conductor insulation shall make a finished insulated conductor have an insulation resistance of not less than 100 megohms based on 1000 conductor feet, or not less than 30.5 megohms based on a conductor kilometer, when tested in tap water at room temperature at the end of an immersion of not less than 6 h. The temperature of the water during the last hour shall be $15.6 \pm 1.0^\circ\text{C}$ ($60.0 \pm 1.8^\circ\text{F}$). The test is to be made as described in 920.1 – 920.6 of UL 1581. The temperature factors M in Table 52.1 do not apply. For silicone, the temperature factor is 1.00 for any room temperature.

HEAT SHOCK RESISTANCE TEST

56 General

Section 56 effective July 2, 1998

56.1 Insulation or jacket shall not show any cracks (either on the inside or outside surface) after a specimen is wound around a mandrel in accordance with Tables 56.1 – 56.3 and then is subjected to a temperature of $121.0 \pm 1.0^\circ\text{C}$ ($249.8 \pm 1.8^\circ\text{F}$) for PVC and to a temperature of $150.0 \pm 1.0^\circ\text{C}$ ($302.0 \pm 1.8^\circ\text{F}$) for TPE in a full-draft circulating-air oven for 1 h as described in 540.1 of UL 1581.

56.2 The insulation and jacket on finished Type TFN and TFFN wire shall comply with the requirement in 56.1 when using a mandrel having a diameter of 0.094 inch or 2.5 mm and when tested with the nylon in place.

Table 56.1
Mandrel diameters for parallel cord in heat-shock resistance test

Revised Table 56.1 effective October 13, 2000

Type	AWG size	Mandrel diameter	
		inch	mm
XTW	22	0.094	2.5
	20	0.094	2.5
	18	0.094	2.5
Clock, SPT-1W, SPE-1, and SPT-1	18	0.109	2.76
	20	0.094	2.5
SPT-2, SPT-2W, SPE-2	18	0.166	4.0
	16	0.188	5.0
SPT-2, SPE-3	18	0.188	5.0
	16	0.219	5.5
	14	0.250	6.0
	12	0.281	7.0
	10	0.312	8.0
TPT	27	0.094	2.5

Table 56.2
Mandrel diameters for conductor insulation in heat-shock resistance test – Type CXTW cord, other cords with twisted conductors, and Type CXTW wire

AWG sizes	Insulation thickness		Mandrel diameter	
	Mils	mm	inch	mm
22, 20	30	0.76	0.094	2.5
18 AWG	15	0.38	0.094	2.5
18 SVT, SVTO, SVTOO, SVE, SVEO, SVEEO	15	0.38	0.109	2.75
18, 17	30	0.76	0.125	3.0
18	45	1.14	0.156	4.0
17, 16 SVT, SVTO, SVTOO, SVE, SVEO, SVEEO	15	0.38	0.125	3.0
16, 15	30	0.76	0.141	3.5
16	45	1.14	0.177	4.5
14	45	1.14	0.188	5.0
14	60	1.52	0.236	6.0
12	45	1.14	0.219	5.5
12	60	1.52	0.250	6.5
10	45	1.14	0.250	6.5
8	60	1.52	0.312	8.0
6	60	1.52	0.359	9.0
4	60	1.52	0.422	10.5
2	60	1.52	0.500	13.0

Table 56.3
Mandrel diameter for heat-shock resistance test

Overall diameter of finished cord or minor dimension of flat cords		Diameter of mandrel	
inch	mm	inch	mm
0.0 – 0.25	0.0 – 6.35	0.5	12.7
0.251 – 0.312	6.36 – 7.92	0.81	20.6
0.313 – 0.375	7.93 – 9.52	1.13	28.6
0.376 – 0.437	9.53 – 11.1	1.37	34.9
0.438 – 0.500	11.2 – 12.7	1.69	42.8
0.501 – 0.563	12.8 – 14.3	2.00	50.8
0.564 – 0.626	14.4 – 15.9	2.13	54.0
0.627 – 0.685	16.0 – 17.4	2.56	65.1
0.686 – 0.748	17.5 – 19.0	2.87	73.0
0.749 – 0.850	19.1 – 21.6	3.13	79.4
0.851 – 1.00	21.7 – 25.4	3.25	82.6
1.01 – 1.13	25.5 – 28.6	3.50	88.9
1.14 – 1.25	28.7 – 31.7	3.75	95.3
1.26 – 1.37	31.8 – 34.9	4.25	108

Table 56.3 Continued on Next Page

Table 56.3 Continued

Overall diameter of finished cord or minor dimension of flat cords		Diameter of mandrel	
inch	mm	inch	mm
1.38 – 1.50	35.0 – 38.1	4.50	114
1.51 – 1.63	38.2 – 41.3	5.00	127
1.64 – 1.75	41.4 – 44.4	5.25	133
1.76 – 1.87	44.5 – 47.6	5.63	143
1.88 – 2.00	47.7 – 50.8	6.00	152

Notes:
For round cable having an overall diameter less than 19 mm, the specimen shall be wound six close turns around the mandrel.
For round cable having a diameter of 19 mm or greater, the specimen shall be wound one complete turn around the mandrel.
For flat cables having a major dimension less than 25 mm, the specimen shall be wound six turns around the mandrel. For flat cables having a major dimension of 25 mm or greater, the specimen shall be wound one turn around the mandrel.

DEFORMATION TEST

57 General

Section 57 effective July 2, 1998

57.1 Specimens of Class 2.9, 2.11, 2.22 or 2.29 PVC insulation (integral insulation and jacket in the case of clock cord and Type XTW cord) or jacket from finished flexible cord other than Type TPT, and specimens of 60°C Class 2.9 PVC insulation from finished Type TF and TFF fixture wire, shall decrease no more than 50 percent in thickness – that is T_2/T_1 shall be 0.50 or more – under the load indicated in Table 57.1 while being maintained at a temperature of $121.0 \pm 1.0^\circ\text{C}$ ($249.8 \pm 1.8^\circ\text{F}$). The method of test is described in 560.1 – 560.6 of UL 1581.

57.2 Specimens of Class 2.24 FEP insulation from finished fixture wire Type PF, PFF, PGF, and PGFF shall decrease no more than 25 percent in thickness – that is, T_2/T_1 shall be 0.75 or more – under the load indicated in Table 57.1 while being maintained at a temperature of $121.0 \pm 1.0^\circ\text{C}$ ($249.8 \pm 1.8^\circ\text{F}$). The method of test is described in 560.1 – 560.6 of UL 1581.

57.3 The thickness of 90°C Class 2.22 PVC insulation in and the nylon jacket on finished Type TFN and TFFN wire shall decrease no more than 25 percent – that is, T_2/T_1 shall be 0.75 or more – when a specimen of the finished wire (with the nylon in place) is tested as indicated in 560.1 – 560.6 of UL 1581, at $136.0 \pm 1.0^\circ\text{C}$ ($276.8 \pm 1.8^\circ\text{F}$) and the measurements are made over the nylon.

