UL 1651

STANDARD FOR SAFETY

Optical Fiber Cable

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UL Standard for Safety for Optical Fiber Cable, UL 1651

Fourth Edition, Dated May 15, 2015

Summary of Topics

This revision of ANSI/UL 1651 dated April 13, 2023 includes requirements for Sunlight Resistance Test – Deletion of Carbon-Arc Exposure; 10.1

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 3, 2023.

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UL 1651

Standard for Optical Fiber Cable

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Fourth Edition

May 15, 2015

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through April 13, 2023.

The most recent designation of ANSI/UL 1651 as an American National Standard (ANSI) occurred on April 13, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover single and multiple optical-fiber cables for control, signaling, and communications, rated a minimum of 60°C, as described in Article 770 and other applicable parts of the National Electrical Code (NEC). Cables complying with these requirements are:

Type OFNP – Plenum – A nonconductive cable for use in ducts, plenums, and other spaces used for environmental air. A nonconductive cable contains no metallic members and no other electrically conductive materials.

Type OFCP – Plenum – A conductive cable for use in ducts, plenums, and other spaces used for environmental air. A conductive cable contains non-current-carrying conductive members such as metal strength members and metallic vapor barriers.

Type OFNR – Riser – A nonconductive cable for vertical use in shafts or from floor to floor.

Type OFCR – Riser – A conductive cable for vertical use in shafts or from floor to floor.

Type OFN and OFNG – General Purpose – Nonconductive cables for general purpose use.

Type OFC and OFCG – General Purpose – Conductive cables for general purpose use.

1.2 Smoke and fire considerations are as follows for the cables covered in these requirements:

a) TYPE OFNP and OFCP CABLES – Cables that are intended for installation in accordance with Section 770.154 (A) of the National Electrical Code (ANSI/NFPA 70) in a duct, plenum, or other space used to transport environmental air without the cable being enclosed in a raceway in that space are tested for smoke and flame characteristics in accordance with 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 in 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) TYPE OFNR and OFCR CABLES – Cables that are intended for use in vertical runs in a shaft, or that penetrate more than one floor, in accordance with Section 770.154 (B) of the National Electrical Code, ANSI/NFPA 70, are tested for flame-propagation characteristics in accordance with the Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666. A cable that complies has a flame-propagation height less than 12 ft, 0 in or 366 cm and temperatures are 850.0°F (454.4°C) or less at a height of 12 ft, 0 in or 366 cm.

c) TYPE OFN, OFNG, OFC, and OFCG CABLES – Type OFN and OFC cables are intended for installation in accordance with Section 770.154 (C) or (D) of the National Electrical Code, ANSI/NFPA 70, comply with a 70,000 Btu/h (20.5 kW) vertical-tray flame test. The cable manufacturer chooses one of the following tests:

1) The UL test described in 9.2.1 and 9.2.2 of these requirements. These paragraphs apply the test 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, to cable that is surface marked or designated by a marker tape as "OFN" or "OFC".

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2) The FT4/IEEE 1202 test as described in 9.3.1 of these requirements, which applies 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 tests in loading (more cables are used, with small cables bundled, and the spacing between cables or bundles is limited), burner angle, and failure criterion.

Type OFCG and OFNG cables are to comply with the FT4/IEEE 1202 test.

1.3 Cables covered in these requirements are not required by the NEC to be used in raceway. These cables are capable of use without the physical protection of raceway but may be pulled into conduit or installed in other raceway.

1.4 The overall jacket on a cable that has "sun res" or "sunlight resistant" in a surface marking or on a marker tape complies with a 720-h sunlight-resistance test.

1.5 These requirements do not cover cables that contain current-carrying conductors. Requirements for cables that contain electrical and optical fiber members are found in the applicable standard for the electrical cable.

1.6 These requirements do not cover the optical performance of the cable.

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 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 and Terms

3.1 Wherever the designation "UL 2556" is used in this wire Standard, reference is to be made to the designated part(s) of the Standard for Wire and Cable Test Methods, UL 2556.

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 The materials used in a cable are not specified.

5 Optical-Fiber Cable

5.1 The assembly of an optical-fiber cable is not specified, however an overall jacket or covering is required. The dimensions of the components making up the optical fiber cable shall be measured as described in the section titled Thickness (Insulation and jacket) of UL 2556. The construction of the optical fiber, the coating, and the buffer (loose or tight), of a strength member, of any nonmetallic tape, wrap, braid, jacket, of any metal armor or braid, or of other components is not specified. Non-current-carrying metal or other electrically conductive parts may be included only in optical-fiber cable Types OFC, OFCG, OFCP, or OFCR.

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5.2 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, 16.1 specifies a tag, reel, or carton marking.

PERFORMANCE

6 Changes in Construction

6.1 In regard to the tests described in Sections 7 – 9, a construction is to be considered changed (and therefore the full number of burns specified in the chosen test is to be repeated) if differences in kind and amount of material are introduced that affect the flame characteristics of the cable.

7 Smoke and Fire Testing of Type OFNP and OFCP Cable

7.1 Type OFNP and OFCP cable shall comply with the flame-spread and smoke-density limits stated in 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, when specimens of the finished cable are tested in sets as described in ANSI/NFPA 262. Typically, the test specimens of this cable are the smallest and largest diameters of the cable that the manufacturer intends to produce in the construction. See 1.2(a).

8 Fire Testing of Type OFNR and OFCR Cable

8.1 Type OFNR and OFCR cables shall comply with the flame-propagation limits stated in the requirements for test for flame propagation height of electrical and optical-fiber cables installed vertically in shafts (UL 1666) when specimens of the finished cable are tested in sets as described in UL 1666. See 1.2(b).

