



UL 1425

Underwriters Laboratories Inc. Standard for Safety

Cables for Non-Power-Limited Fire-Alarm Circuits



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UL Standard for Safety for Cables for Non-Power-Limited Fire-Alarm Circuits, UL 1425

Second Edition, Dated October 24, 2005

Summary of Topics

Revision pages have been issued for the Standard for Non-Power-Limited Fire-Alarm Circuits, UL 1425, to reflect the latest ANSI approval date and to incorporate the proposal dated March 12, 2010 and May 14, 2010. This proposal includes the following:

- ***Quad-rated TC, PLTC, FPL and NPLF.***

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The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 12, 2010 and May 14, 2010.

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UL 1425

Standard for Cables for Non-Power-Limited Fire-Alarm Circuits

First Edition – January, 1998

Second Edition

October 24, 2005

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The most recent designation of ANSI/UL 1425 as an American National Standard (ANSI) occurred on August 6, 2010. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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INTRODUCTION

1 Scope

1.1 This Standard states the construction, test, and marking requirements covering the safety of electrical and electrical/optical-fiber cables rated 60°C to 250°C and intended for 150-volt and lower-potential non-power-limited circuits that are controlled and powered by a fire-alarm system. These cables are for installation in buildings as specified in Article 760 and other applicable parts of the National Electrical Code (NEC), NFPA 70. Cables covered by these requirements are:

- a) Type NPLFP – These cables are for installation in “other spaces used for environmental air” [See NEC 300-22(c)].
- b) Type NPLFR – These cables are for installation in vertical runs in a shaft or for installation in vertical runs that penetrate more than one floor.
- c) Type NPLF – These cables are for general-purpose fire-alarm use in buildings. General purpose does not include use as plenum or riser cable.

1.2 These cables contain two or more insulated circuit conductors with or without one or more insulated or bare equipment-grounding conductor(s). Each insulated circuit and grounding conductor is rated for 600 volts. These cables do not contain any coaxial members. These cables are rated for 150 volts and are so marked.

1.3 Armored cables are covered by interlocked metal strip or a smooth or corrugated metal sheath with or without a jacket over the armor. Cables for encasement in concrete, mortar, other masonry, plaster, or similar construction have metal armor and a jacket over the armor. Cables for direct burial in the earth (see markings in 1.8) are subject to a 1000-pound crushing test. Cables for direct burial are not required to be armored. Cables for direct burial that are armored have a jacket over the armor. All other cables (unarmored, flat or round) have an overall jacket.

1.4 Cables of materials that qualify for temperatures above 60°C (140°F) are marked with a temperature rating. Temperature marking is not required for cables that qualify for a temperature rating of 60°C (140°F).

1.5 Cables that contain one or more electromagnetic shields (see 8.1 – 8.3 regarding constructions) are not required to be marked to indicate the presence of the shielding. A shielded cable that is marked has “shielded” on the tag and either on the overall cable jacket or legible through the jacket.

1.6 Cables that qualify for exposure to sunlight (720-hour sunlight-resistance test – see 25.1) have “sun res” or “sunlight resistant” on the tag and either on the overall cable jacket or legible through the jacket.

1.7 Cables that qualify for burial directly in the earth (1000-pound crushing test – see 29.1) have “dir bur”, “direct burial”, or “for direct burial” on the tag and either on the overall cable jacket or legible through the jacket. Each insulated circuit and grounding conductor in direct-burial cables is insulated for wet locations (see 7.3.1 and 30.1 – 30.8).

1.8 A cable that contains one or more optical-fiber members has "OF " supplementing the type letters and is marked in accordance with 41.1(c).

1.9 These requirements do not cover cables that contain only optical fibers. Optical-fiber cables without electrical conductors are covered in the Standard for Optical Fiber Cable, UL 1651.

