OFS
Fiber Optic Outside Plant Cable Specification

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Leading Optical Innovations

Notice:

Every effort was made to ensure that the information contained in this document was complete and accurate at the time of publication; however, information contained herein is subject to change.

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1. GENERAL

1.1 SCOPE

This specification covers the general design requirements and performance standards for OFS fiber optic cables intended primarily for use in outside plant. The purpose of this document is to provide the essential requirements for raw materials, optical fibers, core/sheath construction, and transmission performance, by which OFS's standard fiber optic outside plant cables can be evaluated and specified.

The product requirements and features described in this specification are those considered useful to the customer for ensuring proper selection, installation, and operation of fiber optic outside plant cables. This document is not intended to be a complete definition of internal OFS manufacturing requirements. Any change in this specification after initial product acceptance will be brought to the customer's attention.

The fiber types, cores, and sheaths covered in this specification are:

Fiber Types:
- Single-Mode *AllWave*®
- Single-Mode with Depressed Cladding
- Single-Mode with Matched Cladding
- Single-Mode *TrueWave*® RS
- Multimode with a 62.5µm Core
- Multimode LaserWave™

Core Types:
- *Lightpack*® Core
- *XpressTube*™ Core
- *AccuRibbon® DC (Dry Core- 12 fibers/ribbon)*
- *AccuRibbon*® Core (4, 6, 8, 12, and 24 fibers/ribbon)

Sheath Types:
- Metallic
- Dielectric

In this specification, all observed or calculated values are rounded off "to the nearest unit" in the last right hand place of figures used in expressing the limiting value. The round-off method of ASTM E 29 is used.

OFS supports industry standards such as Telcordia Technologies, Electronic Industries Association (EIA), Telecommunications Industry Association (TIA), Insulated Cable Engineers Association (ICEA), International Telecommunications Union (ITU), International Electrotechnical Commission (IEC), Rural Utilities Service (RUS), and American Society for Testing and Materials (ASTM). OFS reserves the right to change later issues of this specification to reflect changes in industry standards.

1.2 DOCUMENT ORGANIZATION

Section 1 - Scope, product qualification, quality assurance and general fiber optic cable characteristics
Section 2 - Optical Fiber Requirements - Geometry and basic optical and mechanical properties
Section 3 - Fiber Optic Cable: Cores – *Lightpack*, XpressTube, AccuRibbon DC and *AccuRibbon*
Section 4 - Fiber Optic Cable: Sheaths - Standard Applications
Section 5 - Fiber Optic Cable: Sheaths - Specialty Applications
Section 6 - Fiber Optic Cable: Mechanical, Environmental, and Electrical Requirements
Section 7 - Fiber Optic Cable: Length, Marking, and Shipping Requirements
Section 8 - Fiber Optic Cable: Material Requirements
Section 9 - Fiber Optic Cable: Ordering Code
Section 10 - Shipping Reels
Section 11 - External References

1.3 PRODUCT QUALIFICATION

This document contains both material and product design requirements that must be met to ensure satisfactory performance of fiber optic cables in their intended field environments. The material requirements are measured per OFS's Raw Material Inspection Plan.

Product requirements can be classified as:

"Initial Requirements" - measured once in order to qualify a cable design
"Qualification Requirements" - measured only periodically (e.g., annually)
"Routine Requirements" - measured on a routine, regularly scheduled basis by the quality organization

Generally, product performance can be verified through Qualification Requirements. As an aid for implementation of inspection procedures by customers, all OFS designated Qualification Requirements in this document are so identified with a "(QR)" affixed to the requirement title. Initial Requirements are identified with a "(IR)" affixed to the requirement title. All other requirements are Routine Requirements "(RR)".

1.4 QUALITY ASSURANCE

To ensure a continuing level of quality in production cables, a quality system consistent with TL 9000, "Quality System Requirements" and ISO 9001, "Quality Systems-Model for Quality Assurance in Design/Development, Production, Installation, and Servicing", is provided for all optical fiber and fiber optic cables.

The adequacy of all materials is assured through incoming inspection, source inspection, or vendor certified test data. Fiber is measured and classified before being placed into inventory, and then selected from inventory to satisfy customer order requirements. Inspection of cable construction characteristics is the responsibility of the employees producing the product. All cables are tested for compliance to customer specified transmission requirements in Final Test. Adequacy of this quality control system is assured through product and process audits conducted by the Quality Improvement organization. Typical product flow including product inspections and product audits is shown in Figure 1.

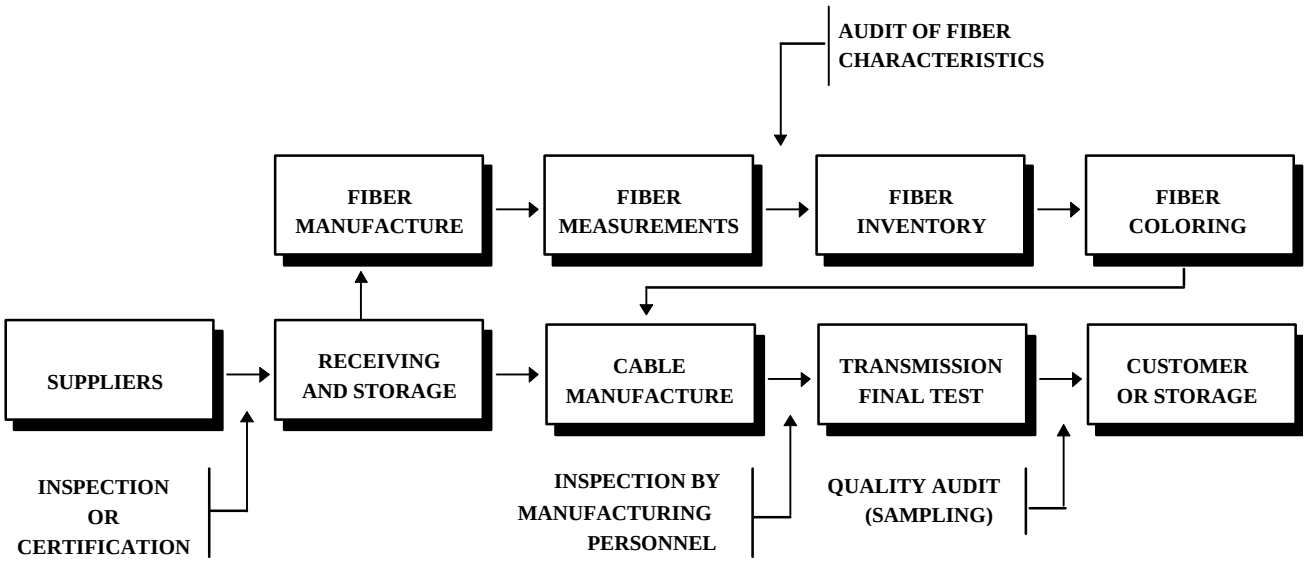

Figure 1: Quality Inspections & Audits

1.5 GENERAL FIBER OPTIC CABLE CHARACTERISTICS

1.5.1 General Properties

High quality optical fibers made with pure silica-based glass have very low loss for infrared wavelengths and can be used to carry large amounts of information for very long distances in optical communication systems. High fiber strength is obtained by protecting the surface of the glass fibers with thin coating layers of polymeric materials.

The coated fibers are then placed in cable structures having additional layers to protect the fibers during the rigors of outside plant installation, and to provide long term reliable operation in the outside plant environment. The design philosophy in meeting these objectives is to provide high quality, rugged, well-tested fiber optic cables that are compact and have a high strength-to-weight ratio. Compact fiber optic cables are easier to handle and install in the field and provide longer lengths for field installation.

1.5.2 Absence of Residual Stress

Provided that recommended installation practices are followed, the residual stress on fibers following installation will be so small as to cause no degradation of fiber mechanical stability or transmission performance.

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2. OPTICAL FIBER REQUIREMENTS

2.1 GENERAL INFORMATION

OFS Cables are available with four types of single-mode fibers and with 62.5µm and LaserWave™ multimode fiber. *AllWave*® Single-Mode fiber (TIA/EIA Class IVa Detail Specification 492CAAB, ITU G.652.C) is available for use with transmission systems in the entire wavelength region from 1280 to 1625 nm. Dispersion Unshifted Single-Mode fibers (TIA/EIA Class IVa, ITU G.652) with either a depressed cladding or matched cladding design are offered for optimized system operation in the 1310 nm window. *TrueWave*® RS (Reduced Slope) Nonzero-Dispersion Single-Mode Fibers (TIA/EIA Class IVd, ITU G.655) is available for systems designed for dense wavelength division multiplexing (DWDM) with erbium-doped fiber amplifiers (EDFA). Multimode fibers are available for optimized system operation at 850 and/or 1300 nm.

All OFS fibers feature the *D-LUX*® dual coating system, which provides unparalleled performance in a wide range of environmental conditions. The advantages of *D-LUX* coating are excellent resistance to micro bending induced losses, superior abrasion and cut-through resistance, enhanced aging and reliability characteristics through superior hydrolytic stability, and long term preservation of color code integrity. The coating is easily stripped using mechanical methods.

Each fiber is prooftested to ensure that it will survive installation loads and associated long-term residual stresses, even under extreme environmental conditions. The optical, dimensional, and mechanical properties are measured for compliance to Industry Specifications (Telcordia, TIA/EIA, IEC, etc.). Excellent control of fiber geometry permits low loss splicing using either mechanical or fusion techniques. In addition, all OFS Single-Mode Fibers are manufactured to meet low polarization mode dispersion (PMD) performance in cable.

Six fiber types are covered in this specification:

- single-mode *AllWave*® fiber
- single-mode fiber with depressed cladding
- single-mode fiber with matched cladding
- single-mode *TrueWave*® RS fiber
- multimode fiber with a 62.5 µm core
- multimode LaserWave™ fiber

A cross-sectional diagram for the six fiber types is shown below.