8.2 The test specimens are to be representative of the entire size range in each construction. Typically, the test specimens of this cable are the smallest and largest diameters of cable that the manufacturer intends to produce in the construction.

9 Vertical-Tray Flame Tests on Type OFN, OFC, OFNG, and OFCG Cables

9.1 General

9.1.1 The cable manufacturer shall specify either the UL test referenced in 9.2.1 and 9.2.2 or the FT4/IEEE 1202 test referenced in 9.3.1 for each construction of Type OFC and OFN cables. It is not required that the same test be specified for all constructions. See 1.2(c).

9.1.2 Type OFCG and OFNG cables shall comply with the FT4/IEEE 1202 test referenced in 9.3.1. See 1.2(c).

9.2 UL test

9.2.1 Type OFN and OFC cables of a given construction shall not exhibit damage that reaches the upper end of any specimen (a maximum of 8 ft, 0 in or 244 cm) when sets of cable specimens as described in 9.2.2 are separately installed in a vertical ladder type of cable tray and are subjected to 20 min of flame as described under 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.

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9.2.2 The vertical-tray flame test specimens are to be representative of the entire size range in each construction. Typically, the test specimens of this cable are two sets each of the smallest and largest diameters (equivalent diameter for a cable that is not round is calculated as $1.1284 \times (TW)^{1/2}$, in which T is the thickness of the cable and W is the width of the cable) of cable that the manufacturer intends to produce in the construction. The cable is acceptable if none of the specimens exhibits char of the jacket or covering that reaches the upper end of the specimen.

9.3 FT4/IEEE 1202 test

9.3.1 Finished cable shall not exhibit a char length in excess of 1.5 m or 4 ft, 11 in when each of four sets of specimens as detailed in 9.2.2 is tested as described under 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. Where char length in excess of 1.5 m or 4 ft. 11 in is reached on any individual cable in any set of specimens tested, compliance in tests of additional sets of specimens is required to qualify the full size range desired by the manufacturer.

10 Sunlight Resistance Test

10.1 For cable that is marked for use in sunlight, the ratio of the average tensile strength and ultimate elongation of five conditioned specimens of the overall jacket to the average tensile strength and ultimate elongation of five unconditioned specimens of the overall jacket shall be 0.80 or more when the finished cable is conditioned and tested as described in the Weather (sunlight) Resistance Test, in UL 2556, using 720 hours of xenon-arc exposure.

11 Durability Test of Ink Printing

11.1 Ink printing of the responsible organization and factory identifications required in 15.1(b) and in 15.4 is acceptable on the outer surface of a cable if the printing on each of 2 specimens of the ink-printed jacket remains legible after being rubbed repeatedly with a felt-faced weight as described in Durability of Ink Printing Test, UL 2556 (The aging temperature shall be the same as for the Flexibility Test. For cables rated 60°C, room temperature only.)

12 Limited Combustible

12.1 *Deleted*

12A Flexibility Test

12A.1 For cables rated higher than 60°C, aged specimens of optical fiber cable shall not show any cracks on either the inside or outside surface after specimens are wound onto a cylindrical mandrel of the diameter indicated in 12A.2.

12A.2 The specimens that are to be aged in accordance with the test “Conditioning of Specimens,” described in UL 2556 for the length of time and at the temperature indicated for the jacket material in the applicable table of physical properties in UL 1581. The conditioning shall be followed by 16 to 96 h of rest in still air at room temperature before the specimens are wound onto a mandrel. The aged specimens shall be wound at room temperature for six complete turns (adjacent turns touching) onto a circular mandrel having a diameter twice that of the diameter over the overall jacket.

Each specimen shall be unwound before being examined.

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MARKINGS

13 Intervals

13.1 All printing on the outside surface of the outermost cable surface and anywhere within the finished cable shall be readily legible and shall be repeated at the following intervals throughout the entire length of the cable:

a) Markings on the outer surface of the cable or on a marker tape that is readily legible through a translucent or transparent jacket shall be repeated at intervals that are not longer than 40 in or 1.02 m.

b) Information on a marker tape that is not readily legible through the jacket (see 15.2) shall be repeated at intervals that are not longer than a nominal 24 in or 610 mm (maximum 25 in or 635 mm).

14 Coding

14.1 The color and other identification of individual optical fibers, members, and jackets to distinguish one from the other is not specified.

15 Information on or in the Cable

15.1 The following information shall appear at the intervals indicated in 13.1 throughout the entire length of the finished cable. Except for (a), the sequence of items is not specified. Other information, where added, shall not confuse or mislead and shall not conflict with these requirements. See 18.1 for date marking.

a) CABLE TYPE-LETTER DESIGNATION – Use of the word "Type" is not required:

"Type OFNP" and "Type OFCP" for cables that comply with the requirements in this Standard as well as complying with 7.1 and 1.2(a) as to flame propagation and smoke density in 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 (plenum flame test). These cables may be marked "FT6"; where used, this marking is to be spaced from the other cable markings required in this paragraph.

"Type OFNR" and "Type OFCR" for cables that comply with the requirements in this Standard as well as complying with 8.1, 8.2, and 1.2(b) as to flame-propagation characteristics in the Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666 (near flame test).

"Type OFNG" and "Type OFCG" for cables that comply with the requirements in this Standard as well as complying with 1.2(c) and 9.3.1 as to cable damage in 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. These cables may be marked "FT4/IEEE 1202" or "FT4"; where used, this marking is to be spaced from the other cable markings required in this paragraph.

"Type OFN" and "Type OFC" for cables that comply with the requirements in this Standard as well as complying with 1.2(c) and 9.2.1 or 9.3.1 with regard to cable damage in the UL Flame Exposure or 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. Where the vertical-tray flame test with which the cable complies consists of the FT4/IEEE 1202 Type of Flame Exposure, the cable may

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