1.10 These requirements do not cover cables for electric-light, power, control, Class 1, Class 2, or Class 3 circuits.

1.11 These requirements do not cover cables for power-limited fire-alarm circuits (see UL 1424).

1.12 Smoke and flame tests are as follows for the cables covered in these requirements:

a) **PLENUM CABLES** – All Type NPLFP cables are tested for smoke and flame characteristics as specified in Smoke and Flame Testing of Plenum Cables, Section 22, which references the National Fire Protection Association Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces, ANSI/NFPA 262. A cable that complies exhibits a maximum flame-propagation distance that is not greater than 5 ft, 0 inch or 152 cm, a peak optical density of smoke produced of 0.50 or less (32 percent light transmission), and an average optical density of smoke produced of 0.15 or less.

b) **RISER CABLES** – Jacketed Type NPLFR cables are tested for flame-propagation characteristics as specified in Flame Testing of Riser Cables, Section 23, which references the Standard Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666. A cable that complies exhibits a flame-propagation height under 12 ft, 0 inch or 366 cm and attains a temperature no higher than 850.0°F (454.4°C) at a height of 12 ft, 0 inch or 366 cm.

c) **GENERAL-PURPOSE CABLES** – Jacketed Type NPLF cables comply with one of the two 70,000 Btu/h (20.5 kW) vertical-tray flame tests specified in Alternative Vertical-Tray Flame Tests of General-Purpose Cables, Section 24. The cable manufacturer chooses one of the following tests:

1) The UL test referenced in 24.1.2 – 24.3.3. These paragraphs apply the test method described as the UL Flame Exposure (smoke measurements are not applicable) in the Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685.

2) The FT4/IEEE 1202 test referenced in 24.1.2 and 24.4.1. These paragraphs apply the test method described as the FT4/IEEE 1202 Type of Flame Exposure (smoke measurements are not applicable) in the Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685. This test differs from the UL test in loading (a greater number of cable lengths are used, with small cables bundled, and the spacing between cables or bundles is limited), burner angle, and failure criterion. A cable that complies is eligible to be marked "FT4/IEEE 1202" or "FT4" on the surface or on a marker tape as indicated in 40.1(i).

2 Units of Measurement

2.1 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements 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 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

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

CONSTRUCTION

4 Materials

4.1 Each material in a cable shall be compatible with all of the other materials in the cable.

4.2 Cables for non-power-limited fire-alarm circuits shall comply in all respects with the applicable requirements for construction details, test performance, and markings.

5 Circuit and Grounding Conductors

5.1 Each circuit and grounding conductor shall be of soft-annealed copper that complies with the American Society for Testing and Materials Standard Specification for Soft or Annealed Copper Wire, ASTM B 3. See Electromagnetic Shields, Section 8, concerning drain wires (copper).

5.2 Each circuit and grounding conductor shall be round.

5.3 Each circuit and grounding conductor shall be solid or stranded. A stranded conductor shall consist of round strands with a right- or left-hand direction of lay. The length of lay of the wires (strands) of a stranded conductor shall not exceed 20 times the calculated diameter over the assembled conductor. Seven strands, concentric, is the stranding assumed in these requirements; however, individual strand diameter, any mix of different strand diameters, the number of strands, and the stranding type are not specified. See Metal Coating of Conductors, Section 6.

5.4 Circuit and grounding conductors shall be of standard 18 – 12 AWG sizes. See the final sentence of 12.2 regarding grounding conductor size relative to the size(s) of the circuit conductors.

5.5 All solid and stranded circuit conductors are to be identified as a particular AWG size in the marking [see 40.1(b)] on or in the cable 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, as described in 5.6, by determination of the diameter. 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 5.7. Determination of the conductor size by measurement of the d-c resistance as described in D-C Resistance Test of a Conductor, Section 17, is the referee method in all cases.

5.6 Where measured as the means of size verification (see 5.5), the diameter of a solid circuit or grounding conductor shall not be smaller than the minimum diameter indicated for the size in Table 5.1 when the diameter of the conductor is determined from measurements made as follows:

a) Measurements of the diameter of a solid conductor are to be made over the metal-coated or uncoated conductor by optical means or by means of a machinist's micrometer caliper having flat surfaces both on the anvil and on the end of the spindle. In either case, the equipment 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 0.0001 inch or 0.001 mm. The maximum and minimum diameters at a given point on the solid conductor 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 diameter indicated in Table 5.1 is an absolute minimum. The unrounded average of the two diameter readings is therefore to be compared directly with the minimum in the table for the purpose of determining whether the solid conductor does or does not comply with the diameter requirement.

5.7 Where measured as the means of size verification (see 5.5), the cross-sectional area of a stranded circuit or grounding conductor shall not be smaller than the minimum area indicated for the size in Table 5.1. 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.