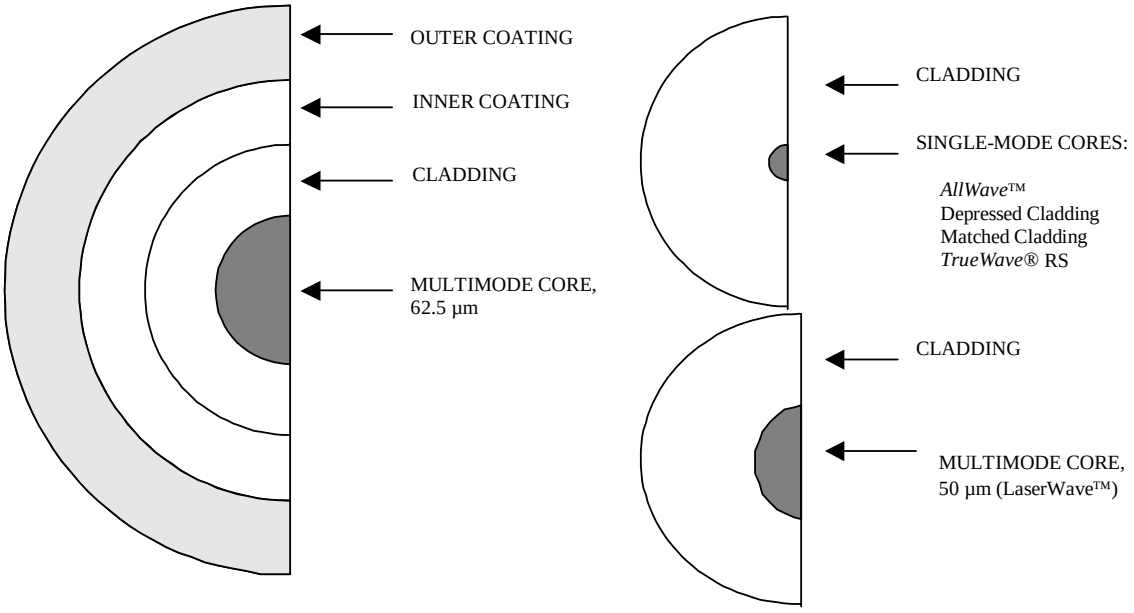

Figure 2: Coated Fiber Cross-Section

2.1.1 *AllWave*® Single-Mode Fiber

AllWave® fiber is the first fiber designed for use with transmission systems over the entire wavelength region from 1280 to 1625 nm. *AllWave*® fiber is manufactured by a new process that practically eliminates the incorporation of OH ions (water) into the fiber. This results in lower attenuation in the region from 1350 to 1450 nm, opening more wavelengths for use. *AllWave*® fiber has attenuation, mode field, and dispersion characteristics similar to Depressed and Matched Cladding fibers and is fully compatible with these fibers.

2.1.2 Depressed Cladding Single-Mode Fiber

OFS Depressed Cladding Single-Mode Fiber consists of a germanium doped core within two concentric synthetic silica cladding layers. In this design, the inner cladding layer is doped with fluorine to lower its refractive index relative to the outer layer. This design results in a smaller mode field diameter for improved microbending and macrobending performance. The dispersion characteristics of the fiber are optimized for systems operating in the 1310 nm region, although effective operation at 1550 nm is possible.

2.1.3 Matched Cladding Single-Mode Fiber

OFS Matched Cladding Single-Mode Fiber consists of a germanium doped core and a silica cladding. In this design, the inner cladding has the same index of refraction as the outer cladding. The fiber is fully compatible with other commercially available matched cladding fibers. The dispersion characteristics of the fiber are optimized for systems operating in the 1310 nm region, although effective operation at 1550 nm is possible.

2.1.4 *TrueWave*® RS (Reduced Slope) Single-Mode Fiber

TrueWave® RS Fiber is the first Nonzero Dispersion Fiber (NZDF) specially designed for use in dense wavelength division multiplexing (DWDM) applications operating in both the C-Band (1530 to 1565 nm) and in the L-Band (1565 to 1625 nm). The fiber has nonzero dispersion over these wavelength operating regions to eliminate the four-wave mixing that typically occurs in dispersion-shifted fibers. This permits many closely spaced channels to be transmitted simultaneously without cross interference. The dispersion value is small enough to allow 10 Gb/s transmission rates at each of multiple wavelengths, over distances of at least 250 km, without dispersion compensation.

Because of its reduced dispersion slope, the chromatic dispersion of *TrueWave*® RS Fiber is more uniform across the various DWDM wavelengths than any other commercial NZDF. This results in *TrueWave*® RS having the least sensitivity of dispersion to temperature of any NZDF—especially important for emerging 40 Gb/s channel rates. *TrueWave*® RS fiber's low dispersion slope also reduces the need for complex dispersion compensation, and allows improved performance at short wavelengths without compromising performance at long wavelengths.

2.1.5 62.5 µm Multimode Fiber

OFS 62.5 micron multimode fiber consists of a germanium doped silica core within a silica cladding. The refractive index of the core is varied with radial position to achieve optimum bandwidth and attenuation performance at both 850 nm and 1300 nm.

2.1.6 LaserWave™ Multimode Fiber

OFS LaserWave multimode fiber is the first laser optimized multimode fiber product designed to support low cost solutions from 10 Mbps through 10 Gbps up to at least 300 meters. The LaserWave fiber solution is available with two performance specifications. LaserWave 300 fiber is designed specifically to support 300-meter link lengths for 10 Gbps applications. LaserWave 300 features a DMD controlled core that assures 10 Gbps support with 850nm serial applications for distances up to 300 meters. LaserWave 150 fiber provides similar legacy support but is better suited to extend the distance of 1 Gbps LAN applications at 850nm and supports very short reach 10 Gbps interconnects in SANs, Central Offices, and LANs.

2.2 FIBER REQUIREMENTS

The optical fibers used in OFS's outside plant cables must meet certain optical, dimensional, and mechanical requirements. These requirements, as given in the following tables, are expressed as a design value with a tolerance or as an extreme (maximum or minimum) value. Because of the automated controls used in the fiber manufacturing process, actual values will be distributed over the allowed range with most near the nominal and few near the limits.

2.2.1 Single-Mode Fiber Requirements

The following table specifies the requirements that *AllWave*® single-mode fibers for outside plant cables shall meet. The requirement type (i.e. IR, QR, or RR as defined in Section 1.3) and test method are also specified.

Table 1: Fiber Requirements – *AllWave*® Fiber

Fiber Attribute	Test Method		Requirement	Notes
	TIA/EIA*	IEC**	AllWave®	
Cladding Diameter	TIA/EIA-455-176	IEC 60793-1-A2	125.0 ± 1.0 μm	1
Cladding Non-Circularity	TIA/EIA-455-176	IEC 60793-1-A2	≤1.0%	1
Colored Fiber Diameter	TIA/EIA-455-173	IEC 60793-1-A2	250 ± 15 μm	1
Core Diameter			8.3 μm	3
Difference in Index of Refraction			0.33%	3
Mode Field Diameter Concentricity Error	TIA/EIA-455-176	IEC 60793-1-A2	≤ 0.5 μm	1
Mode Field Diameter	TIA/EIA-455-164 or TIA/EIA-455-167	IEC 60793-1-C9A or IEC 60793-1-C9B	9.2 ± 0.4 μm @ 1310 nm	1
Minimum Proof Strength	TIA/EIA-455-31	IEC 60793-1-B1	0.70 GPa (100 kpsi)	1
Fiber Curl	TIA/EIA-455-111	IEC 60793-1-B8A	≥ 4 m	1
Attenuation	TIA/EIA-455-61 or TIA/EIA-455-78	IEC 60793-1-C1A or IEC 60793-1-C1C	See Section 9	1
Attenuation at 1385 nm (cable)	TIA/EIA-455-78		≤0.35 dB/km	1
Point Discontinuities	TIA/EIA-455-59	IEC 793 -1-C1C	≤0.10 dB	1
Zero-Dispersion Wavelength	TIA/EIA-455-175	IEC 60793-1-C5C	1310 +12 / -10 nm	1
Zero-Dispersion Slope	TIA/EIA-455-175	IEC 60793-1-C5C	≤ 0.092 ps/nm^2-km	1
Maximum Dispersion 1285 to 1330 nm	TIA/EIA-455-175	IEC 60793-1-C5C	3.5 ps/nm-km	3
Cabled Polarization Mode Dispersion Link Design Value† (OFS Cable)	TIA/EIA-455-113 TIA/EIA-455-122 or TIA/EIA-455-124	IEC 61941, Technical Report Type 2, CDV86A/460/CDV	≤0.1 ps/√km	2
Cable Cutoff Wavelength	TIA/EIA-455-170	IEC 60793-1-C7B	≤ 1260 nm	1
Fiber Macrobend: (100 turns, 75 mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤0.05 dB @ 1310 nm ≤0.10 dB @ 1550 nm	2
Fiber Macrobend: (1 turn @ 32mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤ 0.5 dB@ 1550 nm	2
Coating Strip Force	TIA/EIA-455-178	IEC 60793-1-B6	1.3 N (0.3lbf) ≤ F ≤ 8.9 N (2.0 lbf)	2
Dynamic Tensile Strength	TIA/EIA-455-28	IEC 60793-1-B2A or IEC 60793-1-B2B	Unaged: >550 kpsi (3.8 GPa) Aged: >440 kpsi (3.0 GPa)	2
Dynamic Fatigue	TIA/EIA-455-76	IEC 60793-1-B7A	≥ 20	2
Static Fatigue	TIA/EIA-455-97	IEC 60793-1-B7D	≥ 20	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR) 3. Typical Value, Not Specified

* OFS complies with the latest revision of the TIA/EIA Test Method

** There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.

† The PMD Link Design Value complies with IEC SC 86A/501/CD, Method 1, April 23, 1999 (N=20, Q=0.01%). Details are described in "Guideline for Statistical Specification of Polarisation Mode Dispersion of Optical Fibre Cables"; *Draft Technical Report – Type 3*, IEC.