57.4 Specimens of Class 2.13 XLPE-insulated grounding conductor taken from finished cord and of Type XF and XFF fixture wires insulated with Class 38 (UL 1581) XLPO shall decrease no more than 50 percent in thickness – that is, T_2/T_1 shall be 0.50 or more under the load indicated in Table 57.1 while being maintained at a temperature of $121.0 \pm 1.0^\circ\text{C}$ ($249.8 \pm 1.8^\circ\text{F}$). The method of test is described in 560.1 – 560.6 of UL 1581.

57.5 Specimens of Class 2.26 PE insulation taken from finished cord shall not decrease more than 50 percent in thickness – that is, T_2/T_1 shall be 0.50 or more – when, as indicated in 560.1 – 560.6 of UL 1581, a specimen of the insulated conductor is tested under the load indicated in Table 57.1 while being maintained at a temperature of $100.0 \pm 1.0^\circ\text{C}$ ($212.0 \pm 1.8^\circ\text{F}$).

57.6 Specimens of Class 1.14, 1.18, 2.20 and 2.28 TPE insulation, integral insulation and jacket, or jacket from the finished cord or cable shall decrease no more than 50 percent in thickness that is, T_2/T_1 shall be 0.50 or more – under the load indicated in Table 57.1 while being maintained at a temperature of $150.0 \pm 1.0^\circ\text{C}$ ($302.0 \pm 1.8^\circ\text{F}$). The method of test is to be as described in 560.1 – 560.6 of UL 1581.

Table 57.1
Specimen loading

Table 57.1 revised April 13, 2000

Specimen	Load exerted on specimen
	gf
Nos. 24 and 22 AWG insulated conductors (separated if from parallel cords)	200
Nos. 20, 18, and 17 AWG insulated conductors (separated if from parallel cords)	300
Nos. 16 and 15 AWG insulated conductors (separated if from parallel cords)	400
Type PF, PFF, PGF, and PGFF fixture wires	500
No. 14 AWG and larger sizes of insulated conductor (separated if from parallel cords)	500
Jacket	2000

COLD-BEND TEST

58 General

Section 58 effective July 2, 1998

58.1 Specimens shall not show any inside or outside surface cracks when, as indicated in 580.1 of UL 1581, a specimen that has been subjected for 4 h to the low temperature indicated in Table 58.2 is wound around the diameter of mandrel indicated in Table 58.1 while the mandrel and specimen are at the test temperature.

58.2 The 90°C Class 12B (UL 1581) PVC insulation and nylon jacket on Type TFN and TFFN wire shall comply with the requirements in 56.1 using a temperature of $-20.0 \pm 2.0^{\circ}\text{C}$ ($-4.0 \pm 3.6^{\circ}\text{F}$) when tested with the nylon in place.

58.3 Class 2.26 PE insulation taken from finished cord shall not show any inside or outside surface cracks when, as indicated in 580.1 of UL 1581, a specimen of the insulated conductor that has been subjected for 4 h to air at a temperature of $-20.0 \pm 2.0^{\circ}\text{C}$ ($-4.0 \pm 3.6^{\circ}\text{F}$) is wound around the diameter of mandrel indicated in Table 58.1 while the mandrel and specimen are at the test temperature.

58.4 The Class 1.14, 1.18 TPE jacket and the Class 2.20 and 2.28 TPE insulation on an individual insulated conductor removed from finished Type SEOO, SEO, SE, SJEOO, SJEO, SVEOO, SVEO, or SVE cord or round Type SRDE, SPE-1, NISPE-1, SPE-2, or NISPE-2 cord or the Class 1.14 and 1.18 TPE integral insulation and jacket on the complete finished parallel Type SRDE, SPE-1, SPE-2, or SPE-3 cord shall not show any cracks on the inside or outside surface when, as indicated in 580.1 of UL 1581, a specimen of the insulated conductor or complete cord that has been subjected for 4 h to circulating air that is at a temperature of $-50.0 \pm 2.0^{\circ}\text{C}$ ($-58.0 \pm 3.6^{\circ}\text{C}$) for cord that is surface marked “-50C” or “minus 50C”, or $-40.0 \pm 2.0^{\circ}\text{C}$ ($-40.0 \pm 3.6^{\circ}\text{F}$) for cord that may be surface marked “-40C” or “minus 40C”, is wound around the diameter of mandrel indicated in Table 58.1 while the mandrel and specimen are at the test temperature.

Revised 58.4 effective April 13, 1999

58.5 The Class 38 (UL 1581) XLPO insulation on Type XF and XFF fixture wires shall not show any cracks on the inside or outside surface when, as indicated in 580.1 of UL 1581, a specimen of the insulated conductor that has been subjected for 4h to air at a temperature of $-20.0 \pm 2.0^{\circ}\text{C}$ ($-4.0 \pm 3.6^{\circ}\text{F}$) is wound around the diameter of mandrel indicated in Table 58.1 while the mandrel and specimen are at the test temperature.

Table 58.1
Mandrel diameters and number of turns in cold-bend test

Overall diameter of finished round conductor or cord or length of minor axis of flat cord		Mandrel diameter		Number of complete turns of specimen around mandrel
inch	mm	inch	mm	
0.125 or less	3.18 or less	0.250	6.5	6
0.250	6.35	0.500	12.7	6
0.375	9.52	0.750	19.0	6
0.500	12.70	1.000	25.4	6
0.625	15.88	1.250	31.8	6
0.750	19.05	1.500	38.0	1
0.875	22.22	1.750	44.5	1
1.000	25.40	2.000	50.8	1
1.125	28.58	2.250	57.1	1
1.250	31.75	2.500	63.5	1
1.375	34.92	2.750	69.9	1
1.500	38.10	3.000	76.2	1
1.625	41.28	3.250	82.6	1
1.750	44.45	3.500	88.9	1
1.875	47.62	3.750	95.2	1
2.000	50.80	4.000	101.6	1

Table 58.2
Temperature for cold-bend test

Table 58.2 revised May 18, 1998

Item being tested	Test temperature
Wire or cord marked "-70C" or "minus 70C"	$-70.0 \pm 2.0^{\circ}\text{C}$ ($-94.0 \pm 3.8^{\circ}\text{F}$)
Wire or cord marked "-60C" or "minus 60C"	$-60.0 \pm 2.0^{\circ}\text{C}$ ($-76.0 \pm 3.8^{\circ}\text{F}$)
Wire or cord marked "-50C" or "minus 50C"	$-50.0 \pm 2.0^{\circ}\text{C}$ ($-58.0 \pm 3.6^{\circ}\text{F}$)
SPE-1, SPE-2, SPE-3, SVEO, SVE, SJEOO, SJEO, SJE, SEO, SE, or SRDE marked "-40C" or "minus 40C"	$-40.0 \pm 2.0^{\circ}\text{C}$ ($-40.0 \pm 3.8^{\circ}\text{F}$)
Outdoor service cord, SPT-2W, SPT-1W, XTW or CXTW cord or CXTW wire, marked "-40C" or "minus 40C" or not marked with a low-temperature rating	
PG, PFF, PGF, or PGFF wire	$-35.0 \pm 2.0^{\circ}\text{C}$ ($-31.0 \pm 3.6^{\circ}\text{F}$)
Jacket or outdoor cord and insulation of outdoor cords and wire for decorative lighting after 720 h of exposure to carbon-arc radiation and water spray	$-30.0 \pm 2.0^{\circ}\text{C}$ ($-22.0 \pm 3.8^{\circ}\text{F}$)