5.8 The nominal diameters indicated in Table 5.1 for solid and stranded circuit and grounding conductors are to be used in calculating the dimensions needed for various parts of the cable when using Tables 13.1, 13.2, 14.1, 14.2, 18.1, and 20.1.

Table 5.1
Dimensions of conductors

AWG size of conductor	Diameter of solid conductor				Cross-sectional area of stranded conductor				Nominal diameter of stranded conductor (7 strands)	
	Nominal See 5.8		Minimum See 5.6(b)		Nominal		Minimum			
	mils	mm	mils (0.99 × nominal)	mm	cmil	mm ²	cmil (0.98 × nominal)	mm ²	mils	mm
18	40.3	1.02	39.9	1.013	1620	0.823	1588	0.807	45.6	1.16
17	45.3	1.15	44.8	1.138	2050	1.04	2009	1.02	51.3	1.30
16	50.8	1.29	50.3	1.278	2580	1.31	2528	1.28	57.6	1.46
15	57.1	1.45	56.5	1.435	3260	1.65	3195	1.62	64.7	1.64
14	64.1	1.63	63.5	1.613	4110	2.08	4028	2.04	72.7	1.85
13	72.0	1.83	71.0	1.81	5180	2.63	5076	2.58	81.6	2.07
12	80.8	2.05	80.0	2.03	6530	3.31	6399	3.24	91.5	2.32

5.9 Each circuit and grounding conductor and each shield shall be continuous throughout the entire length of the finished cable as determined by the Continuity Test of Conductors and Shields, Section 16.

5.10 A joint in a solid circuit or grounding conductor or in one of the individual wires of a stranded circuit or grounding conductor shall be made in a workmanlike manner, shall be smooth, and shall not have any sharp projections. A joint in a stranded conductor is to be made by separately joining each individual wire or by machine brazing or welding of the conductor as a whole so that the resulting solid section of the stranded conductor is not longer than 1/2 inch or 13 mm, there are no sharp points, and the distance between brazes or welds in a single conductor does not average less than 3000 ft or 915 m in any reel length of insulated single conductor. A joint made before insulation is applied to a conductor shall not increase the diameter of the solid conductor or individual wire (strand). A joint made after insulating shall not increase the diameter of the solid conductor or individual wire (strand) by more than 20 percent. Joints made after insulating shall be insulated by applying a bonded patch or by molding. The insulation shall comply with the requirements in this Standard. An individual member jacket or an overall cable jacket that is damaged to the point of exposing the underlying assembly or that is opened for the purpose of making any repair under the jacket either shall be stripped and replaced in its entirety or a second, duplicate jacket shall be applied over the first for the entire length of the member or cable. The total thickness of the two jackets shall not exceed any limitation determined for a particular cable in an applicable flame or smoke-and-flame test or other test specified in this Standard.

5.11 Any section of a circuit or grounding conductor that includes a factory joint shall have a tensile strength that is not less than 85 percent of the tensile strength of an adjacent section of the conductor not having a joint.

6 Metal Coating of Conductors

6.1 Where any copper circuit or grounding conductor contacts insulating, jacketing, or other nonmetallic cable material that corrodes unprotected copper in the test described in Conductor Corrosion, Section 500 of UL 1581, the copper conductor shall be covered with a coating of tin, a tin/lead alloy, nickel, silver, or of another (evaluation required) metal or alloy.

6.2 Use of a metal coating is not specified on a solid circuit or grounding conductor or the individual wires (strands) of a stranded circuit or grounding conductor on which a metal coating is not required for corrosion protection.

6.3 The temperature rating of the cable shall not exceed the temperature indicated in Table 6.1 for the diameter and metal coating of the individual strands.

...