The following table specifies the requirements that Depressed/Matched Cladding single-mode fibers for outside plant cables shall meet. The requirement type (i.e. IR, QR, or RR as defined in Section 1.3) and test method are also specified.

Table 2: Fiber Requirements – Depressed/Matched Cladding Fibers

Fiber Attribute	Test Method		Requirement		Notes
	TIA/EIA*	IEC**	Depressed Cladding	Matched Cladding	
Cladding Diameter	TIA/EIA-455-176	IEC 60793-1-A2	125.0 ± 1.0 μm		1
Cladding Non-Circularity	TIA/EIA-455-176	IEC 60793-1-A2	≤1.0%		1
Colored Fiber Diameter	TIA/EIA-455-173	IEC 60793-1-A2	250 ± 15 μm		1
Core Diameter			8.3 μm		3
Difference in Index of Refraction			0.37%	0.33%	3
Mode Field Diameter Concentricity Error	TIA/EIA-455-176	IEC 60793-1-A2	≤ 0.6 μm		1
Mode Field Diameter	TIA/EIA-455-164 or TIA/EIA-455-167	IEC 60793-1-C9A or IEC 60793-1-C9B	8.8 ± 0.5 μm @ 1310 nm	9.2 ± 0.4 μm @ 1310 nm	1
Minimum Proof Strength	TIA/EIA-455-31	IEC 60793-1-B1	0.70 GPa (100 kpsi)		1
Fiber Curl	TIA/EIA-455-111	IEC 60793-1-B8A	≥ 2 m		1
Attenuation	TIA/EIA-455-61 or TIA/EIA-455-78	IEC 60793-1-C1A or IEC 793 -1-C1C	See Section 9		1
Attenuation at Water Peak	TIA/EIA-455-78		≤1.0 dB/km @ 1383 ± 3 nm		1
Point Discontinuities	TIA/EIA-455-59	IEC 60793-1-C1C	≤0.10 dB		1
Zero-Dispersion Wavelength	TIA/EIA-455-175	IEC 60793-1-C5C	1310 ± 10 nm	1310 +12 / -10 nm	1
Zero-Dispersion Slope	TIA/EIA-455-175	IEC 60793-1-C5C	≤ 0.092 ps/nm^2-km		1
Maximum Dispersion 1285 to 1330 nm	TIA/EIA-455-175	IEC 60793-1-C5C	2.8 ps/nm-km	3.5 ps/nm-km	3
Cabled Polarization Mode Dispersion Link Design Value† (OFS Cable)	TIA/EIA-455-113 TIA/EIA-455-122 or TIA/EIA-455-124	IEC 61941, Technical Report Type 2, CDV86A/460/CDV	≤0.1 ps/√km		2
Cable Cutoff Wavelength	TIA/EIA-455-170	IEC 60793-1-C7B	≤ 1260 nm		1
Fiber Macrobend: (100 turns, 75 mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤0.05 dB @ 1310 nm ≤0.10 dB @ 1550 nm		2
Fiber Macrobend: (1 turn @ 32mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤ 0.5 dB@ 1550 nm		2
Coating Strip Force	TIA/EIA-455-178	IEC 60793-1-B6	1.3 N (0.3lbf) ≤ F ≤ 8.9 N (2.0 lbf)		2
Dynamic Tensile Strength	TIA/EIA-455-28	IEC 60793-1-B2A or IEC 60793-1-B2B	Unaged: >550 kpsi (3.8 GPa) Aged: >440 kpsi (3.0 GPa)		2
Dynamic Fatigue	TIA/EIA-455-76	IEC 60793-1-B7A	≥ 20		2
Static Fatigue	TIA/EIA-455-97	IEC 60793-1-B7D	≥ 20		2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR) 3. Typical Value, Not Specified

* OFS complies with the latest revision of the TIA/EIA Test Method

** There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.

† The PMD Link Design Value complies with IEC SC 86A/501/CD, Method 1, April 23, 1999 (N=20, Q=0.01%). Details are described in "Guideline for Statistical Specification of Polarisation Mode Dispersion of Optical Fibre Cables"; *Draft Technical Report – Type 3*, IEC.

The following table specifies the requirements that all *TrueWave*® RS (nonzero-dispersion) single-mode fibers for outside plant cables shall meet. The requirement type (i.e. IR, QR, or RR as defined in Section 1.3) and test method are also specified.

Table 3: Fiber Requirements – *TrueWave*® RS Fibers

Fiber Attribute	Test Method		Requirement	Notes
	TIA/EIA*	IEC**	*TrueWave*® RS	
Cladding Diameter	TIA/EIA-455-176	IEC 60793-1-A2	125.0 ± 1.0 μm	1
Cladding Non-Circularity	TIA/EIA-455-176	IEC 60793-1-A2	≤1.0%	1
Colored Fiber Diameter	TIA/EIA-455-173	IEC 60793-1-A2	250 ± 15 μm	1
Mode Field Diameter Concentricity Error	TIA/EIA-455-176	IEC 60793-1-A2	≤ 0.6 μm	1
Mode Field Diameter	TIA/EIA-455-164 or TIA/EIA-455-167	IEC 60793-1-C9A or IEC 60793-1-C9B	8.4 ± 0.6μm @1550nm 8.9 ± 0.6μm @1625nm	1 3
Minimum Proof Strength	TIA/EIA-455-31	IEC 60793-1-B1	0.70 GPa (100 kpsi)	1
Fiber Curl	TIA/EIA-455-111	IEC 60793-1-B8A	≥ 2 m	1
Attenuation	TIA/EIA-455-61 or TIA/EIA-455-78	IEC 60793-1-C1A or IEC 60793-1-C1C	See Section 9	1
Attenuation at Water Peak	TIA/EIA-455-78		≤1.0 dB/km @ 1383 ± 3 nm	1
Point Discontinuities	TIA/EIA-455-59	IEC 60793-1-C1C	≤0.10 dB @ 1550 and 1600nm	1
Chromatic Dispersion	TIA/EIA-455-175	IEC 60793-1-C5C	2.6 to 6.0 ps/nm-km @1530 to 1565 nm 4.0 to 8.9 ps/nm-km @1565 to 1625 nm	1
Dispersion Slope	TIA/EIA-455-175	IEC 60793-1-C5C	≤ 0.05 ps/nm^2-km Typical: (0.045 ps/nm^2-km)	1
Cabled Polarization Mode Dispersion Link Design Value† (OFS Cable)	TIA/EIA-455-113 TIA/EIA-455-122 or TIA/EIA-455-124	No equiv IEC test	≤0.1 ps/√km	2
Cable Cutoff Wavelength	TIA/EIA-455-170	IEC 60793-1-C7B	≤ 1260 nm	1
Fiber Macrobend: (100 turns, 75 mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤ 0.05 dB @ 1550 and 1625 nm	2
Fiber Macrobend: (1 turn @ 32mm diameter)	TIA/EIA-455-62	IEC 60793-1-C11	≤ 0.5 dB @ 1550 and 1625 nm	2
Coating Strip Force	TIA/EIA-455-178	IEC 60793-1-B6	1.3 N (0.3lbf) ≤ F ≤ 8.9 N (2.0 lbf)	2
Dynamic Tensile Strength	TIA/EIA-455-28	IEC 60793-1-B2A or IEC 60793-1-B2B	Unaged: >550 kpsi (3.8 GPa) Aged: >440 kpsi (3.0 GPa)	2
Dynamic Fatigue	TIA/EIA-455-76	IEC 60793-1-B7A	≥ 20	2
Static Fatigue	TIA/EIA-455-97	IEC 60793-1-B7D	≥ 20	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR) 3. Typical Value, Not Specified

* OFS complies with the latest revision of the TIA/EIA Test Method

** There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.

† The PMD Link Design Value complies with IEC 86A/501/CD, Method 1, April 23, 1999, (n=20, Q=0.01%). Details are described in "Guideline for statistical specification of polarisation mode dispersion on optical fibre cables," *Draft Technical Report – Type 3*, IEC.

The refractive index profiles for depressed and matched cladding single-mode fibers are given below (d= core diameter).

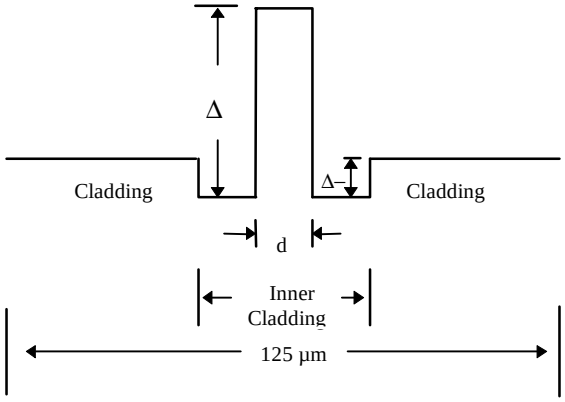

Figure 3: Refractive Index Profile, Single-Mode Fiber with Depressed Cladding

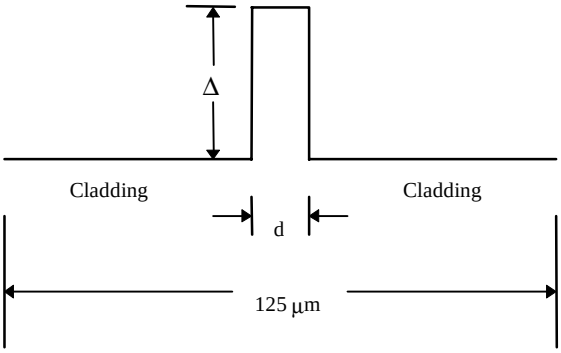

Figure 4: Refractive Index Profile, Single-Mode Fiber with Matched Cladding

2.2.2 Multimode Fiber Requirements

The following table specifies the requirements that the 62.5 µm multimode fibers for outside plant cables shall meet. The requirement type (i.e. IR, QR, or RR as defined in Section 1.3) and test method are also specified.

