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Applications
Engineering Note

Flame Retardant Cable Testing and Listing to Industry Safety Requirements

AEN071, Revision 4

Corning Optical Communications manufactures quality flame retardant optical fiber cables for indoor applications, which comply with the requirements of the National Electric Code® (NEC® 2023) published by the National Fire Protection Agency (NFPA). To ensure compliance to these requirements, a Nationally Recognized Testing Laboratory (NRTL) using applicable industry test standards certifies all cables made by Corning Optical Communications. A NRTL is an independent laboratory recognized by the Occupational Safety and Health Administration (OSHA) to test products to applicable product safety standards, such as those written by the Underwriters Laboratory (UL), Canadian Standards Association (CSA) and others. NRTL functions are to provide independent evaluation, testing, and certification of manufacturers' cables. The NRTL program is part of the OSHA Directorate of Technical Support. As part of OSHA's directive to ensure products are safe for use, the NRTL program recognizes the capabilities of private sector organizations to determine if specific products meet industry safety standards. OSHA's recognition of an NRTL is an acknowledgment of the organization's ability to perform product safety testing and certification.

Third Party Testing

Corning Optical Communications has chosen Intertek Testing Services ETL Semko (ITS) as the NRTL to test and certify its flame retardant optical fiber cables. ITS has a long-standing tradition as a quality independent testing laboratory. ITS has been recognized as a NRTL since 1989 and has been in the safety testing business since the 1950's. The ITS listing mark "ETL" is accepted in the United States and Canada, and ITS conducts testing and certification worldwide under other nationally recognized marks such as the S (Sweden) and GS (Germany) marks. Local inspectors and authorities having jurisdiction throughout North America recognize the ETL mark. ITS provides a broad range of product safety testing and certification services for companies in multiple industries, markets and applications. More specifically, in the telecommunications industry, companies such as Alcoa Fujikura Ltd., Tyco Electronics, Berk-Tek, Mohawk/CDT, CommScope® and Hitachi rely on ITS to certify and list their cable products.

Flame Retardant Testing Standards

ITS and UL are both recognized by OSHA as NRTLs with similar test facilities. They both certify that products bearing their mark have met the requirements of the applicable safety standards when tested to industry standard test procedures. They perform the same safety tests to certify and list products, and conduct periodic follow-up inspections to verify continued compliance. Specifically for optical fiber cables, both agencies certify that

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manufacturers' cables meet the requirements of UL 1651, "Optical Fiber Cable," which is a national standard approved by the American National Standards Institute (ANSI). UL 1651 requirements cover single fiber and multi-fiber optical cables for control, signaling and communications as described in Article 770 and other applicable parts of the NEC. Cables complying with the requirements are Type OFNP, OFCP, OFNR, OFCR, OFN, OFNG, OFC and OFCG cables. UL 1651 specifies the requirements for listing cable of these types and they include flame performance testing, marking durability, and other marking requirements. The two most common requirements in the telecommunications industry are Type OFNR (riser) and Type OFNP (plenum) cables. The industry standard tests specified for these listings are UL 1666, "Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts," and NFPA 262, "Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces." While UL and NFPA authored these flame test procedures, once adopted by ANSI, they became nationally recognized test procedures, performed by ITS, UL and other NRTLs.

This work was to ensure that all NRTL testing is conducted in accordance with the applicable testing standards. For example, regarding NFPA 262, four independent testing laboratories, including UL and ITS, conducted a tunnel harmonization study. The purpose of the harmonization study was to ensure that cable testing, regardless of the testing facility, would produce statistically reliable and repeatable results. The project consisted of round robin testing of numerous cables at each facility and resulted in changes to test facilities when required.

Summary

Corning Optical Communications prefers to use ITS, who is a respected and trusted testing organization. ITS is a NRTL for the testing and listing of products to existing industry safety standards. Corning Optical Communications' decision to use ITS does not signify or imply any changes in cable design or performance. Corning Optical Communications continues to manufacture quality, safe optical fiber cables for flame retardant applications.