Table 6.1
Maximum temperature rating of cable relative to diameter and metal coating of conductor strands

Metal coating of copper strands	Diameter of each strand	
	Smaller than 0.015 inch or 0.38 mm	At least 0.015 inch or 0.38 mm
Uncoated or coated with tin or a tin/lead alloy	150°C (302°F)	200°C (392°F)
Coated with silver	200°C (392°F)	200°C (392°F)
Coated with nickel	over 200°C (392°F)	over 200°C (392°F)

7 Insulation

7.1 General

7.1.1 Each circuit conductor and insulated grounding conductor shall be insulated for its entire length.

7.1.2 The insulated circuit and grounding conductors used in the cable shall consist of either or both of the following conductors (the mix is not specified):

- a) CONDUCTORS OTHER THAN NEC WIRES – Insulated conductors that are unmarked except for size where used as a circuit conductor [the size marking is not required – see 40.1(b)] and that comply with the construction requirements in 7.2.1.1 and 7.2.1.2 and the performance requirements (six tests) referenced in 7.2.1.2 (a) – (f).
- b) NEC WIRES – Constructions of NEC wires that are as specified in 7.3.1 and are unmarked except for size where used as a circuit conductor [the size marking is not required – see 40.1(b)]. The six tests referenced in 7.2.1.2 (a) – (f) do not apply to NEC wires.

7.1.2 revised September 22, 2006

7.2 Conductors other than NEC wires

7.2.1 Material and application

7.2.1.1 Where, for an insulated circuit or grounding conductor, the cable manufacturer chooses to use an insulated conductor (non-NEC conductor) other than an unmarked National Electrical Code wire (NEC wire) constructed as specified in 7.3.1, the conductor shall be insulated with a material appropriate for insulating a 600-volt fixture wire or branch-circuit wire; the material shall be one of the insulation materials specified in Table 7.1 or referenced in note (a) to Table 7.1. An overall nonmetallic braid shall be used on conductors insulated with silicone rubber. The braid on a conductor insulated with silicone rubber shall be a single braid complying with the Standard for Fixture Wire, UL 66.

Exception: A protective covering is not required for silicone insulation that has a tensile strength of at least 1200 lbf/in² or 8.27 MN/m² or 827 N/cm² or 0.844 kgf/mm² or an insulation thickness at least 50% more than required in Table 7.3.

Table 7.1
Index to insulation and jacket materials

Material(s) ^a	Temperature rating of insulation	Temperature rating of jacket	Applicable table of physical properties in UL 1581 (see 7.2.2.1 and 7.2.2.2)
CP	90°C (194°F)	90°C (194°F)	50.1
	75°C (167°F)	75°C (167°F)	50.1
Thermoplastic CPE	—	90°C (194°F)	50.28
Thermoset CPE	—	90°C (194°F)	50.29
	—	75°C (167°F)	50.30
ECTFE	150°C (302°F)	150°C (302°F)	50.63
ETFE			
EPCV	90°C (194°F)	90°C (194°F)	50.62
	75°C (167°F)	75°C (167°F)	50.62
FEP	200°C (392°F) ^b	200°C (392°F) ^b	50.70
NBR/PVC	—	90°C (194°F)	50.83
LDFRPE and HDFRPE	—	75°C (167°F)	50.133
	—	75°C (167°F)	50.80
Neoprene	—	90°C (194°F)	50.124
	—	75°C (167°F)	50.123
PTFE (TFE)	250°C (482°F) ^b	250°C (482°F) ^b	50.219
PFA and MFA	200°C (392°F) ^b	200°C (392°F)	50.137
	250°C (482°F) ^b	250°C (482°F)	50.137
PVC	105°C (221°F)	105°C (221°F)	50.182
	90°C (194°F)	90°C (194°F)	50.182
	75°C (167°F)	75°C (167°F)	50.182
	60°C (140°F)	60°C (140°F)	50.182
PVDF and PVDF copolymer	—	150°C (302°F)	50.185
	—	125°C (257°F)	50.185
SRPVC (semirigid PVC)	105°C (221°F)	—	50.183
	90°C (194°F)	—	50.183
	75°C (167°F)	75°C (167°F)	50.183
	60°C (140°F)	60°C (140°F)	50.183
Silicone rubber	200°C (392°F) ^b	200°C (392°F) ^b	50.210
	150°C (302°F)	150°C (302°F)	50.210
TPE	105°C (221°F)	105°C (221°F)	50.223
	90°C (194°F)	90°C (194°F)	50.224
XL:			
XLPE			
XLPVC	105°C (221°F)	105°C (221°F)	50.245
XLEVA	90°C (194°F)	90°C (194°F)	50.237
blends of these	75°C (167°F)	75°C (167°F)	50.241

^a See 7.2.1.2 for a long-term evaluation of an insulation or jacket material not named in the first column (new material) or not complying with the short-term tests referenced in the last column.