Table 4: Multimode Fiber Requirements

Fiber Attribute	Test Method		Requirement	Notes
	TIA/EIA*	IEC**		
Cladding Diameter	TIA/EIA-455-176	IEC 60793-1-A2	125.0 ± 1.0 µm	1
Cladding Non-Circularity	TIA/EIA-455-176	IEC 60793-1-A2	≤2.0%	1
Colored Fiber Diameter	TIA/EIA-455-173	IEC 60793-1-A2	250 ± 15 µm	1
Core Diameter	TIA/EIA-455-176	IEC 60793-1-A2	62.5± 3.0 µm	3
Numerical Aperture	TIA/EIA-455-177 TIA/EIA-455-47	IEC 60793-1-A1A	0.275 ± 0.015	1
Core Non-Circularity	TIA/EIA-455-176	IEC 60793-1-A2	< 6 %	1
Core Diameter Concentricity Error	TIA/EIA-455-176	IEC 60793-1-A2	≤ 3.0 µm	1
Minimum Proof Strength	TIA/EIA-455-31	IEC 60793-1-B1	0.70 GPa (100 kpsi)	1
Fiber Curl	TIA/EIA-455-111	IEC 60793-1-B8A	≥ 2m	1
Attenuation	TIA/EIA-455-46	IEC 60793-1-C1A IEC 60793-1-C1C	See Section 9	1
Fiber Bandwidth	TIA/EIA-455-51	IEC 60793-1-C2A	See Section 9	1
Point Discontinuities	TIA/EIA-455-59	IEC 60793-1-C1C	≤0.2 dB	1
Fiber Macrobend	TIA/EIA-455-62	IEC 60793-1-C11	≤0.5 dB at any usable wavelength	2
Coating Strip Force	TIA/EIA-455-178	IEC 60793-1-B6	1.3 N (0.3lbf) ≤ F ≤ 8.9 N (2.0 lbf)	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR) 3. Typical Value, Not Specified

* OFS complies with the latest revision of the TIA/EIA Test Method

** There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.

The refractive index profile for the multimode fiber is given below.

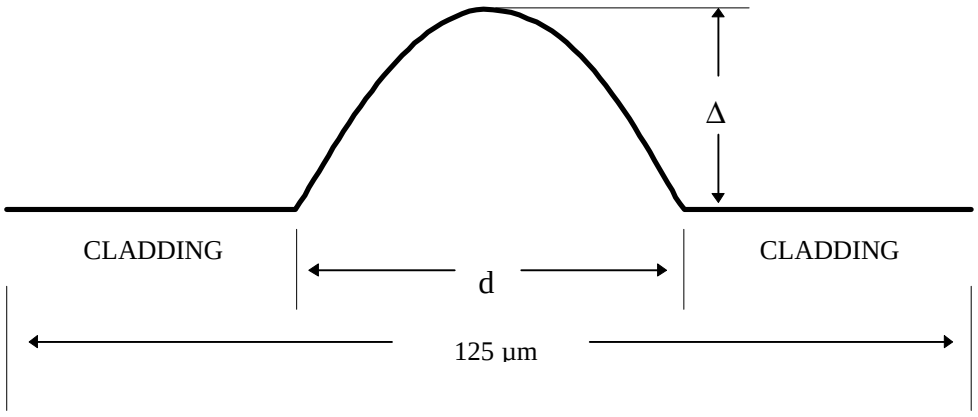

Figure 5: Refractive Index Profile, Multimode Fiber

2.3 OTDR SETTINGS

Optical time domain reflectometers (OTDRs) require the setting of the fiber's group index of refraction in order to calculate and display distance. For measuring the reflectance (return loss) of splices using an OTDR, the Rayleigh Backscattering Coefficient of the fiber must be set. The following tables list these values for various OFS fiber types and OTDR wavelengths.

Table 5: Guidelines for OTDR Settings for Group Index of Refraction (IOR) - Single-Mode Fiber

	Fiber Type			
	***AllWave*®**	**Depressed Cladding**	**Matched Cladding**	***TrueWave*® RS**
1310 nm Source	1.466	1.466	1.466	1.470
1550 nm Source	1.467	1.467	1.467	1.470
1625nm Source				1.470

Table 6: Guidelines for OTDR Settings for Group Index of Refraction (IOR) - Multimode Fiber

	62.5 µm
850 nm source	1.496
1300 nm Source	1.491

Table 7: Guidelines for Rayleigh Backscattering Coefficients - Single-Mode Fiber

	Fiber Type			
1µs Pulse Width	***AllWave*®**	**Depressed Cladding**	**Matched Cladding**	***TrueWave*® RS**
1310 nm Source	-49.6 dB	-49.2 dB	-49.6 dB	-45.4 dB
1550 nm Source	-52.1 dB	-51.8 dB	-52.1 dB	-49.8 dB
1625 nm Source				-51.1 dB

3. FIBER OPTIC CORE CHARACTERISTICS

3.1 *Lightpack*® CORE CONSTRUCTION

3.1.1 Fiber Color Code

All fibers used in OFS cable cores are color coded to facilitate individual fiber identification. The individual fiber colors used in *Lightpack* cable cores are given in the following table.

Table 8: Fiber Color Code - Lightpack® Core

Fiber No.	Fiber Color
1	Blue (BL)
2	Orange (OR)
3	Green (GR)
4	Brown (BR)
5	Slate (SL)
6	White (WH)
7	Red (RD)
8	Black (BK)
9	Yellow (YL)
10	Violet (VI)
11	Rose (RS)
12	Aqua (AQ)

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3.1.2 *Lightpack* Cable Core Construction

The basic building block of a *Lightpack* cable core is a bundle of 4 to 12 fibers held together loosely with two helically applied binders. The *Lightpack* cable core consists of an extruded plastic tube, filled with filling compound and containing up to eight fiber bundles (up to 96 fibers). The design intent of filling operations for *Lightpack* cable cores is to fill all voids within the cable core. Color-coding both the fibers and the binders provides positive identification of each fiber.

The cross-section of a *Lightpack* cable core is shown below.

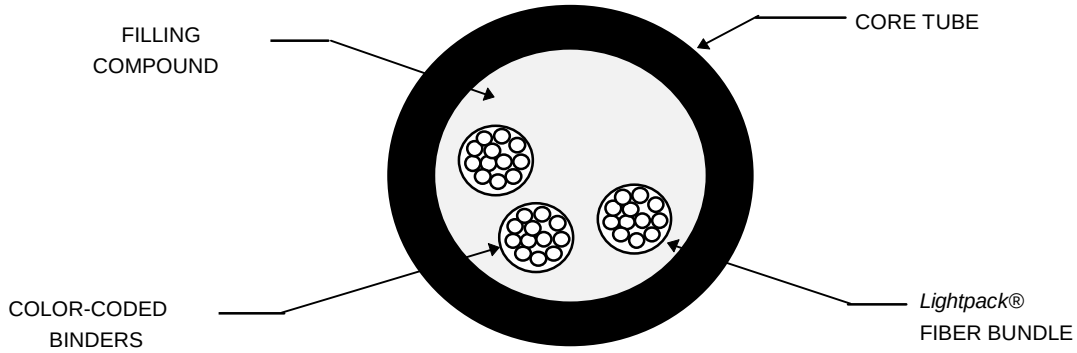

Figure 6: *Lightpack*® Cable Core

3.1.2.1 *Lightpack* Fiber and Bundle Identification

Each fiber in a *Lightpack* cable can be uniquely identified through the use of a single color code for both the fibers and binders. In each bundle the required fiber count starts with fiber #1 (the blue fiber) and continues in sequence. Each bundle of fibers is identified in the same manner starting with the bundle with the blue binders.

Table 9 lists the standard *Lightpack* cable fiber counts and the fiber allocation within each color-coded bundle. As an alternative, cables with up to 36 fibers can be supplied with 6 fibers to a bundle (see Table 10). Other fiber bundles and fiber counts can be supplied on a special request basis.

Table 9: *Lightpack*® Cable: Standard Fiber Counts

Guaranteed Cable Fiber Count	No. of Bundles	Number of Fibers per Bundle							
		Blue	Orange	Green	Brown	Slate	White	Red	Black
4	1	4							
6	1	6							
8	1	8							
12	1	12							
18	2	12	6						
24	2	12	12						
30	3	12	12	6					
36	3	12	12	12					
48	4	12	12	12	12				
60	5	12	12	12	12	12			
72	6	12	12	12	12	12	12		
84	7	12	12	12	12	12	12	12	
96	8	12	12	12	12	12	12	12	12

Table 10: *Lightpack*® Cable: 6-Fiber Bundles - Standard Fiber Counts

Guaranteed Cable Fiber Count	No. of Bundles	Number of Fibers per Bundle					
		Blue	Orange	Green	Brown	Slate	White
6	1	6					
12	2	6	6				
18	3	6	6	6			
24	4	6	6	6	6		
30	5	6	6	6	6	6	
36	6	6	6	6	6	6	6

3.2 *XpressTube*™ CORE CONSTRUCTION

3.2.1 Fiber Color Code

All fibers used in OFS cable cores are color coded to facilitate individual fiber identification. The individual fiber colors used in *XpressTube*™ cable cores are given in the following table.