Addendum – Information on Fire Retardant Fiber Optic Cables

Terms and Definitions – pertinent to terminology in the NEC

Abandoned Optical Fiber Cable – Installed optical fiber cable that is not terminated at equipment other than a connector and not identified for future use with a tag.

Cable Tray – A rigid structural system used to support cables and raceways.

Canadian Standards Association (CSA) – Non-statutory, voluntary membership

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association engaged in standards development and certification activities.

Exposed (to Accidental Contact) – A conductive optical fiber cable in such a position that, in case of failure of supports or insulation, contact between the cables non-current-carrying conductive members and an electrical circuit may result.

General Purpose – Cable applications which do not include a riser or plenum area (i.e., typically horizontal, single-floor installations).

Intertek Testing Services (ITS) – An independent laboratory that conducts testing and conducts audits of qualified suppliers for electrical equipment and cables. Lists products by using the ETL mark.

Listed - Cables that have been tested and found acceptable for use in their intended application.

Characteristics typically tested include flame-resistance, smoke generation, compliance with regulatory codes and performance under other specified conditions.

Network Interface Unit (NIU) - A device that converts a broadband signal into component voice, audio, video, data and interactive service signals and which isolates network-powered and premises signal circuits.

Network-Powered Broadband Communications (NPBC) Circuit – A circuit extending from the communications utility's serving terminal or tap up to and including the NIU.

Optical Fiber Cable – A factory assembly of one or more optical fibers having an overall covering.

Optical Fiber Raceway – An enclosed channel designed expressly for holding and routing listed optical fiber cables.

Plenum – A compartment or chamber that forms part of the air distribution system and to which other air ducts are connected.

Point of Entrance – The point in a building at which the cable emerges from an

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external wall, concrete floor slab, or rigid metal conduit or intermediate metal conduit grounded to an electrode.

Riser – An opening or shaft through which cable may pass vertically from floor-to-floor inside a building.

Article 770 - Optical Fiber Cables

Article 770 addresses optical fiber cable when used in place of, or in conjunction with, electrical conductors for communications signaling and control circuits. Optical fiber cable is preferable to metallic conductor cable due to the higher bandwidth and system performance as well as immunity to electrical noise. Corning Cable Systems recommends all-dielectric optical fiber cable for most applications involving the NEC. The Code requires that cable used as wiring within buildings not only be listed for the intended application and installed appropriately, but that the cable must also be correctly marked for its intended use. The appropriate markings are listed below in descending order of fire-resistance rating. The applicable markings designated by the Canadian Standards Association (CSA) are included for comparison with NEC markings:

Cable Marking – Non-Conductive

NEC/CSA Listing	Nonconductive Optical Fiber Cable Types	Applicable Flame/ Smoke Test
OFNP/FT-6	Plenum	NFPA 262
OFNR	Riser	UL 1666
OFNG/FT-4	General Purpose	CSA C22.2 No. 0.3-96
OFN, OFN-LS	General Purpose, Limited-Smoke	UL 1685 (vertical-tray test)

Type OFNP: Optical Fiber Nonconductive Plenum, OFCP Optical Fiber Conductive Plenum Cables must pass the NFPA 262 test, which used to be referred to as the American National Standard Institute ANSI/UL 910, Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air. The CSA FT-6 listing can also be obtained by passing NFPA 262.

Type OFNR: Optical Fiber Nonconductive Riser, OFCR Optical Fiber

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Conductive Riser Optical fiber cable used in vertical shafts or in runs between floors must have fire-resistant characteristics capable of preventing the spread of fire from floor-to-floor. Cables are tested to ANSI/UL 1666, Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.

Type OFNG: Optical Fiber Nonconductive General Purpose, OFCG Fiber Conductive General-Purpose Type OFNG cable must be resistant to the spread of fire and suitable for general purpose use, with the exception of risers and plenums. One method used to define the resistance to the spread of fire is the CSA C22.2 No. 0.3-M-01, Vertical Flame Test Cables in Cable Trays. The OFNG listing is intended for the CSA FT-4 designation.