Table 58.2 Continued on Next Page

Table 58.2 Continued

Item being tested	Test temperature
Any other wire, cable, or cord	-20.0 ±2.0°C (-4.0 ±3.6°F)

OIL AND GASOLINE RESISTANCE TESTS FOR TYPES TFN AND TFFN

59 Oil Resistance

Section 59 effective July 2, 1998

59.1 Specimens of insulation from finished Type TFN and TFFN fixture wires that are marked as being oil-resistant (see 73.1 for required marking) shall retain at least the amount of tensile strength and elongation indicated in Table 50.156 of UL 1581 after aging of the finished wire in oil as indicated in the table.

60 Gasoline Resistance

Section 60 effective July 2, 1998

60.1 Finished Type TFN and TFFN fixture wires that are marked as being gasoline-resistant (see 73.1 for required marking) shall be shown acceptable for use in the presence of gasoline by means of an investigation in which the following are studied – physical properties, electrical resistance, and flexibility of the insulation during and after immersion for not less than 30 d in water-saturated ASTM Reference Fuel C [see 480.11 of UL 1581 and ASTM D 471-95] at a temperature of 30.0 ±1.0°C (86.0 ±1.8°F).

NO. 22 AWG DECORATIVE-LIGHTING WIRES AND CORDS

61 Abrasion Test

Revised Section 61 effective October 13, 2000

61.1 The insulation on the No. 22 AWG size of Type XTW and CXTW wire and of the straightened individual conductors from finished Type CXTW cord shall not wear through to expose the conductor or conductors in 400 or fewer cycles of the abrasion procedure described in Abrasion of No. 22 AWG Type XTW and CXTW Wire and Cord, Test, Section 1500 of UL 1581. See note ^b to Tables 11.1 and 11.2 and the last sentence of 11.2.

62 Flexing Test

Revised Section 62 effective October 13, 2000

62.1 No more than half of the strands in the No. 22 AWG size of Type XTW and CXTW cord and wire shall be broken by 6000 cycles of the flexing described in Flexing of No. 22 AWG Type XTW and CXTW Wire and Cord, Test, Section 1520 of UL 1581. See note ^b to Tables 11.1 and 11.2 and the last sentence of 11.2.

SHIELDED CORDS

63 Flexing Test

63.1 The circuit conductors in a shielded Type S, SE, SO, SOO, SEO, SEOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJE0, SJE00, SJT, SJTO, SJTOO, SEW, SOW, SOOW, SEOW, SEOOO, STW, STOW, STOOO, SJEW, SJOW, SJOOW, SJEOW, SJE00W, SJTW, SJTOW, SJTOOW, SV, SVE, SVO, SVOO, SVEO, SVEOO, SVT, SVTO, or SVTOO flexible cord not complying with 39.1– 39.6 shall remain unbroken when specimens of the finished cord are carrying rated current and are flexed for 15,000 cycles as described in Flexing of Shielded Cords, Test, Section 1582 of UL 1581. This test is similar to the flexing test described in the IEC 227 series of standards.

63.1 effective July 2, 1998

64 Durability of Ink-Print Test

Section 64 effective July 2, 1998

64.1 All required surface printing is acceptable if the printing on specimens remains legible after being subjected to the test described in Durability of Indelible-Ink Printing, Test, Section 1690 of UL 1581.

MARKINGS

POLARITY

65 Grounded-Conductor Polarity

Section 65 effective July 2, 1998

65.1 Identification

65.1.1 In a flexible cord other than a shaver cord, clock cord, 3–6 conductor parallel Type XTW, Type CXTW, elevator cables (Types E, EO, ETT, and ETP), and heater cords (Types HPD, HSJ, HSJO, and HPN), one conductor that is intended to be used as a grounded circuit conductor shall have a continuous marker or its equivalent, readily distinguishing it from the other conductor or conductors, and signifying that it is the grounded conductor of the cord. In the elevator cables and the clock, shaver, decorative-lighting, and heater cords mentioned, identification of the conductor as a grounded circuit conductor is acceptable but is not required. The identification of a cord shall consist of one of the means described in 65.3.1 – 65.8.1, as applicable. The identification of a fixture wire is covered in 65.2.1.

65.1.1 revised February 6, 2001

65.2 Fixture wire

65.2.1 The color of a finished fixture wire (single-conductor) shall comply with the following:

- a) A braidless type of wire that is intended to be used as a grounded circuit conductor shall be finished to show the color white or natural grey throughout the entire length and circumference of its outer surface, or shall be identified by three continuous straight or helical, unbroken white stripes on other than green insulation, along its entire length. See 67.3 for details on stripes. Straight stripes are to be placed a nominal 120° apart. The following means shall not be used as polarity identification on the surface of a braidless type of fixture wire: one or more continuous or broken ridges; one or more continuous or broken grooves; or indent, raised, or ink printing of words, numbers, or symbols.
- b) A braid-covered wire that is intended to be used as a grounded circuit conductor either shall have:
 - 1) The braid finished to show the color white throughout the entire length and circumference of the wire, or
 - 2) A white tracer (see 65.8.2) in a braid of color contrasting with white.
- c) A braid-covered or braidless wire that is intended for use as an ungrounded circuit conductor shall be of a color or combination of colors other than and in contrast with white, natural grey, green, and green and yellow.

65.2.1 revised February 6, 2001

65.3 Tracer in braid

65.3.1 A tracer (see 65.8.2) may be in the braid on one conductor of a color contrasting with that of the braid. No tracer shall be used in the braid on any other conductor of a cord in which the braid of one conductor is finished to show a solid white or natural grey color except that, in the case of Type C or PD cord in which the braids on all of the conductors are finished to show a solid white or natural grey color, the identified conductor shall have no tracer in the braid and every other conductor shall have a tracer of a contrasting color in the braid.

65.4 Colored insulation

65.4.1 White or natural grey colored insulation may be used or a surface coating may be used on the entire length and circumference of one conductor and insulation or a surface coating of a readily distinguishable color is to be on the entire length and circumference of every other conductor of the cord. This method is applicable only in the case of a cord having no braid on any individual conductor.

65.5 Surface marking

65.5.1 One or more stripes, ridges, and/or grooves may be used on the exterior of the cord in a manner that definitely identifies one conductor. This method is applicable only in the case of an integral parallel cord and 2-conductor Type XTW.