Table 11: Fiber Color Code - *XpressTube*™ Core

Fiber No.	Fiber Color
1	Blue (BL)
2	Orange (OR)
3	Green (GR)
4	Brown (BR)
5	Slate (SL)
6	White (WH)
7	Red (RD)
8	Black (BK)
9	Yellow (YL)
10	Violet (VI)
11	Rose (RS)
12	Aqua (AQ)

3.2.2 XpressTube™ Cable Core Construction

The basic building block of a *XpressTube*™ cable core is a bundle of 12 fibers held together loosely with a plastic tube, filling compound, and a ripcord to facilitate tube entry. The *XpressTube*™ cable core consists of an extruded plastic core tube containing up to twelve fiber tubes (up to 144 fibers). Color-coding both the fibers and the fiber tubes provides positive identification of each fiber.

The cross-section of a *XpressTube*™ cable core and XpressTube™ Unit is shown below.

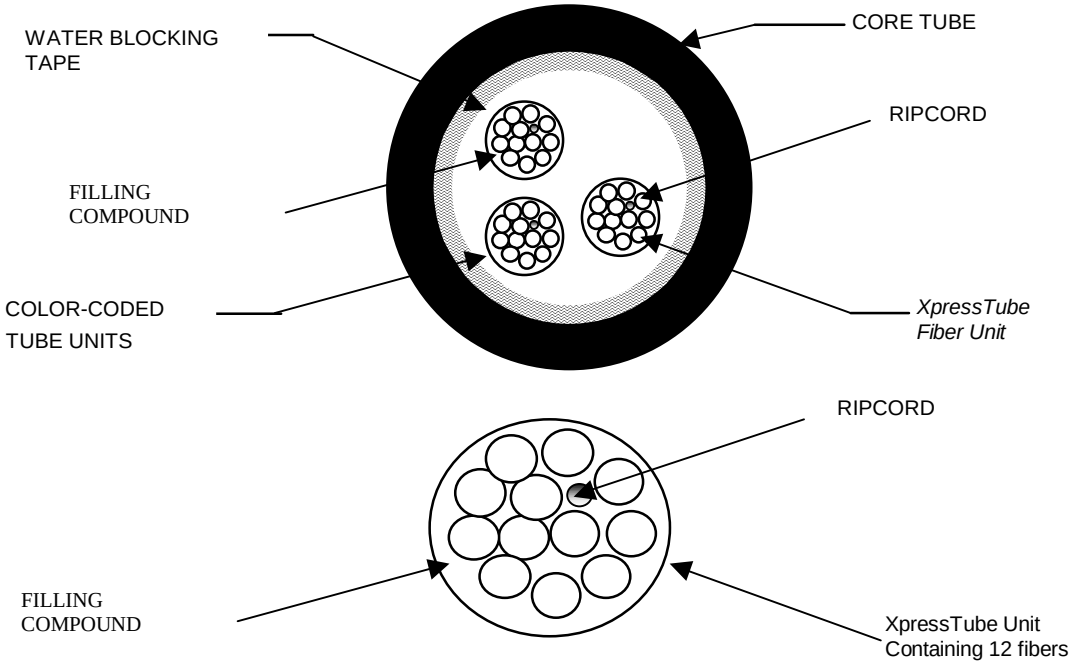

Figure 7: *XpressTube*™ Cable Core and XpressTube™ Unit

3.2.2.1 *XpressTube*™ Fiber and Fiber Tube Unit Identification

Each fiber in a *XpressTube*™ cable can be uniquely identified through the use of a single color code for both the fibers and fiber tube units. In each fiber tube unit the required fiber count starts with fiber #1 (the blue fiber) and continues in sequence. Each tube unit of fibers is identified in the same manner starting with the blue tube.

Table 9 12 lists the standard *XpressTube*™ cable fiber counts and the fiber allocation within each color-coded tube. Other fiber tube units and fiber counts can be supplied on a special request basis.

Table 12: *XpressTube*™ Cable: Standard Fiber Counts

Cable Fiber Count	No. of Tubes	Number of Fibers per Tube											
		Blue	Orange	Green	Brown	Slate	White	Red	Black	Yellow	Violet	Rose	Aqua
24	2	12	12										
36	3	12	12	12									
48	4	12	12	12	12								
60	5	12	12	12	12	12							
72	6	12	12	12	12	12	12						
84	7	12	12	12	12	12	12	12					
96	8	12	12	12	12	12	12	12	12				
108	9	12	12	12	12	12	12	12	12	12			
120	10	12	12	12	12	12	12	12	12	12	12		
132	11	12	12	12	12	12	12	12	12	12	12	12	
144	12	12	12	12	12	12	12	12	12	12	12	12	12

3.3 *AccuRibbon*® and *AccuRibbon® DC* CORE CONSTRUCTION

3.3.1 Fiber Color Code

All fibers used in OFS cable cores are color coded to facilitate individual fiber identification. The individual fiber colors used in *AccuRibbon* and *AccuRibbon DC* cable cores are given in the following table.

Table 13: Fiber Color Code - *AccuRibbon*® and *AccuRibbon® DC* Core

AccuRibbon® Unit Type	Fiber Number	Fiber Color
4-Fiber Ribbon*	1	Blue (BL)
	2	Orange (OR)
	3	Green (GR)
	4	Brown (BR)
6-Fiber Ribbon*	5	Slate (SL)
	6	White (WH)
8-Fiber Ribbon	7	Red (RD)
	8	Black (BK)
12-Fiber Ribbon**	9	Yellow (YL)
	10	Violet (VI)
	11	Rose (RS)
	12	Aqua (AQ)
24-Fiber Ribbon	13	Blue (BL)
	14	Orange (OR)
	15	Green (GR)
	16	Brown (BR)
	17	Slate (SL)
	18	White (WH)
	19	Red (RD)
	20	Black (BK)
	21	Yellow (YL)
	22	Violet (VI)
	23	Rose (RS)
	24	Aqua (AQ)

Twenty-four fiber ribbons are organized as two twelve-fiber sub-units.
* Four and Six fiber ribbons may use the 12 fiber-coding scheme depending on application.
** AccuRibbon DC is only available with 12 fiber ribbons

3.3.2 *AccuRibbon* and *AccuRibbon DC* Cable Core Constructions

AccuRibbon units may contain 4, 6, 8, 12, or 24 fibers per ribbon. The *AccuRibbon DC* cable core has AccuRibbon units with 12 fibers per ribbon. Each *AccuRibbon* unit is a flat array of colored fibers bonded by a UV light-curable matrix material as shown in the following figure.

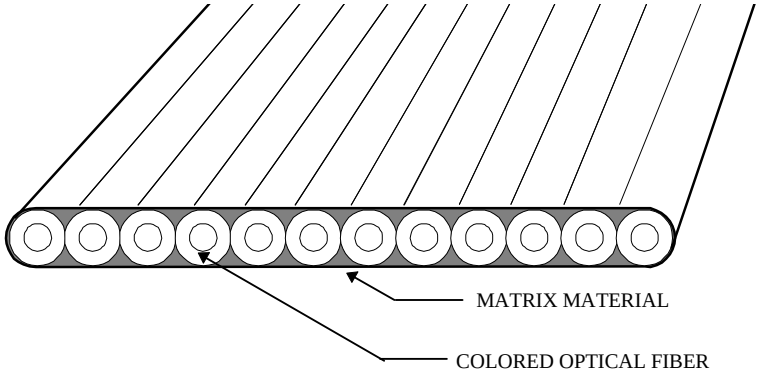

Figure 8: 12-Fiber *AccuRibbon*® Unit

The nominal dimensions of the ribbon cross section are as follows:

Table 14: *AccuRibbon*® Unit Dimensions

Number of Fibers/Ribbon	Width mm (in)	Height mm (in)
4	1.08 (0.0425)	0.300 (0.0118)
6	1.59 (0.0626)	0.300 (0.0118)
8	2.10 (0.0827)	0.300 (0.0118)
12	3.14 (0.1236)	0.302 (0.0119)
24	6.18 (0.2431)	0.305 (0.0120)

3.3.2.1 Number of Ribbons Per Core Tube

AccuRibbon units are stacked in a rectangular array and given a controlled twist to minimize stress when the cable is bent. The maximum number of ribbons in a cable core depends on the ribbon size and is as follows:

Table 15: Maximum Number of *AccuRibbon*® Units in Cable Core Tube

Core Tube OD: (mm) (in)	4.1 (0.16)	6.1 (0.24)	6.1 (0.24)	6.1 (0.24)	7.9 (0.31)	7.9 (0.31)	10.4 (0.41)	10.4 (0.41)	14.0 (0.55)	19.3 (0.76)
Number of Fibers Per Ribbon*	4	6	8	12	8	12	12	24	24	24
Maximum # of Ribbons in Core	2	6	5	4	12	12	18	10	24	36
Maximum # of Fibers in Core	8	36	40	48	96	144	216	240	576	864

* 4 fiber ribbons are available only in DVX and DDX sheath options

The *AccuRibbon* stack is housed in an extruded plastic tube (See Figure 9) in which filling compound displaces air within the tube.

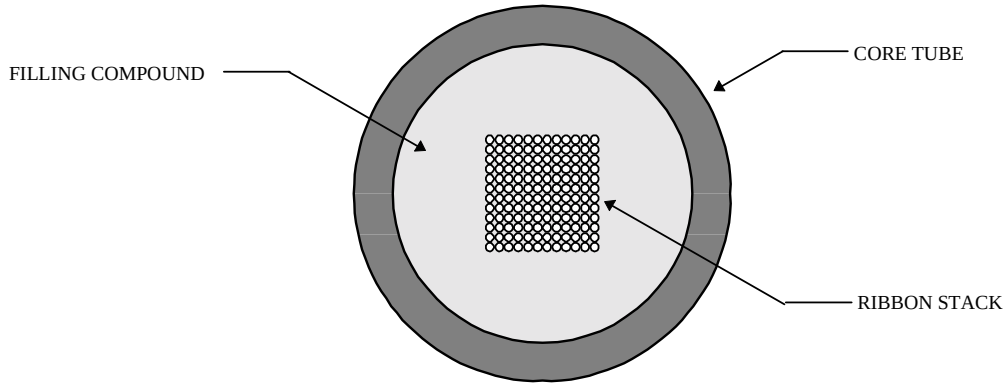

Figure 9: *AccuRibbon*® Cable Core

The *AccuRibbon* stack is housed in an extruded plastic tube (See Figure 910) containing gel-free, water-blocking tape.