Type OFN-LS (OFNR-LS): Optical Fiber Nonconductive General Purpose (Riser), Limited Smoke Type OFN-LS listing combine flame and smoke requirements and is obtained by meeting UL 1685, Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables. UL 1685 also incorporates a measurement procedure and pass/fail criteria for monitoring smoke density. The purpose of this test is to qualify the cables for the additional marking "-LS." Cables passing both UL 1685 and ANSI/UL 1666 are marked OFNR-LS (riser, limited smoke).

Type OFN: Optical Fiber Nonconductive General Purpose Type OFN cable must be resistant to the spread of fire and suitable for general purpose use, with the exception of risers and plenums. One method used to determine the flame-resistant properties of cable in this listing classification is the vertical-tray flame test described in UL 1685. CSA C22.2 No. 0.3-M-01 can also be used as it is more restrictive than the UL 1685 test.

Even though OFNG and OFN both represent general purpose cable listings, they are different. Type OFNG cable meets the FT-4 (CSA) designation requirements for use in Canada, whereas Type OFN cable does not.

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Cable Type	Permitted Substitutions
OFNP	None
OFCP	OFNP
OFNR	OFNP
OFCR	OFNP, OFCP, OFNR
OFNG, OFN	OFNP, OFNR
OFCG, OFC	OFNP, OFCP, OFNR, OFCR, OFNG, OFN

Optical Fiber Cable Substitutions

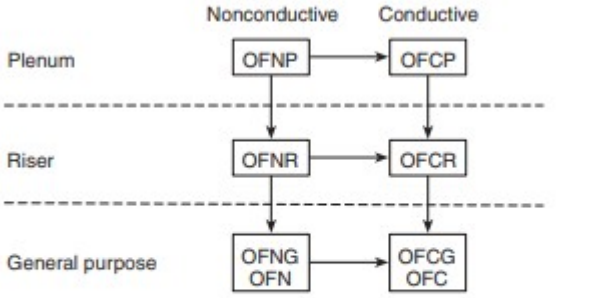

FIGURE 770.154 Cable Substitution Hierarchy.

Cable Substitution Hierarchy

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Table 770.179 Cable Markings

Cable Marking	Type
OFNP	Nonconductive optical fiber plenum cable
OFCP	Conductive optical fiber plenum cable
OFNR	Nonconductive optical fiber riser cable
OFCR	Conductive optical fiber riser cable
OFNG	Nonconductive optical fiber general-purpose cable
OFCG	Conductive optical fiber general-purpose cable
OFN	Nonconductive optical fiber general-purpose cable
OFC	Conductive optical fiber general-purpose cable

NEC Cable Markings

Local Building Codes: Installers should always consult the local building codes to which officials will inspect. Cables that satisfy the 2023 NEC® requirements may not satisfy local codes in effect for a particular area.

Optical Fiber Cable Applications Rather than develop separate performance standards for optical communications technology, the NEC adapts existing electrical cabling requirements whenever possible. Subsequently, Section 770.24 and 300.11 requires that installation of optical fiber cables conform to the requirements of Sections 300.4 (D). Section 300.4 (D) requires that cables and cable raceways installed parallel to framing members, such as joist, rafters or studs, shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 32 mm (1.25 in) from the nearest edge of the framing member where nails or screws are likely to penetrate or be protected from penetration by a steel plate or sleeve. Additionally, Section 770.3 requires that circuits and equipment comply with the requirements of Section 300.22. Section 300.22 incorporates the requirements applicable to the installation and use of electrical wiring and equipment in ducts, plenums and other air-handling spaces.