Revised 65.5.1 effective October 13, 2000

65.6 Tinned conductor

65.6.1 A coating of tin or other metal (see 12.1) may be used on all of the individual strands of one conductor. No tin or other white metal shall be used on the strands of any other conductor. This method is applicable only in the case of an integral parallel cord and 2-conductor Type XTW.

Revised 65.6.1 effective October 13, 2000

65.7 Colored braid

65.7.1 The braid on one conductor may be finished to show a solid white or natural grey color with the braid on every other conductor of the cord finished to show a readily distinguishable solid color.

65.8 Light-blue insulation

65.8.1 In a cord having a jacket that is not integral with the circuit-conductor insulation, the insulation on one circuit conductor may be finished to show a light blue color throughout its entire length and circumference. The insulation on all other circuit conductors in the cord shall be of a color readily distinguishable from light blue, white, and natural grey. This method applies only in the case of a cord having no braid on any individual conductor.

65.8.2 A tracer, as referred to in 65.2.1, 65.3.1, and 67.1 shall be no more than two carriers wide, and all ends comprising the tracer shall be applied from adjacent carriers if two are used.

66 Separation of Grounded and Grounding Conductors in Cords

Section 66 effective July 2, 1998

66.1 Deleted March 13, 2001

67 Grounding-Conductor Polarity Identification

Section 67 effective July 2, 1998

67.1 Each conductor intended to be used as a grounding conductor in a cord (strictly for grounding only and never as a circuit conductor) shall have a green braid with or without one or more yellow tracers (see 65.8.2) or the compound employed on each grounding conductor (without a braid) shall have a green outer surface with or without one or more straight or helical, broken (non-continuous) or unbroken yellow stripes. See 67.3 for details on stripes. See also 5.1, 8.4, 15.3, 15.4, and 16.3.3.2 – 16.3.3.6.

67.1 revised April 13, 2000

67.2 Deleted April 13, 2000.

67.3 Stripes as specified in 65.2.1 and 67.1 shall be of even or varying width and shall occupy a total of 5 – 70 percent of the calculated circumference of the outer surface of the finished insulated conductor in the case of a yellow stripe(s) or a total of 15 – 70 percent of the calculated circumference of the outer surface of the finished insulated conductor in the case of white stripes, with no individual width less than 5 percent of that same circumference. The width shall be measured perpendicular to each stripe. Where broken stripes are appropriate, they shall consist of a series of identical marks and spaces, the length of each mark shall be at least 1/8 inch or 3 mm and the linear spacing between marks shall not be greater than 3/4 inch or 19 mm.

67.3 revised February 6, 2001

MAKER

68 Identification of Responsible Organization and Factory

Section 68 effective July 2, 1998

68.1 Each wire and flexible cord shall have a durable, distinctive marking throughout its entire length by means of which it can be identified readily as the product of the organization that is responsible for the product. If the organization that is responsible for the product is different from the actual manufacturer, both the responsible organization and the actual manufacturer shall be identified by name or by acceptable coding such as by trade name, trademark, the assigned electrical reference number, or the assigned combination of colored marker threads. The meaning of any coded identification shall be made available. A private labeler may also be identified.

68.2 If the organization responsible for the product produces wire or flexible cord in more than one factory, every length of finished fixture wire or flexible cord that the organization produces shall carry a durable marking – which may be in code – by means of which the wire or cord can be identified as the product of a particular factory.

68.3 In the case of a braid-covered fixture wire, the responsible organization and factory marking shall consist of one of the following:

- a) The name of the manufacturer, his trade name for the product, or both, or any other acceptable distinctive marking by means of which the organization responsible for the product can readily be identified and, if required, an acceptable identification of the factory durably and legibly printed at intervals no longer than 12 inches or 305 mm on a tape located between the braid and the insulation or under the insulation. In the case of Types SF-1, SF-2, SFF-1, and SFF-2 fixture wire, this information may instead be durably and legibly printed at intervals no longer than 12 inches or 305 mm on the surface of the silicone-rubber insulation (under the braid). The printing on the insulation is to be considered durable if unreeling and straightening a sample of the finished wire and then removing the glass braid does not decrease the legibility of the printing.
- b) The responsible organization's assigned identifying colored marker thread or threads located between the braid and the insulation or under the insulation.

68.4 In the case of a nylon-jacketed fixture wire or one not requiring a covering over the insulation, the responsible organization and factory marking shall consist of one of the following:

- a) The name of the manufacturer, that manufacturer's trade name for the product, or both, or any other acceptable distinctive marking by means of which the organization responsible for the product can readily be identified, and, if required, an acceptable identification of the factory:
 - 1) Durably and legibly indelible-ink printed, indent printed (the thickness of the jacket or insulation shall not be reduced by the indenting to less than the minimum acceptable), or embossed on the outer surface of the finished wire at intervals no longer than 12 inches or 305 mm (legible indelible-ink printing is acceptable on the insulation under a nylon jacket if the nylon is transparent), or
 - 2) Durably and legibly indelible-ink printed at intervals no longer than 12 inches or 305 mm on an acceptable tape under the insulation.
- b) The responsible organization's assigned colored marker thread or threads located under the insulation.

68.5 In the case of a parallel cord or a jacketed cord, the responsible organization and factory marking either shall consist of the responsible organization's assigned colored marker thread or threads located under the jacket or under the insulation on one of the circuit conductors, or shall consist of the name of the manufacturer or private labeler, that manufacturer's or private labeler's trade name for the product, or both, or any other acceptable distinctive marking by means of which the organization responsible for the product can readily be identified and, if required, an acceptable identification of the factory durably and legibly indelible-ink printed, indent printed (the thickness of the jacket or insulation shall not be reduced by the indenting to less than the minimum acceptable), or embossed in smooth areas on the outer surface of the finished cord at intervals no longer than 24 inches or 610 mm. In the absence of smooth areas, the marking may be durably and legibly indelible-ink printed at intervals no longer than 24 inches or 610 mm on an acceptable tape in the cord. Legible indelible-ink printing is acceptable on the insulation under a nylon jacket if the nylon is transparent.

68.6 In the case of a braid-covered cord, the responsible organization and factory marking shall consist either of the responsible organization's assigned colored marker thread or threads located anywhere under the overall braid but not woven in a braid on any individual conductor or of the name of the manufacturer, that manufacturer's trade name for the product, or both, or any other acceptable distinctive marking by means of which the organization responsible for the product can readily be identified and, if required, an acceptable identification of the factory durably and legibly indelible-ink printed at intervals no longer than 24 inches or 610 mm on an acceptable tape in the cord.