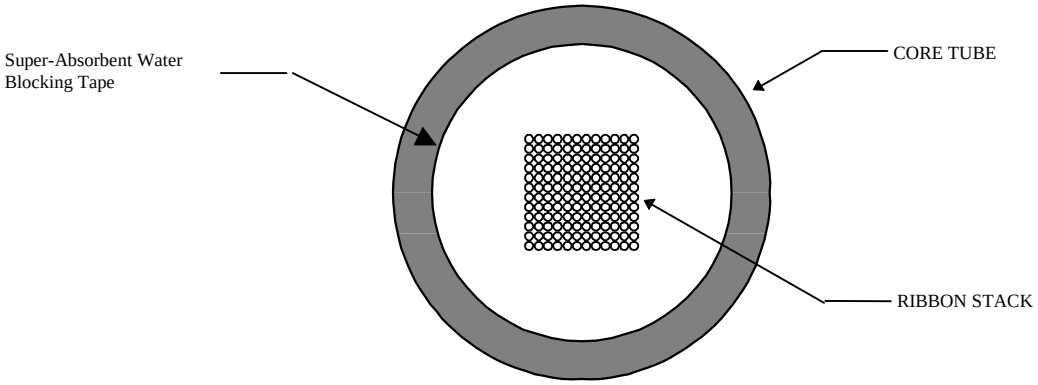

Figure 10: *AccuRibbon*® DC Cable Core (Only Available with 12 fibers/ribbon)

3.3.2.2 *AccuRibbon* Unit Identification and Fiber Orientation:

Each *AccuRibbon* unit has identifying marks at approximately 150 mm (6 inch) intervals along its length. These marks uniquely identify each *AccuRibbon* unit within a cable.

3.3.2.2.1 Ribbon Identification - 4/6/8-Fiber Ribbons:

The identification marks on these ribbons consist of vertical bar and box marks. A ”box” is used to code groups of five. Figure shows examples of the marking methods for these smaller ribbons. Table 16 lists the different markings for each of the ribbons.

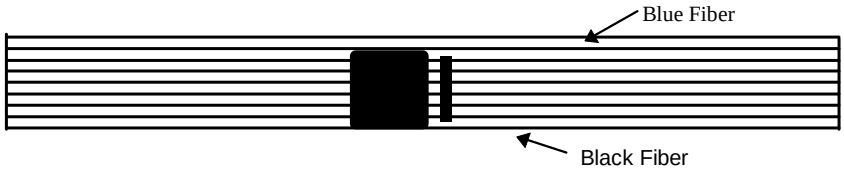

Figure 11: 8-Fiber Single-Mode *AccuRibbon*® Unit Identification for Ribbon 6

Table 16: 4/6/8-Fiber *AccuRibbon*® Unit Identification Code for Ribbons with Single Units

***AccuRibbon*® Unit Number**†	***AccuRibbon* Unit Marking**
1	|
2	||
3	|||
4	||||
5	■
6	■ |
7	■ ||
8	■ |||
9	■ ||||
10	■ ■
11	■ ■ |
12	■ ■ ||

† See Table 15 for Maximum Number of Ribbons available in AccuRibbon and AccuRibbon DC Core Tubes

3.3.2.2.2 Ribbon Identification - 12-Fiber Ribbon:

For a standard 12-fiber ribbon, the marking consists of three character sets separated by dashes as shown below.

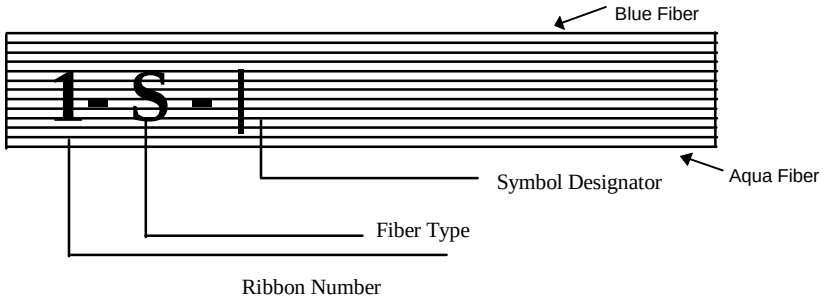

Figure 102: 12-Fiber Single-Mode *AccuRibbon*® Unit Identification

Table 17: 12-Fiber *AccuRibbon*® Unit Identification Code – Effective 10/1/2001

Ribbon Number	Ribbon Marking	Fiber Type
1	1 - X - |	
2	2 - X - ||	
3	3 - X - |||	
4	4 - X - ||||	
5	5 - X - ▮	**X = S** for Depressed/Matched Cladding Fiber
6	6 - X - ▮ |	
7	7 - X - ▮ ||	
8	8 - X - ▮ |||	**= AW** for *AllWave*® Fiber
9	9 - X - ▮ ||||	
10	10 - X - ▮▮	
11	11 - X - ▮▮ |	**= TW** for *TrueWave*® RS Fiber
12	12 - X - ▮▮ ||	
13	13 - X - ▮▮ |||	
14	14 - X - ▮▮ ||||	**= 62.5** for 62.5µm Fiber
15	15 - X - ▮▮ ▮	
16	16 - X - ▮▮ ▮ |	
17	17 - X - ▮▮ ▮ ||	
18	18 - X - ▮▮ ▮ |||	

3.3.2.2.3 Ribbon Identification - 24-Fiber Ribbons Manufactured with Sub-Units

24-fiber ribbons are double marked as shown below. Each ribbon half contains a unique marking that remains on the ribbon after the ribbon is split into two units.

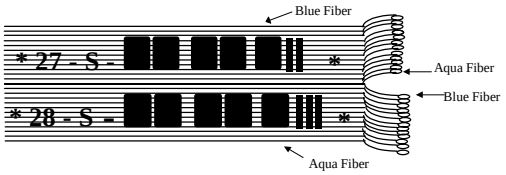

Figure 13: 24-Fiber Single-Mode *AccuRibbon*® Unit Identification for Ribbon 14, Sub-Units 27 and 28

Table 18: *AccuRibbon*® Unit Identification Code for 24-Fiber Ribbons with Two Sub-Units

Ribbon #	Sub-Unit #	Ribbon Marking[1]	Ribbon #	Sub-Unit #	Ribbon Marking[1]
1	1	* 1 - X - | *	19	37	* 37 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||*
	2	* 2 - X - || *		38	* 38 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||| *
2	3	* 3 - X - ||| *	20	39	* 39 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮ |||| *
	4	* 4 - X - |||| *		40	* 40 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ *
3	5	* 5 - X - ▮ *	21	41	* 41 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ | *
	6	* 6 - X - ▮ | *		42	* 42 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ || *
4	7	* 7 - X - ▮ || *	22	43	* 43 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ||| *
	8	* 8 - X - ▮ ||| *		44	* 44 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ |||| *
5	9	* 9 - X - ▮ |||| *	23	45	* 45 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ *
	10	* 10 - X - ▮▮ *		46	* 46 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ | *
6	11	* 11 - X - ▮▮ ▮ | *	24	47	* 47 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||*
	12	* 12 - X - ▮▮ ▮ || *		48	* 48 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||| *
7	13	* 13 - X - ▮▮ ▮ ||| *	25	49	* 49 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ |||| *
	14	* 14 - X - ▮▮ ▮ |||| *		50	* 50 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ *
8	15	* 15 - X - ▮▮ ▮▮ ▮ *	26	51	* 51 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ | *
	16	* 16 - X - ▮▮ ▮▮ ▮ | *		52	* 52 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ || *
9	17	* 17 - X - ▮▮ ▮▮ ▮ || *	27	53	* 53 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ||| *
	18	* 18 - X - ▮▮ ▮▮ ▮ ||| *		54	* 54 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ |||| *
10	19	* 19 - X - ▮▮ ▮▮ ▮ |||| *	28	55	* 55 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ *
	20	* 20 - X - ▮▮ ▮▮ ▮▮ *		56	* 56 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ | *
11	21	* 21 - X - ▮▮ ▮▮ ▮▮ | *	29	57	* 57 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||*
	22	* 22 - X - ▮▮ ▮▮ ▮▮ || *		58	* 58 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||| *
12	23	* 23 - X - ▮▮ ▮▮ ▮▮ ||| *	30	59	* 59 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ |||| *
	24	* 24 - X - ▮▮ ▮▮ ▮▮ |||| *		60	* 60 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ *
13	25	* 25 - X - ▮▮ ▮▮ ▮▮ ▮ *	31	61	* 61 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ | *
	26	* 26 - X - ▮▮ ▮▮ ▮▮ ▮ | *		62	* 62 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ || *
14	27	* 27 - X - ▮▮ ▮▮ ▮▮ ▮ || *	32	63	* 63 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ||| *
	28	* 28 - X - ▮▮ ▮▮ ▮▮ ▮ ||| *		64	* 64 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ |||| *
15	29	* 29 - X - ▮▮ ▮▮ ▮▮ ▮ |||| *	33	65	* 65 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ *
	30	* 30 - X - ▮▮ ▮▮ ▮▮ ▮▮ *		66	* 66 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ | *
16	31	* 31 - X - ▮▮ ▮▮ ▮▮ ▮▮ | *	34	67	* 67 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ ||*
	32	* 32 - X - ▮▮ ▮▮ ▮▮ ▮▮ || *		68	* 68 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ |||*
17	33	* 33 - X - ▮▮ ▮▮ ▮▮ ▮▮ ||| *	35	69	* 69 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ |||| *
	34	* 34 - X - ▮▮ ▮▮ ▮▮ ▮▮ |||| *		70	* 70 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ *
18	35	* 35 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮ *	36	71	* 71 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮ | *
	36	* 36 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮ | *		72	* 72 - X - ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ ▮▮ || *

[1] **X= "S" for Depressed/Matched Cladding Fibers, ="AW" for AllWave® Fiber, ="TW" for TrueWave® Fiber, ="62.5" for 62.5µm Fiber**

The following table specifies the requirements that fiber ribbons shall meet.