^b 150° (302°F) is stated in Table 6.1 as the limit for the cable temperature rating (see 13.3.3) where conductor strands are used that are smaller in diameter than 0.015 inch or 0.38 mm and are uncoated or are coated with tin or a tin/lead alloy. The indicated rating higher than 150°C (302°F) applies where, regardless of diameter, the solid conductor or strands are coated with silver [200°C (302°F)] or nickel [250°C (482°F)].

7.2.1.2 The insulation shall be solid with or without a solid dielectric skin (a thin, solid, extruded layer that is or is not separable) applied over the solid insulation. A skin is not required to be of the same material as the insulation. The insulation shall be applied directly to the metal conductor, shall have a circular cross

section, and shall fit tightly to the conductor with no more than nominal adherence (a test is not specified). The insulation shall be uniform and shall not have any defects (bubbles, open spots, rips, tears, cuts, or foreign material) that are visible with normal or corrected vision without magnification. The insulation shall comply with the physical property requirements in 7.2.2, and the following performance tests apply to the insulated conductors (non-NEC conductors) described in this paragraph and in 7.2.1.3:

- a) Heat Shock Test, Section 18.
- b) Deformation Test, Section 19.
- c) Cold Bend Test of Insulation, Section 20.
- d) Test for Insulation Resistance at 60.0°F (15.6°C), Section 27.
- e) Mechanical Water Absorption Test of Insulation in Direct-Burial Cable, Section 30. (Not required if conductors comply with the requirements in item f).
- f) Long Term Insulation Resistance in Water Test of conductors in cables marked "Wet Location", Section 30A.

7.2.1.2 revised September 22, 2006

7.2.1.3 Insulation or a jacket that is of material generically different from any insulation/jacket material named in Table 7.1 (new material), or that is of material named in Table 7.1 yet does not comply with the applicable short-term tests, shall be of a material and in thicknesses and with a temperature rating appropriate for a non-power-limited fire-alarm cable. The material shall be evaluated for the requested temperature rating as described in Long-Term Aging, Section 481 of UL 1581. Long-term air-oven aging is not required for any material for which Table 47.1 of UL 1581 indicates a table of physical properties requirements under Specific Materials, Section 50 of UL 1581. Investigation of the electrical, mechanical, and physical characteristics of the cable using either material shall show the material to be comparable in performance to an insulation or jacket material named in Table 7.1 for the applicable temperature rating. The investigation shall include tests such as crushing, impact, abrasion, deformation, heat shock, and dielectric voltage-withstand.

7.2.2 Physical properties tests

7.2.2.1 Specimens prepared from samples of the insulation and overall jacket shall have values of tensile strength and ultimate elongation that comply with the applicable table of physical properties in UL 1581 referenced in Table 7.1 (see 7.2.1.2 regarding noncompliance with these short-term tests). The samples are to be taken from the finished cable. The specimens are to be prepared from the samples and the testing is to be conducted as indicated in 7.2.2.2.

7.2.2.2 The methods of preparation of samples, of selection and conditioning of specimens, and of making the measurements and calculations for ultimate elongation and tensile strength shall be as indicated under the heading "Physical Properties Tests of Insulation and Jacket" in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581. For jackets from cables having an overall diameter not greater than 0.200 inch or 5.1 mm, tubular or die-cut specimens are to be tested. Tubular specimens are not to be prepared from jackets of larger cables.

7.2.3 Thicknesses

7.2.3.1 General

7.2.3.1.1 The average thickness and the minimum thickness at any point of the insulation (including any skin) shall not be less than indicated in Table 7.2.

Table 7.2
Thicknesses^a of insulation (including any skin) on 18 – 12 AWG conductors

Material in Table 7.1	Minimum average		Minimum at any point	
	inch	mm	inch	mm
Silicone rubber	0.030	0.76	0.027	0.69
FEP, ETFE, ECTFE, PTFE, TFE	0.020	0.51	0.018	0.46
PVC under a nylon ^a jacket	0.015	0.38	0.012	0.30
PVC not under a nylon jacket, TPE	0.030	0.76	0.027	0.69
Any material named or referenced in Table 7.1 yet not named in this table	0.030	0.76	0.027	0.69
^a The thickness of the nylon is to be measured by means of a micrometer microscope or other optical instrument that is calibrated to read directly to at least 0.0001 inch (0.1 mil) or 0.010 mm. The measurement at the thinnest point of the nylon is to be recorded to the nearest 0.0001 inch or 0.010 mm and shall not be less than 0.0040 inch (4.0 mils) or 0.10 mm.				