OTHER IDENTIFICATION

69 Cord Type, Conductors, Temperature, and Voltage

69.1 Each of the following flexible cords shall be marked throughout its entire length with the type-letter designation (inclusion of the word "Type" is optional), the total number and size of the circuit and grounding conductors (for example, "18/3" or "18/2 with gnd"); and, for cords having a high-temperature rating higher than the lowest high-temperature rating possible for the type, the high-temperature rating in degrees C (the temperature rating in degrees F is acceptable in parentheses in addition to but not in place of the rating in degrees C). The sequence of these markings is not specified. See 82.1.

TST, SP-1, SPE-1, NISPE-1, SPE-2, NISPE-2, SP-2, NISP-2, SPE-2, NISPE-2, SP-3, SPE-3, SPT-1, NISPT-1, SPT-1W, SPT-2, NISPT-2, SPT-2W, SPT-3, SV, SVE, SVEO, SVO, SVOO, SVT, SVTO, SVTOO, SJ, SJE, SJO, SJEO, SJEOO, SJOO, SJT, SJTO, SJTOO, S, SE, SO, SEO, SEOO, SOO, ST, STO, STOO, SJEW, SJOW, SJEOW, SJEOOW, SJOOW, SJTW, SJTOW, SJTOOW, SEW, SOW, SEOW, SEOOW, SOOW, STW, STOW, STOOOW, HSJ, HSJO, HPN, SRD, SRDE, and SRDT, and XTW.

69.1 revised February 6, 2001

69.2 A Type SRDE, SPE-1, NISPE-1, SPE-2, NISPE-2, SPE-3, SVE, SVEO, SJE, SJEO, SJEOO, SE, SEO, or SEOO cord shall be surface marked with the applicable high-temperature rating "105C" or "90C" and with the low-temperature rating "-50C" if the cord was tested at -50°C (-58°F) as indicated in 58.4. Cord tested at -40°C (-40°F) may be surface marked "-40C". The word "minus" may be used in place of the minus sign.

Revised 69.2 effective April 13, 1999

69.3 Except that the temperature marking may be achieved by means of a colored thread or threads (see Table 69.1) located under the insulation, the markings required in 69.1 shall be durably and legibly indelible-ink printed, indent printed (the thickness of the jacket or insulation shall not be reduced by the indenting to less than the minimum acceptable), or embossed in smooth areas on the outer surface of the finished cord at intervals no longer than 24 inches or 610 mm. In the absence of smooth areas on the surface of a jacketed cord, the markings are acceptable if durably and legibly indelible-ink printed at intervals no longer than 24 inches or 610 mm on an acceptable tape in the cord. Legible indelible-ink printing is acceptable on the insulation under a nylon jacket if the nylon is transparent.

69.3 effective July 2, 1998

Table 69.1
Temperature marker threads

Table 69.1 effective July 2, 1998

Temperature		Number of threads	Color of threads
°C	°F		
75	167	One	Green
90	194	One	Red
105	221	One	Yellow
125	257	One	Brown
150	302	One	Orange
200	392	One	Black
250	480	Two	Black

69.4 At the manufacturer's option, a flexible cord may bear a surface or internal marking of its voltage rating.

69.4 effective July 2, 1998

69.5 The manufacturer's name, type designation "HOISTWAY CABLE", voltage rating and temperature rating (for 90 C rated cables) shall be durably and legibly printed in ink on the surface of at least one of the conductors of the parallel construction or the twisted construction without a jacket (in a multilayer cable the marking shall appear on one of the wires in the outer layer) and on the surface of the jacket of twisted construction with a jacket. Each conductor shall have its (AWG) durably and legibly printed in ink except in the case of the parallel construction where alternately one conductor may be marked with the number and size of conductors, eg. 4/18 AWG. The distance between the required markings shall not exceed 24 inches or 610 mm.

69.5 effective July 2, 1998

69.6 The words "STEEL CORE" shall be surface marked for cords that are provided with a steel core. The distance between the required markings shall not exceed 24 inches or 610 mm.

69.6 effective July 2, 1998

70 Grounding-Conductor Identification on Cord Surface

Section 70 effective July 2, 1998

70.1 Type SP-1, SPE-1, SPT-1, SP-2, SPE-2, SPT-2, SP-3, SPE-3, SPT-3, and HPN cords with one grounding conductor (see 16.3.3.2 – 16.3.3.6) shall be durably surface marked by means of readily legible indent printing or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with whichever of the following wording is applicable "Green conductor for grounding only" or "Green conductor with yellow stripe(s) for grounding only" or "Green conductor with or without yellow stripe(s) for grounding only".

No Text on This Page

71 Fixture-Wire Temperature Identification

Section 71 effective July 2, 1998

71.1 Except as specified in 75.2, there shall be a green thread (which indicates a temperature limit of 75°C or 167°F) in Type RFH-2 and FFH-2 fixture wires; a red thread (which indicates a temperature limit of 90°C or 194°F) in Type TFN and TFFN fixture wires; an orange thread (which indicates a temperature limit of 150°C or 302°F) in Type XF, XFF, SFF-1, SFF-2, PFF, and PGFF fixture wires; and a black thread (which indicates a temperature limit of 200°C or 392°F) in Type SF-1, SF-2, PF, and PGF fixture wires. In any case, the temperature-indicating threads shall be located either immediately under the insulation or under the separator.

71.2 It is acceptable to omit the temperature marker thread required in 71.1 from a Type SF-1, SF-2, SFF-1, or SFF-2 fixture wire if the type-letter designation such as "Type SFF-2" either is:

- a) Included in the surface-of-the-insulation printing mentioned in 68.3, or
- b) Durably and legibly ink printed on the outside surface on the finished braid at intervals no longer than 24 inches or 610 mm.

It is acceptable to omit the temperature marker thread required in 71.1 from other types of fixture wire if the type-letter designation is durably and legibly ink printed on the outside surface of the finished wire at intervals no longer than 24 inches or 610 mm.

72 Low-Temperature Identification on the Surface of Indoor Fixture Wires

Section 72 effective July 2, 1998

72.1 Any type of fixture wire, if acceptable for use at -50°C (-58°F) in accordance with 38.1, shall be durably surface marked by means of indent printing, embossing, or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with "-50C" or "minus 50C".

73 Gasoline-and-Oil-Resistance Identification on Fixture Wire

Section 73 effective July 2, 1998

73.1 Type TFN and Type TFFN fixture wires that comply with the requirements for use in the presence of oil (see 59.1) and/or gasoline (see 60.1) may be marked to indicate such resistance. This marking shall consist of the wording indicated in Table 73.1 and shall comply with 68.1.