Table 19: Mechanical and Environmental Requirements for Single-Mode Fiber Ribbons

Ribbon Test	Test Method*	Requirement	Notes
Ribbon Dimensions (Unaged)	ICEA S-87-640-2000 (Section 7.14), Bellcore GR-20 (Section 5.1.2)	12-Fiber Ribbon: Width ≤3.22 mm, Height ≤0.360 mm, Planarity ≤0.050 mm, Extreme fibers ≤2.882 mm 24-Fiber Ribbon: Width ≤6.50 mm, Height ≤0.360 mm, Planarity & Extreme fibers tested for conformance as two, 12-fiber ribbons	1
Resistance to Twist (Unaged and Aged)	ICEA S-87-640-2000 (Section 7.16), Bellcore GR-20 (Section 5.2.1), FOTP 141	After 20 cycles, ±180° twist, 500g load, no fiber separation or de-bonding.	2
Ribbon Separation (Unaged)	ICEA S-87-640-2000 (Section 7.18), Bellcore GR-20 (Section 5.2.2)	• Fiber peel force ≤ 4.4 N (1 lbf) • Matrix material removable • Color retained, any 2.5 cm identifiable • Single fiber and Sub-group separable • No damage to fibers	2
Ribbon Residual Twist (Flatness) (Aged)	ICEA S-87-640-2000 (Section 7.17), Bellcore GR-20 (Section 5.2.3), FOTP-131	< 8° twist per centimeter	2
Ribbon Strippability (Unaged & Aged)	ICEA S-87-640-2000 (Section 3.4.4.6) Bellcore GR-20 (Sections 5.3.4 and 6.3.4), TIA ITM-9**	Ribbon strips with no fiber breaks and residue removed after one wipe with alcohol pad.	2
Cable Material Compatibility Wasp Spray Exposure	ICEA S-87-640-2000 (Section 7.15) Bellcore GR-20 (Sections 6.3.4, and 6.6.8)	Aged ribbons shall not exhibit cracking, splitting, or delamination after aging.	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR)

* OFS complies with the latest revision of the TIA/EIA Test Method [There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods]. Telcordia Generic Requirements (GR) documents are currently identified under the "Bellcore" name.

** Standard being revised

4. SHEATHS (STANDARD APPLICATIONS)

The sheaths described in this section are:

METALLIC	DIELECTRIC
— *AccuRibbon*® DuctSaver (Y)	— *AccuRibbon* DuctSaver / Dielectric Crossply (F)
— *AccuRibbon*® DuctSaver+ (2)	— Central Flex (1)
— LXE-ME (S)	— Dielectric Drop (D)
— LXE-RL (R)	— LXE-DE (N)
— Mini-LXE (Armored Drop) (V)	— Modified LXE-DE (3)
— Primary RL (H)	— AccuRibbon® TL (X)
— Primary Armor (M)	

These sheaths are described in detail in this Section, and they are intended for use in standard Outside Plant Applications (i.e., aerial, buried, or underground applications in typical environments). The corresponding cable code designator (in parenthesis) will assist in selecting options when ordering per the cable code described in Section 9. The available core/sheath combinations are given in Table 20. Cable diameters and weight are given in Table 21 through Table 26.

The tensile rating for all cables except the drop cables is 2.7 kN (600 lbf). The tensile rating is 1.8 kN (400 lbf) for the Mini-LXE (Armored Drop) cable, and 1.4 kN (300 lbf) for the Dielectric Drop cable.

All sheaths utilize the centrally located core constructions described in Section 3 (see Section 4.3 for the available combinations). All applications of Electrolytic Chrome Coated Steel (ECCS) armor utilize an adhesive polymer coating to inhibit corrosion and bond to the adjacent jacket. In addition, all sheaths may include water-blocking yarns, powder, or tapes which for simplicity may not be specifically included in the descriptions which follow.

4.1 METALLIC SHEATHS

4.1.1 *AccuRibbon* DuctSaver SHEATH (Y)

The construction of the *AccuRibbon* DuctSaver sheath is shown in Figure 114. The DuctSaver sheath consists of a helical application of a layer of glass strength elements over which a second layer of reinforced glass strength elements is applied, in the opposite direction. Two ripcords, opposite from each other among the outer layer of strength members, are added to aid in the removal of the inner jacket of High Density Polyethylene (HDPE). Two additional ripcords are provided over the inner layer of HDPE, over which a 0.15 mm (0.006 in.) corrugated ECCS armor is applied. The sheath is then coated with an outer layer of black high density polyethylene (HDPE) jacket.

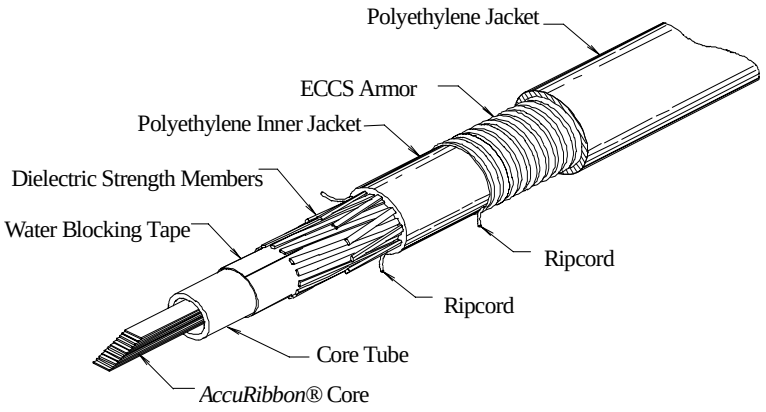

Figure 114: *AccuRibbon*® DuctSaver Metallic Sheath

4.1.2 *AccuRibbon* DuctSaver+ SHEATH (2)

The construction of the *AccuRibbon* DuctSaver+ sheath is shown in Figure 125. The sheath includes an overlapped armor layer of 0.15 mm (0.006 in.) corrugated ECCS over the *AccuRibbon* cable core. A ripcord under the armor eases its removal. The sheath is completed with a single helical application of dielectric strength members and a circular extrusion of a black, medium density polyethylene (MDPE) jacket.

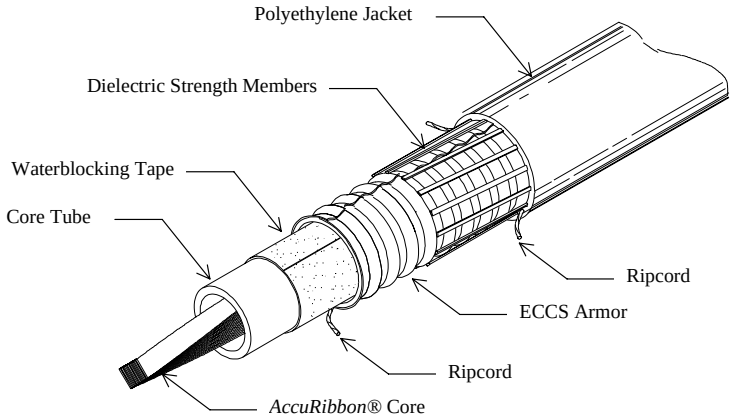

Figure 125: *AccuRibbon*® DuctSaver+ Metallic Sheath

4.1.3 LXE-ME SHEATH (S)

The construction of the LXE-ME sheath is shown in Figure 136. An overlapped armor layer of 0.15 mm (0.006 in) corrugated ECCS envelopes the core tube and has a ripcord under it to ease its removal. Two steel wire strength members run longitudinally along the armor, diametrical from each other. A ripcord is located next to each steel wire for ease of sheath removal. The sheath is completed with a black high density polyethylene (HDPE) jacket.

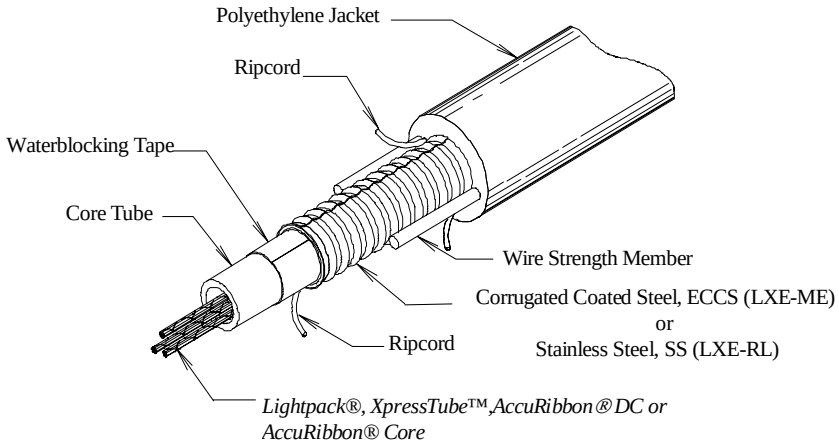

Figure 136: LXE-ME or LXE-RL Sheath

4.1.4 LXE-RL SHEATH (R)

The construction of this sheath is the same as the LXE-ME sheath (See Figure 136) except the ECCS armor is replaced with an adhesive-coated 0.13 mm (0.005 in.) stainless steel armor which provides additional protection against rodents.

4.1.5 Mini-LXE (Armored Drop) SHEATH (V)

The construction of the Mini-LXE sheath is similar to the LXE-ME sheath (See Figure 136). An overlapped armor layer of 0.15 mm (0.006 in.) corrugated ECCS envelopes the core tube. Two steel wire strength members run longitudinally along the armor, diametrical from each other. The sheath is completed with a black medium density polyethylene (MDPE) jacket.