7.2.3.1.2 The thicknesses are to be determined by means of measurements made as described in Thicknesses of Insulation on Flexible Cord and on Fixture Wire, Section 250 of UL 1581. The 0.003-inch (3-mil) or 0.08-mm thickness-reduction allowance in 250.5 of UL 1581 is to be applied only to insulation that has an average thickness (including any skin) of at least 0.015 inch or 0.38 mm and that is from a stranded conductor that leaves one or more strand impressions in the insulation that are too small to accommodate the smaller pin referred to in 250.11 of UL 1581. For this application, the pin is to be 0.0200 inch (20.0 mils) or 0.508 mm in diameter.

7.2.3.1.3 The average thickness resulting from the five sets of measurements taken as described in 250.3 of UL 1581 is to be rounded to the same number of decimal places as the average thickness is stated in Table 7.2. The rounding is to be done as described in 7.2.3.2 – 7.2.3.5, which apply the American Society of Testing and Materials Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications, ASTM E 29.

7.2.3.2 Rounding to the nearest 0.0001 inch

7.2.3.2.1 A figure in the fourth decimal place is to remain unchanged where the figure in the fifth decimal place is 0 – 4 and the figure in the fourth decimal place is odd or even, or where the figure in the fifth decimal place is 5 and the figure in the fourth decimal place is even (0, 2, 4, and so forth). A figure in the fourth decimal place is to be increased by 1 where the figure in the fifth decimal place is 6 – 9 and the figure in the fourth decimal place is odd or even, or where the figure in the fifth decimal place is 5 and the figure in the fourth decimal place is odd (1, 3, 5, and so forth).

7.2.3.3 Rounding to the nearest 0.001 inch

7.2.3.3.1 A figure in the third decimal place is to remain unchanged where the figure in the fourth decimal place is 0 – 4 and the figure in the third decimal place is odd or even, or where the figure in the fourth decimal place is 5 and the figure in the third decimal place is even (0, 2, 4, and so forth). A figure in the third decimal place is to be increased by 1 where the figure in the fourth decimal place is 6 – 9 and the figure in the third decimal place is odd or even, or where the figure in the fourth decimal place is 5 and the figure in the third decimal place is odd (1, 3, 5, and so forth).

7.2.3.4 Rounding to the nearest 0.001 mm

7.2.3.4.1 A figure in the third decimal place is to remain unchanged where the figure in the fourth decimal place is 0 – 4 and the figure in the third decimal place is odd or even, or where the figure in the fourth decimal place is 5 and the figure in the third decimal place is even (0, 2, 4, and so forth). A figure in the third decimal place is to be increased by 1 where the figure in the fourth decimal place is 6 – 9 and the figure in the third decimal place is odd or even, or where the figure in the fourth decimal place is 5 and the figure in the third decimal place is odd (1, 3, 5, and so forth).

7.2.3.5 Rounding to the nearest 0.01 mm

7.2.3.5.1 A figure in the second decimal place is to remain unchanged where the figure in the third decimal place is 0 – 4 and the figure in the second decimal place is odd or even, or where the figure in the third decimal place is 5 and the figure in the second decimal place is even (0, 2, 4, and so forth). A figure in the second decimal place is to be increased by 1 where the figure in the third decimal place is 6 – 9 and the figure in the second decimal place is odd or even, or where the figure in the third decimal place is 5 and the figure in the second decimal place is odd (1, 3, 5, and so forth).

7.3 NEC wires

7.3.1 Where the cable manufacturer chooses to use a National Electrical Code wire (NEC wire) as an insulated circuit or grounding conductor, the wire used shall be one of the constructions of 600-volt NEC fixture wire or branch-circuit wire specified in Table 7.3. The conductor shall be of copper. The finished insulated conductor shall comply with the wire Standard indicated in Table 7.3 except that there shall not be any marking or temperature identification. Conductors insulated for wet locations (the first column of Table 7.3 shows a "W" in the type letters for these conductors) shall be used in cables that are marked [see marking in 40.1(f)] for burial directly in the earth. The six performance tests referenced in 7.2.1.2 (a) – (f) do not apply to NEC wires.