Table 73.1
Markings for gasoline- and oil-resistant Type TFN and TFFN fixture wires

Enclosure to be indicated by marking	Wording required on outside surface of insulation or nylon jacket
Oil resistant at 75°C (167°F)	"Oil resistant II"
Oil resistant at 60°C (140°F)	"Oil resistant I"
Gasoline resistant	"Gasoline resistant"
Oil resistant at 75°C (167°F) and gasoline resistant	"Gasoline and oil resistant II"
Oil resistant at 60°C (140°F) and gasoline resistant	"Gasoline and oil resistant I"

74 Tag and Reel Markings

74.1 A tag on which the following information is indicated plainly (the sequence of the items is not specified) shall be tied to every shipping length of finished wire or cable. However, where the wire or cable is wound on a reel or coiled in a carton, it is appropriate for the tag to be glued, tied, stapled, or otherwise attached to the reel or carton instead of to the wire or cable or for the tag to be eliminated and the information printed or stenciled directly onto the reel or carton (see 81.1). Other information, where added, shall not confuse or mislead and shall not conflict with these requirements. See 83.1 for date marking.

- a) The maximum voltage for which the wire or cord is rated.
- b) The manufacturer's name or trademark, or any other appropriate distinctive marking by means of which the organization responsible for the product is readily identifiable. Where the organization that is responsible for the product is different from the actual manufacturer, both the responsible organization and the actual manufacturer shall be identified by name or by appropriate coding such as by trade name, trademark, the assigned electrical reference number, or the assigned combination of colored marker threads. The meaning of any coded identification shall be made available by the organization responsible for the wire or cord. It is appropriate also to identify a private labeler; the means is not specified.
- c) *Deleted*
- d) The type-letter designation for the product ("clock cord" in the case of a clock cord and "shaver cord" in the case of a shaver cord).
- e) The AWG size of the wire or cord.
- f) The responsible organization's assigned identifying colored marker thread or threads for wires and cables, where used in the product.
- g) For an elevator cable that contains one or more optical fibers, the following statement or another statement to the same effect:

"Optical-fiber portion(s) of cable are for installation (optical and electrical functions associated) as described in Article 770 and other applicable parts of the National Electrical Code (NFPA 70), with levels of energy transmitted not exceeding those of Class I laser radiation (21 CFR Part 1040)."

h) For an elevator cable that contains one or more optical-fiber members with any individual optical-fiber member or group of such members having a metal or other electrically conductive part as described in 8.5 or 8.6, the following wording or other wording to the same effect:

"Optical-fiber portion(s) of cable contain non-current-carrying metal or other electrically conductive parts."

74.1 revised April 13, 2000

74.2 If Type SP-1, SPE-1, SP-2, SPT-1, SPE-2, or SPT-2 cord is made in the design (see 16.3.1.2 and 16.3.2.1) with three circuit conductors and without a grounding conductor, the marking on each coil or reel, in addition to that specified in 74.1, shall include the name of the organization to which the product is to be shipped and its intended use.

74.2 effective July 2, 1998

74.3 If Type SP-2, NISP-2, SPE-2, NISPE-2, SPT-2, or NISPT-2 cord employs No. 30 AWG strands, the marking on each coil or reel, in addition to that specified in 74.1, shall include the wording "For use in general-use extension cord sets only."

Revised 74.3 effective April 13, 1999

74.4 No. 20 AWG Types SPT-1, NISPT-1, SP-1, NISP-1, SPE-1, and NISPE-1 in addition to the marking specified in 74.1 shall include the wording "Not for retail sale to the public."

Revised 74.4 effective April 13, 1999

75 Surface Marking of Mobile-Home and Recreational-Vehicle Cords

Section 75 effective July 2, 1998

75.1 A Type SEW, SOW, SEOW, SEOOW, SOOW, STW, STOOW, or STOW cord that complies with the requirements in 32.2 shall be durably surface marked by means of indent printing, embossing, or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with one of the following wordings using the applicable current rating from 32.2 "For mobile-home use: ___ amperes" or "For mobile-home or recreational-vehicle use: ___ amperes". The word "outdoor" may be surface marked on the cord but not required (see 76.1 – 76.3).

75.2 A Type SEW, SOW, SEOW, SEOOW, SOOW, STW, STOOW, or STOW cord that complies with the requirements for recreational-vehicle use in 32.1 shall be durably surface marked by means of indent printing, embossing, or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with the wording using the applicable current rating from 32.1 "For recreational-vehicle use: ___ amperes". The word "outdoor" may be surface marked on the cord but is not required (see 76.1 – 76.3).

76 Surface Marking of Outdoor Service Cords

Section 76 effective July 2, 1998

76.1 In addition to being identified as indicated in 74.1, the outer surface of the jacket on a Type SEW, SOW, SEOW, SEOOW, SOOW, STW, STOW, STOOW, SJEW, SJOW, SJEOW, SJEOOW, SJOOW, SJTW, SJTOOW, or SJTOW service cord shall be durably marked by means of indent printing, embossing, or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with the cord type letters (inclusion of the word "Type" is optional). The word "outdoor" may additionally be marked on any such service cord (see 76.2 and 76.3). The surface marking on outdoor service cord may include the low-temperature designation "-40 C" or "minus 40 C" on cord tested at -40°C (-40°F) in accordance with 32.7. The surface marking on outdoor service cord shall include "-50 C", "-60 C", or "-70 C" as

applicable on cord tested at one of these optionally lower temperatures as indicated in 32.7. In any case, the word "minus" may be used in place of the minus sign and/or the designation "water resistant" or "water resistant 60 C" may be included on an outdoor service cord.

76.2 The tag and/or reel marking for a service cord that is other than the mobile-home and/or recreational-vehicle cord covered in 32.1 and 32.2 and is marked "outdoor" on the outer surface or on an acceptable tape in the cord shall include the statement "For use only in cord sets that are for use outdoors".

76.3 A Type SEW, SOW, SEOW, SEOOW, SOOW, STW, STOW, STOOW, SJEW, SJOW, SJEOW, SJEOWW, SJOOW, SJTW, SJTOOW, or SJTOW cord that is other than the mobile-home and/or recreational-vehicle cord covered in 32.1 and 32.2 and is marked "outdoor" is limited to use in outdoor-use cord sets.

77 Surface Marking of Type SPT-2W, SPT-1W, XTW, and CXTW

Revised Section 77 effective October 13, 2000

77.1 All sizes of Type SPT-2W, SPT-1W, XTW, and CXTW cords and all sizes of Type CXTW wire shall have the outer surface of the finished wire or of one conductor of the parallel or twisted cord durably marked by means of indent printing, embossing, or acceptable indelible-ink printing at intervals no longer than 24 inches or 610 mm with the wire or cord type letters (inclusion of the word "Type" is optional). The word "outdoor" shall not be marked on or in any of the above-mentioned wires and cords. The surface marking of these Types may include the low-temperature designation "-40 C" or "minus 40 C". The surface marking shall include "-50 C", "-60 C", or "-70 C" as applicable on cord or wire tested at one of these three optionally lower temperatures as indicated in Table 58.2. In any case, the word "minus" may be used in place of the minus sign.