1. **Plenum Applications** Section 300.22 addresses: ducts for dust, loose stock or vapor removal; ducts or plenums used for environmental air; and other space used for environmental air. Each of these categories has specific requirements for cable installations. Ducts for Dust, Loose

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Stock or Vapor Removal No wiring system can be installed in ducts used to transport dust, loose stock or flammable vapors. Additionally, no wiring system can be installed in any duct or shaft containing only such ducts, used for vapor removal or for ventilation of commercial-type cooking equipment. [Section 300.22 (A)] Plenums and Spaces used for Environmental Air Type OFNP cable and listed plenum optical fiber raceway can be installed in ducts, plenums and other spaces used for environmental air. Type OFNR, OFNG or OFN cable can be installed in ducts, plenums and other environmental air-handling spaces if the requirements of Article 300.22 are met. In general, this means it must be installed in rigid or intermediate metal conduit, electrical metallic tubing or flexible metallic tubing [Sections 300.22 (B and C).] If the prime purpose of a habitable room or area of a building is air handling, then the restrictions of Section 300.22 (C) apply, whether or not electrical equipment is located in the room. An exception exempts habitable rooms or areas of a building not primarily used for air handling.

2. **Riser Applications** Cable installed in vertical runs and penetrating more than one floor, or cable installed in vertical runs in a shaft, must be Type OFNR/OFCR. Floor penetrations requiring Type OFNR/OFCR cable must contain only cable suitable for riser or plenum use. Listed riser and plenum optical fiber raceway can also be installed in vertical runs in a shaft, or from floor-to-floor. Conductive and nonconductive listed cables (OFNR, OFCR, OFNP and OFCP) can be installed; in its respective listed raceway. Type OFNG or OFN cable may be installed in vertical runs through more than one floor, or may be installed in vertical runs in a shaft, if they are encased in a metal raceway; located in a fireproof shaft having fire stops at each floor; or installed in one- and two-family dwellings. Fire stop requirements are contained in Section 300.21.

3. Other Wiring within Buildings Optical fiber cable installed in areas of a building other than those covered by Items 1 or 2 above must be Type OFNG, OFN or other types as permitted by the substitutions listed in Table 2.0. These cable types can be installed in listed general purpose optical fiber raceway.

4. Raceway Fill Requirements Raceway fill requirements are concerned with the potential fire safety hazards due to overheating and electrical short circuits of cables with current-carrying conductors. 770.110 “Raceways for

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Optical Fiber Cables" clarified that raceway fill tables listed in Chapter 3 and Chapter 9 do not apply when optical fiber cables are installed in a raceway without current carrying conductors. When fiber optic cables are installed with electrical conductors in the same raceway, the fill tables should apply.

5. Transition from Outside Plant to Inside Plant Article 770.48 "Unlisted Cables and Raceways Entering Buildings" provides guidance on unlisted cables and raceways entering a building from outside. Optical fiber cable that enters a building and is in a location not designated as a riser or plenum space from the outside and does not extend more than 50 feet beyond the "point of entrance," and which is terminated in an enclosure, is not required to be listed and marked. The enclosure may be metallic or plastic, such as a splice case or terminal box. This exception allows for reasonable conversion from non-fire-resistant outdoor cable to fire-resistant indoor cable at a convenient location. Nonconductive optical fiber cable does not need to be listed and marked where the cable enters the building from the outside and is run in raceway installed in accordance with Chapter 3 of the NEC.

6. Installation of Optical Fiber Cables and Electrical Conductors Optical fiber cable can occupy the same cable tray or raceway with conductors for electric light, power, Class 1, nonpower-limited fire alarm or medium power network-powered broadband communication circuits operating at 600* volts or less. It can also occupy the same cabinet, outlet box, panel or similar enclosure housing the electrical terminations of those same circuits, as long as it is functionally associated with them, or the optical fiber cable is installed in factory or field-assembled control centers. Conductive and nonconductive optical fiber cable is allowed in the same raceway, cable tray or enclosure with community antenna television (CATV); radio distribution systems and communication circuits; power-limited fire alarm systems; Class 2 and 3 remote-control, signaling and power limited circuits; and low power network-powered broadband communications circuits. Installations must be in accordance with the appropriate sections of the NEC. * Exemptions for industrial establishments may allow for higher voltages.

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7. Information Technology Article 645 contains cabling requirements for information technology (IT) rated spaces, i.e. data centers or computer rooms. For cables extending beyond the computer room, or serving alternate functions, Article 770 may be applicable. To be used under the raised floor of a computer room, optical fiber cable must be listed as Type DP. Type DP cable must comply with the flame-resistant requirements of UL 1685 or CSA C.22 No. 0.3-M-2001 as a minimum. Optical fiber cable types listed in Article 770 comply with Type DP listing requirements.