7.3.1 revised September 22, 2006

Table 7.3
600-volt NEC constructions

Table 7.3 revised September 22, 2006

Type	Constructions for the UL 1425 application	Standard ^a
PAF, PTF	250°C (482°F) dry, 18 or 16 AWG	UL 66
KF-2, KFF-2	200°C (392°F) dry, 18 or 16 AWG	UL 66
PAFF	150°C (302°F) dry, 18 or 16 AWG	UL 66
PF, PGF	200°C (392°F) dry, 18 or 16 AWG	UL 66
FEP	200°C (392°F) dry, 14 or 12 AWG	UL 83
SF-2	200°C (392°F) dry, 18 or 16 AWG	UL 66
PTFF	150°C (302°F) dry, 18 or 16 AWG	UL 66
PFF, PGFF	150°C (302°F) dry, 18 or 16 AWG	UL 66
SFF-2	150°C (302°F) dry, 18 or 16 AWG	UL 66
ZF, ZFF	150°C (302°F) dry, 18 or 16 AWG	UL 66
Z	150°C (302°F) dry, 14 or 12 AWG	UL 83
XHHW-2	90°C (194°F) wet or dry, 14 or 12 AWG	UL 44
RHW-2	90°C (194°F) wet or dry, 14 or 12 AWG	UL 44
RFHH-2	90°C (194°F) dry, 18 or 16 AWG	UL 66
RFHH-3	90°C (194°F) dry, 18 or 16 AWG	UL 66
TFN, TFFN	90°C (194°F) dry, 18 or 16 AWG	UL 66
THHN	90°C (194°F) dry, 14 or 12 AWG	UL 83
XHH	90°C (194°F) dry, 14 or 12 AWG	UL 44
RHH	90°C (194°F) dry, 14 or 12 AWG	UL 44
THHW	75°C (167°F) wet or 90°C (194°F) dry, 14 or 12 AWG	UL 83
XHHW	75°C (167°F) wet or 90°C (194°F) dry, 14 or 12 AWG	UL 44
THWN	75°C (167°F) wet or dry, 14 or 12 AWG	UL 83
THW	75°C (167°F) wet or dry, 14 or 12 AWG	UL 83
RHW	75°C (167°F) wet or dry, 14 or 12 AWG	UL 44
RFH-2	75°C (167°F) dry, 18 or 16 AWG	UL 66
SA	90°C (194°F) dry, 14 or 12 AWG	UL 44
TW	60°C (140°F) wet or dry, 14 or 12 AWG	UL 83
TF, TFF	60°C (140°F) dry, 18 or 16 AWG	UL 66

^a Standard for Thermoset-Insulated Wires and Cables, UL 44; Standard for Fixture Wire, UL 66; Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

8 Electromagnetic Shields

8.1 An electromagnetic shield is not required. Except that a reduction in metal-shield mass and/or coverage affects the performance of the cable in the applicable flame test (see 24.2.2), the construction is not specified for any shield that is applied over an individual insulated conductor, over a pair of insulated conductors, over one or several groups of insulated conductors with or without one or more optical-fiber members in any group, or over the entire cable assembly. The number of shields in a cable is not specified. Material applied as insulation between shields shall be an insulation grade of one of the materials named or referenced in Table 7.1 (thickness not specified). These requirements (UL 1425) do not specify or test for the electrostatic/electromagnetic performance of a shield. Each shield shall be continuous throughout the entire length of the finished cable as determined by the continuity test described in Continuity Test of Conductors and Shields, Section 16.