78 Surface Marking of Low-Leakage-Current Service Cords

Section 78 effective July 2, 1998

78.1 A Type ST, STO, STOO, SJT, SJTOO, SJTO, STW, STOW, STOOW, SJTW, SJTOOW, or SJTOW cord that complies with the requirements in 37.1 (low-leakage-current cord) shall, in addition to being identified as indicated in 74.1, be surface-marked by means of ink printing, indent printing, or embossing at intervals no longer than 24 inches or 610 mm with the legend "max. leakage/10 ft at ___ V: ___ μ A to green & ___ μ A thru jacket", with the blanks filled with the applicable set of values from Table 78.1. The values in the last two columns of Table 78.1 are accurate enough (they are less than 2 percent high) for use in the legend on the cord with "3 m" substituted for "10 ft".

Table 78.1
Voltage and leakage currents for surface marking of low-voltage-current service cords

Table 78.1 revised April 13, 2000

60 Hz RMS supply potential to equipment	Highest RMS leakage current in Microamperes flowing (separately) between each circuit conductor and the grounding conductor ^a	Highest RMS leakage current in Microamperes flowing (separately) between each circuit conductor and foil covering to jacket ^a	Values to be used in cord-surface marking		
			V	μA to green ^b	μA thru jacket ^c
120 V	0 – 3	0 – 9	120	3	9
	0 – 5	0 – 12	120	5	12
	0 – 7	0 – 15	120	7	15
	0 – 10	0 – 20	120	10	20
240 V	0 – 6	0 – 18	240	6	18
	0 – 9	0 – 24	240	9	24
	0 – 14	0 – 30	240	14	30
	0 – 20	0 – 40	240	20	40

^a See test in 37.1.
^b See the last sentence of 1320.3 of UL 1581.
^c See the last sentence of 1320.5 of UL 1581.

79 Surface Marking of VW-1 and FT1 Wire or Flexible Cord

Section 79 revised June 23, 1998

79.1 "VW-1" or "FT1", whichever applicable, shall be durably marked at intervals no longer than 24 inches or 610 mm on the surface of finished flexible cord, fixture wire, and Type CXTW wire that comply with 46.1. A flexible cord or a wire that complies and is not marked is not for VW-1 or FT1 applications. A flexible cord or a fixture wire having an overall nylon jacket, is eligible to be marked under the nylon where the marking is readily legible through the nylon. Braid-covered cords and fixture wires, are eligible to be durably and legibly printed at intervals no longer than 12 inches or 305 mm on the surface of the insulation (under the braid), with only one conductor required to be printed in the case of a flexible cord. The printing on the insulation under a braid is, in this application, defined as durable when unreeling and straightening a sample of the finished conductor and then removing the braid does not decrease the legibility of the printing. Any flexible cord that complies with the VW-1 flame test and is marked with the "VW-1" designation is also eligible to be marked with the "FT1" designation (the sequence is not specified). Any flexible cord or cable that complies with the VW-1 or FT1 flame test is eligible to be marked "FT1" alone even though one or more of the individual conductors (circuit and any grounding) either are not tested or do not comply with the VW-1 test.

80 Surface Marking of Shielded Service and Vacuum-Cleaner Cords

Section 80 effective July 2, 1998

80.1 A shielded service or vacuum-cleaner cord that complies with the type, construction, and performance requirements in 39.1 – 39.3 shall in addition to all other required identification, be surface marked "shielded" by means of ink printing, indent printing, or embossing at intervals no longer than 24 inches or 610 mm.

81 Current Designations

Section 81 effective July 2, 1998

81.1 Other than where specified as a surface marking on the mobile-home and recreational-vehicle cords in 75.1, on recreational-vehicle cords in 75.2, and on low-leakage-current service cords in 78.1, no ampacity or other current designation shall appear on or in a flexible cord, a decorative-lighting wire, a fixture wire, or an elevator cable or on the tag, reel, or carton for a cord, wire, or cable.

82 Acceptable Extra Markings

Section 82 effective July 2, 1998

82.1 A designation that is not required in this Standard (a part, specification, or catalog designation or a trade name or the like) is acceptable in addition to the required surface and tag, reel, or carton markings for a cord, wire or cable if the completed legend containing such designation cannot be read as providing the information prohibited in 81.1 and is in no way confusing or misleading.

83 Date of Manufacture

83.1 The date of manufacture by month and year (or in the sequence month, day, and year) shall be included among the tag, reel, or carton markings described in 74.1, or shall be included among the product surface markings described in this Standard where legible on the outer surface of the product. The date shall be shown in plain language, not in code.

83.1 and heading added April 13, 2000

SUPPLEMENT SA - U.S. GOVERNMENT REQUIREMENTS AND ORDERING INSTRUCTIONS FOR ACQUISITION OF FLEXIBLE CORD AND FIXTURE WIRE

SA1 Scope

Section SA1 added March 13, 2001

SA1.1 The requirements of this supplement cover the additional requirements and ordering instructions of flexible cord and fixture wire conforming to UL 62 for acquisition by the U.S. Government.

SA2 Requirements

Section SA2 added March 13, 2001

SA2.1 CORD AND WIRE TYPES – The flexible cord and fixture wire types described in Tables 6.1 – 6.21 of UL 62 may be ordered in accordance with the applicable requirements specified in the Tables and to the requirements described in this supplement, as implemented by the order.

SA2.2 ORDERING DESIGNATION – The following designation approach shall be used by the U.S. Government when ordering cord or wire conforming to UL 62. The cord and wire shall comply with the requirements as specified in this ordering designation. The Government designation is intended for ordering purposes and not for marking on the wire or cable.

Cord/Wire Designation

Example	<u>UL 62</u>	<u>SJT</u>	<u>3</u>	<u>BC</u>	<u>K</u>	<u>3/16</u>	<u>PVC</u>	<u>PVC</u>	<u>G</u>	
Designation Number	Spec. No.	UL type	Maximum working voltage	Conductor material	Type of conductor(s)	Number and size of conductor(s)	Type of insulation	Outer jacket	Ground wire	Color code of single-conductor
Designation Definition	(2.2.1)	(2.2.2)	(2.2.3)	(2.2.4)	(2.2.5)	(2.2.6)	(2.2.7)	(2.2.8)	(2.2.9)	(2.2.10)

SA2.2.1 SPECIFICATION NUMBER – Underwriters Laboratories Inc. Standard No. UL 62.

SA2.2.2 UL/NEC TYPE DESIGNATION The type designation from Tables 6.1 – 6.21 of UL 62.

SA2.2.3 MAXIMUM WORKING VOLTAGE The maximum working voltage capability shall be designated as follows:

3 - for use at not more than 300 volts

6 - for use at not more than 600 volts

SA2.2.4 CONDUCTOR MATERIAL The conductor material to be used and shall be designated as follows:

BC – bare copper

TC – tin coated copper

SC – silver coated copper

NC – nickel coated copper

NL – nickel alloy

SA2.2.5 TYPE OF CONDUCTOR(S) Where UL 62 indicates an option, the type conductor(s) to be used shall be designated as follows:

E - solid conductor (fixture wire only)

F - concentric-lay-stranded conductor(s) of standard flexibility

K - bunch-stranded conductor(s) of extreme flexibility

SA2.2.6 NUMBER AND SIZE OF CONDUCTOR(S) The number of individual conductors of the same wire to be used shall be designated by that number followed by a slash (/) followed by a number indicating the conductor AWG size. When cables are to be made up of different wire sizes, each different wire size with the number of conductors is individually represented, with a dash separating each different wire size to be used (examples: 3/14; 2/16-2/20).