8. Conductive Optical Fiber Cables Optical fiber cable containing conductive elements, such as for strength or armoring, can be installed according to the same guidance as nonconductive optical fiber cable, except where specifically excluded, when the cable is listed Type OFC, OFCG, OFCR and OFCP. Because the cable with conductive elements meets the same requirements as the nonconductive cable, they are allowed to be substituted according to the guidance in 770.154. Optical fiber cable employing a layer of interlocking armor (steel or aluminum) with or without an overall outer jacket is sometimes used for indoor or indoor/outdoor applications where extra mechanical protection is needed, in addition to the flame-retardant properties of listed optical fiber cable. Interlocking armored cables are the most common type of conductive optical fiber cables.

9. Grounding is covered in Article 770 in sections 770.93 Groundings or Interruption of Non-Current Carrying Metallic Member of Optical Fiber Cables, and section IV “Grounding Methods”. In installations where an optical fiber cable is exposed to contact with electric light or power conductors, the non-current carrying metallic members should be grounded as specified in 770.100, or interrupted by an insulating joint. When the cable enters a building, the grounding or interruption should take place as close as practicable to the point of entrance. When the termination takes place on the outside of the building, the grounding or interruption should take place as close as practicable to the point of termination of the cable.

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Cable Rating Regulations in Europe use Construction Products Regulation (CPR)

Key Points:

- Cables installed in Europe follow CPR not NEC – The CPR system is very different than NEC, i.e. cables that meet plenum (OFNP) or riser (OFNR) requirements do not meet or are not tested to most CPR requirements.
- CPR test requirements consist of seven performance classes from F to A in ascending order with A being a product that cannot burn. The seven classes consist of specific/additional components that evaluate: Flame Spread – Heat Release, Smoke, Flaming Droplets, and Acidity. Each EU country can set specific requirements with the CPR, the same as each state in the US can with the NEC.

NEC: Examples are cable assigned ratings for Riser and Plenum after testing to:

- NEC test requirements for OFNP are listed in NFPA 262
- NEC test requirements for OFNR are delisted in UL 1666

CPR: Fire Standard EN 50575 specific CPR rating for a cable after testing to:

(EN 50575, classifies wire and cable fire ratings according to their behavior of heat of combustion, heat release & smoke production, vertical flame propagation, smoke density and acidity & acid gas content)

Specific CPR Ratings:

- Heat/Flames - Test Standards EN 50399 and EN 60332-1-2: Aca, B1ca, B2ca, Cca, Dca, Eca, Fca
- Smoke – Test Standards EN 50399 and EN 61034-2: s1a, s1b, s1, s2, s3
- Flaming Droplets – Test Standard EN 50399: d0, d1, d2
- Acid Gases – Test Standard EN60754-2: a1, a2, a3

Example of a cable rating under CPR: B2ca s1 d1 a1

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Summary:

The fire performance of cable is classified based on a number of tests:

- Flame spread (EN 60332-1-2, EN 50399).
- Heat release (EN ISO 1716, EN 50399).
- Flaming droplets (EN 50399).
- Smoke release (EN 61034-2).
- Acidity (EN 60754).

Classification of fire performance:

- 7 Classifications for flame spread and heat release: A, B1, B2, C, D, E and F (A is non-combustible and F is no criteria specified).
- 5 classifications for smoke release: s1, s1a, s1b, s2, s3 (s1a is the most smoke-free and s3 is no criteria specified).
- 3 classifications for flaming droplets: d0, d1, d2 (d0 is the most droplet-free and d2 is no criteria specified).
- 3 classifications for acidity: a1, a2, a3 (a1 is the most acidity-free and a3 is no criteria specified.)

Additional information on CPR can be found at:

- https://www.corning.com/catalog/coc/documents/brochures/LAN-1886-A5-BEN.pdf

https://www.corning.com/catalog/coc/documents/faqs/LAN-2055-A4-BEN.pdf

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