8.2 An electromagnetic shield shall be of metal. The following constructions are typical:

- a) A laminated shield tape of polymeric material and metal(s) with or without a bare metal-coated or uncoated (uncoated copper is not to be used with an aluminum-faced tape) copper drain wire in contact with the metal(s) part of the tape. The application of the tape with the metal(s) side in or out is not specified. The size of a drain wire is not specified. A drain wire is to be solid or stranded.
- b) A corrugated or smooth single-metal or bi-metal tape applied longitudinally or helically with or without a bare metal-coated or uncoated (uncoated copper is not to be used with an aluminum tape) copper drain wire in contact with the metal tape (a specific version of this shield is described in 8.3). A jacket or other covering is not required under this shield. A polymer coating is not required. Where used, a polymer coating is to be on only one side of a tape that is applied with a drain wire. In the case of an inward-facing coating on a metal tape applied over the insulation, bonding of the coating to the insulation is not specified. Any inward-facing coating on a metal tape applied over more than one optical-fiber member or insulated conductor is not to bond to the conductors or members. The size of a drain wire is not specified. A drain wire is to be solid or stranded (the stranding is not specified). A metal sheath used as a shield shall comply with 14.1.1 (a), (b), or (c) as applicable.
- c) A serving, wrap, or braid of aluminum wires or of metal-coated or uncoated (uncoated copper is not to be in contact with aluminum wires) copper wires (see 6.3). A braid floodant is not required and is not specified. Where the overall cable jacket is thinner in average thickness than 0.013 inch or 0.33 mm and is thinner at any point than 0.010 inch or 0.25 mm, a wrap or other protective covering shall be provided over the wire serving, wrap, or braid (see note ^c to Tables 13.1 and 13.2). The construction of the protective covering is not specified. The protective covering shall keep bobbin ends and other wire bulges or projections from penetrating the overall cable jacket during and after application of the overall jacket.
- d) An investigated equivalent of (a), (b), or (c).

8.3 The specific metal sheath to which reference is made in 21.2 (regarding use of a 15-times-cable-diameter mandrel in the cold-bend testing of the cable) is to be a version of the shield covered in 8.2(b). A jacket or other covering is not required under this shield. The metal sheath is to consist of a metal tape that is 0.008 inch or 0.2 mm thick with or without a coating on one side. The coating is to be of vinyl or other resin that is bonded to the metal. The tape is to be corrugated or smooth and is to be applied to the cable assembly longitudinally using a positive overlap. Any bonded coating used is to face outward. An inward-facing coating is not to bond to the conductors or optical-fiber members in the cable.

9 Optical-Fiber Members

9.1 Each optical-fiber member shall consist of one of the following and shall be separated from the rest of the cable by material that is electrically nonconductive (an insulation grade is not required):

a) One or more glass fibers that are individually coated and tight buffered and then are covered by a nonmetallic tape, wrap, or braid (complete coverage is required) or by a jacket. Except that the covering shall be electrically nonconductive, the materials, thickness, and other features of these elements are not specified.

b) One or more glass fibers that are individually coated, are or are not tight buffered, are enclosed with or without a gel in a loose buffer tube, and then are or are not covered by a nonmetallic tape, wrap, or braid (complete coverage is required) or by a jacket. Any covering applied shall be electrically nonconductive. A covering is not required over a loose buffer tube that is electrically nonconductive. Except that the tube or covering shall be electrically nonconductive, the materials, thickness, and other features of these elements are not specified.

9.2 No electrical element of the cable shall be located in an optical-fiber member or group of optical-fiber members. Strength members, moisture barriers, heat shields, and other nonelectrical parts of an optical-fiber member are not specified; however, where any such part is of metal or other electrically conductive material, its presence shall be indicated by a marking as detailed in 41.1(d).

9.3 The energy that an optical-fiber cable carries in some laser systems presents a potential risk of eye, or other injury to people. Consequently, where optical-fiber cables are installed in a laser system, the recommendations of the ANSI Z136 laser system safety standards should be applied. To help protect optical-fiber cable installers, users, service personnel, and anyone who handles the optical-fiber cable component of the system after installation, 41.1(c) specifies a tag, reel, or carton marking.

10 Binders

10.1 Use of a binder is not specified over any group of conductors (with or without one or more optical-fiber members in the group) or optical-fiber members, or several such groups within the cable. Where used, a binder shall consist of a binder jacket (extruded binder); an open, skeleton wrap of nonmetallic threads or tape; a metal shield as described in Electromagnetic Shields, Section 8; or a core wrap as described in Core Wrap, Section 11. Except for thickness, which is not specified, a binder jacket shall comply with Overall Cable Jacket, Section 13. The average thickness and the minimum thickness at any point of a binder jacket shall be determined as described in Thicknesses of Jacket on Flexible Cord, Fixture Wire, and Elevator Cable, Section 280 of UL 1581. The material, construction, manner of application, and other details of a thread or tape binder are not specified.