SA2.2.7 TYPE OF INSULATION. The type of insulation to be used for flexible cords shall be as designated in Table 15.1 of UL 62. The type of insulation to be used for fixture wire shall be in accordance with UL 62.

SA2.2.8 OUTER JACKET. The outer jacket material to be used for flexible cords, if applicable, shall be as designated in Table 27.1 of UL 62.

SA2.2.9 EQUIPMENT GROUNDING CONDUCTOR When a grounding conductor is required, it shall be designated by the letter "G".

SA2.2.10 COLOR CODE

SA2.2.10.1 The color code for a single-conductor fixture wire shall be designated by the appropriate identifying number shown in Table SA5.1.

SA2.2.10.2 The color code for multi-conductor cords shall be designated in accordance with Tables SA5.2 and SA5.3, except for parallel cords, which shall identify the grounded conductor in accordance with UL 62.

SA2.2.10.3 Cords with not over three conductors shall be color coded in accordance with Table SA5.2.

SA2.2.10.4 Cords from 4 to 10 conductors shall be color coded in accordance with Table SA5.3, except for elevator cables.

SA3 Quality Assurance

Section SA3 added March 13, 2001

SA3.1 QUALITY ASSURANCE – The products provided shall conform to the producer's own drawings, specifications, standards, and quality assurance practices for the cord or wire ordered as specified in this supplement and the additional requirements of the order designation (see SA2.2). The Government reserves the right to require proof of such conformance. The label or Listing mark of UL may be accepted as evidence that the flexible cord or fixture wire conforms to the basic UL 62 requirements.

SA4 Packaging

Section SA4 added March 13, 2001

SA4.1 PACKAGING – For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see SA5.1). When actual packaging of materiel is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point packaging activity within the Military Department or Defense Agency, or within the Military Department's Systems Command. Packaging data retrieval is available from the managing Military Department or Defense Agency automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

SA5 Ordering documents

Section SA5 added March 13, 2001

SA5.1 ORDERING DOCUMENTS The ordering shall include the following information in the solicitation:

- a. Title, symbol, and date of this specification.
- b. Ordering designation (see SA2.2), which includes type letter designation; maximum working voltage; conductor material; type of conductor(s); number and size of conductor; type of insulation; outer jacket; whether grounding is required; and color coding.
- c. Whether strength strands are required and whether the strands are to be nonmetallic or steel. Such strength strands are strands for mechanical strength and may be employed in a Type E, EO, ETP, or ETT elevator cable. Strands shall be run straight as a fibrous covered or insulated central wire and shall not be cabled with the copper strands of any conductor.
- d. Packaging and marking requirements (see SA4.1). These should include:
 - (1) Length of wire and form or put-up. Wire is normally furnished in continuous lengths of 500 or 1000 feet coiled on spools or reels at the contractor's option. No more than 25 percent of the total footage of any one wire part or identifying number (PIN) should be shipped in lengths less than minimum,
 - (2) Coil, spool, and reel marking requirements, and
 - (3) Level of preservation, packing, and packaging options required and special or unique storage or time conditions.

TABLE SA5.1
Color-code identification for single-conductor fixture wire

Number designator	Color	Number designator	Color
0	Black	5	Green
1	Brown	6	Blue
2	Red	7	Violet (Purple)
3	Orange	8	Gray
4	Yellow	9	White

Note: This Table is not intended to signify a color sequence, but only a number-color identification reference.

TABLE SA5.2
Color codes for cords with not over 3 conductors

Conductor number	Insulation color
1	Black
2	White
3	Green or green with yellow stripe(s)

TABLE SA5.3
Color codes for cords of 4 to 10 conductors

Conductor number	Insulation color
1	Black
2	White
3	Red
4	Green or green with yellow stripe(s)
5	Orange
6	Blue
7	Brown
8	Gray
9	Yellow
10	Purple

Subjects 44, 62, 83, and 1263

1285 Walt Whitman Road
Melville, New York 11747-3081
October 30, 1997

TO: Subscribers to UL's Listing Service for Irrigation Cable OFFY

SUBJECT: List of Compounds Acceptable for Irrigation-Cable Jackets

This bulletin supersedes the Underwriters Laboratories Inc. bulletin of July 12, 1994 on the same subject.

The following is a list of commercially available thermoplastic polyethylene (PE) compounds that UL has found to comply with the requirements for the environmental exposure tests described in the revised Outline of Proposed Investigation of Irrigation cables issued under Subjects 514 and 1263 as a bulletin dated April 23, 1980. They have all exhibited 80 percent of original tensile strength and elongation after the exposures. These compounds may be used interchangeably, without submittal to UL's Engineering Services, with the PE compounds covered in the Type L Follow-Up Service Procedure for Irrigation Cable. Acceptability in any cable construction necessitates compliance with the applicable performance requirements for that cable.

PVC compounds, included in previous bulletins under this subject, are now covered in the QMTT2 category, Polymeric Materials For Use on Wire and Cable.

Any manufacturer interested in obtaining Listing for Irrigation Cable, or in having a particular jacketing compound investigated for use on Irrigation Cable, should contact the UL engineering office to which the manufacturer normally makes submittals.

UNDERWRITERS LABORATORIES INC.

REVIEWED BY:

AUSTIN D. WETHERELL (Ext. 22818)
Staff Engineer
Engineering Services 216S
phone: 516-271-6200
fax: 516-439-6047
e-mail: wetherella@ul.com

WALTER H. HOFFMANN (Ext. 22564)
Standards Engineer
Standards Department
phone: 516-271-6200
fax: 516-271-6021
e-mail: hoffmannw@ul.com

SR:WHH

0044BUL.W02;WHH;mc

PE (POLYETHYLENE) COMPOUNDS FOR USE AS IRRIGATION CABLE JACKETS

Compound Supplier	Compound Designation	Color	Generic Class
BP Chemicals Americas Inc. 620 Fifth Avenue New York, NY 10020 Mr. Colin D. Garside	DFDG 0588 Black 21	 Black	 PE
E. I. Du Pont De Nemours & Co., Inc. Polymer Products Department, ELD Div. Barley Mill Plaza Kirk Mill Building Wilmington, DE 19898 Electrical Industry Group (302) 999-4849	Alathon 1250	Black	PE
Union Carbide Corp. Old Ridgebury Road Danbury, CT 06817 Mr. Luke C. Du 203-794-3046	DFDB 0588 DFDD 6059 DGDJ 3479	 Black	PE PE PE