4.1.6 Primary RL SHEATH (H)

The Primary RL sheath, illustrated in Figure 147 is applied over the *AccuRibbon* or *Lightpack* cable core. An overlapped armor layer of 0.13 mm (0.005 in.) corrugated stainless steel envelopes the core tube and has a ripcord under it to ease its removal. The armor is coated to promote bonding to the outer jacket. The armor application is followed by a single helical application of 0.53 mm (0.021 in.) diameter steel wires and a black high density polyethylene (HDPE) jacket. This sheath provides excellent rodent protection in a very compact and rugged size.

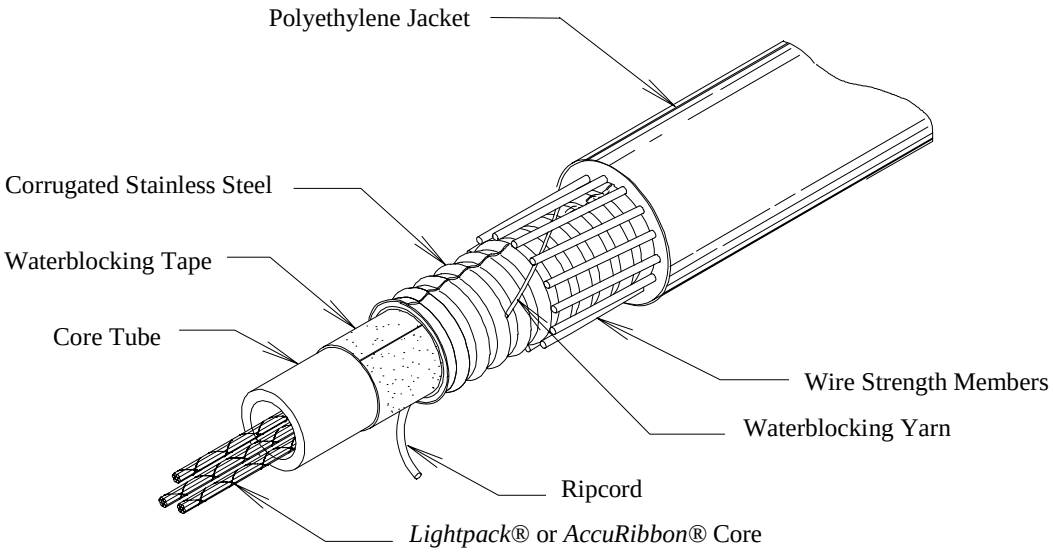

Figure 147: Primary RL Sheath

4.1.7 Primary Armor SHEATH (M)

The Primary Armor design is similar to the Primary RL sheath (See Figure 147) and is available in two specific offerings: an enhanced ground fault resistant sheath, and a compact sheath for high fiber counts.

The Primary Armor sheath with enhanced ground fault resistance is applied over the *Lightpack* cable core for fiber counts up to 48. This alternative is recommended for use in buried plant where additional ground-fault protection is required. The sheath consists of a longitudinally applied tape of 0.15 mm (0.006 in.) corrugated ECCS. The steel armor is followed by a single helical application of 0.53 mm (0.021 in) diameter steel wires. The black high density polyethylene (HDPE) jacket has an increased thickness to provide additional ground fault protection.

The compact sheath for high fiber counts is available with a 24-fiber AccuRibbon core for fiber counts between 264 and 576. This design is similar to the Primary RL design except the stainless steel armor is replaced with a 0.15 mm (.006 in.) ECCS armor.

4.2 DIELECTRIC SHEATHS

4.2.1 *AccuRibbon* DuctSaver / Dielectric Crossply SHEATH (F)

The *AccuRibbon* DuctSaver / Dielectric Crossply sheath illustrated in Figure 158 consists of a helical application of glass strength elements over which a second application of reinforced glass strength elements is applied in the opposite direction. The DuctSaver sheath is only available with an AccuRibbon Core; however, a Lightpack Core is also available with the Dielectric Crossply sheath for up to 96 fibers. Both sheaths, up to 576 fibers, are completed with a black high density polyethylene (HDPE) jacket. The 864-fiber sheath is completed with a black, medium density polyethylene (MDPE) jacket. Two ripcords, to aid in the removal of the outer jacket, are situated, diametrical from each other, amongst the outer layer of strength members.

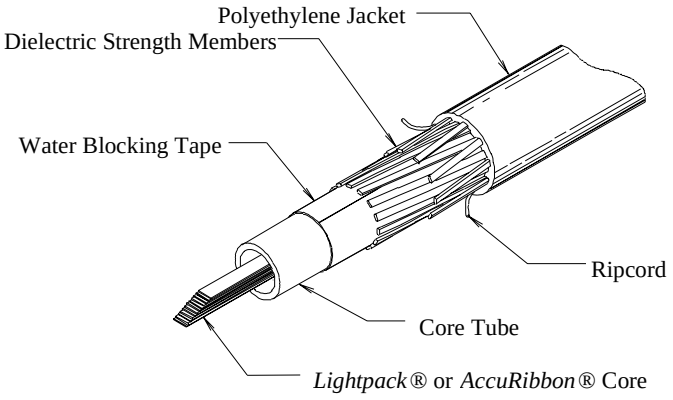

Figure 158: *AccuRibbon*® DuctSaver / Dielectric Crossply Sheath

4.2.2 Central Flex SHEATH (1)

The construction of the Central Flex sheath is shown in Figure 169. A layer of water blocked, glass strength tape is linearly applied over the cable core. Two glass rods are then S-Z stranded, diametrically from each other, over the glass tape. Two rip cords, nestled along the glass rods, are provided to facilitate sheath entry. The sheath is completed with a black high density polyethylene (HDPE) jacket.

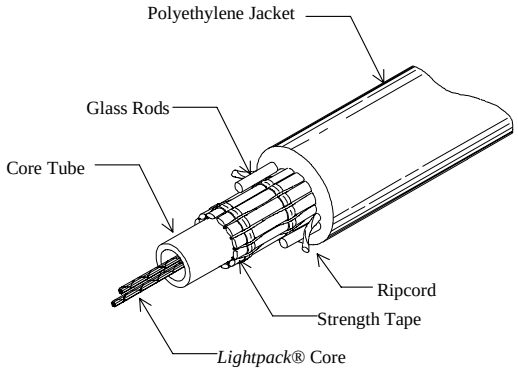

Figure 169: Central Flex Sheath

4.2.3 Dielectric Drop SHEATH (D)

The Dielectric Drop sheath is similar to the Dielectric Crossply sheath (See Figure 158) except that only one layer of glass strength elements is helically applied over the core tube. The sheath is completed with a black medium density polyethylene (MDPE) jacket. Two ripcords, to aid in the removal of the outer jacket, are situated, diametrical from each other, amongst the layer of strength members.

4.2.4 LXE-DE SHEATH (N)

The LXE-DE sheath is shown in Figure20. Two groups of glass strength members are longitudinally applied, diametrical from each other, over the cable core. The two rip cords, nestled along the strength members, provide extremely easy sheath entry. The sheath is completed with a black high density polyethylene (HDPE) jacket.

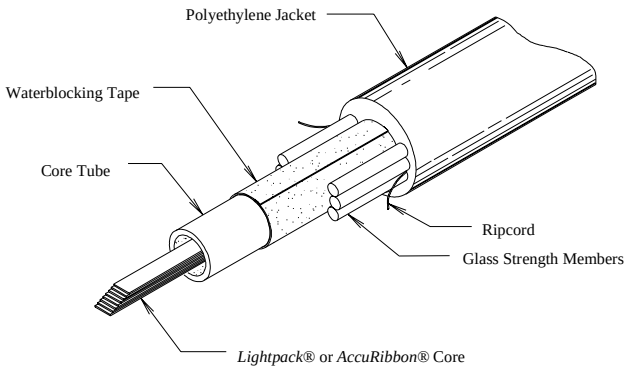

Figure 20: LXE-DE Sheath

4.2.5 Modified LXE-DE Sheath (3)

The modified LXE-DE sheath is similar to the LXE-DE design but instead of having 3 glass strength members longitudinally applied, diametrical to each other, it has 2 glass strength members applied in the same manner, over the cable core. The two rip cords, nestled along the strength members provide extremely easy sheath entry. The sheath is completed with a black high density polyethylene (HDPE) jacket.

4.2.6 AccuRibbon® TL Sheath (X)

The AccuRibbon TL sheath consist of a central tube that is covered by a layer of water blocking tape to aid in the prevention of water entering the core. The cable construction is completed with a flame retardant and low smoke, zero halogen (LSZH) jacket containing integrated strength members. The UL 1666 and 1685 rating means the AccuRibbon TL passes riser rating and difficult flame tests designed to minimize smoke emissions.

4.3 CORE/SHEATH COMBINATIONS

The following table lists all the available core/sheath combinations for standard applications.

Table 20: Available Combinations for Sheath/Core - Standard Applications

SHEATH TYPE	Fiber Counts							
	***Lightpack*® Core**	***XpressTube™ Core***	***AccuRibbon® DC Core***	***AccuRibbon*® Core**				
	Loose Fibers	12-Fibers/Tube	12 –Fiber Ribbon	4-Fiber Ribbon	6-Fiber Ribbon	8-Fiber Ribbon	12-Fiber Ribbon	24-Fiber Ribbon
METALLIC SHEATHS:								
(Y) AccuRibbon DuctSaver								264-576
(2) AccuRibbon DuctSaver+								744-864
(V) Mini-LXE (Armored Drop)	2-18			4-8	6-12			
(S) LXE-ME	2-96	24 – 144	12-216		6-36	8-96	12-216	240
(R) LXE-RL	2-96	24 - 144			6-36	8-96	12-216	240
(M) Primary Armor	2-48							264 - 576
(H) Primary RL	2-96						12-216	216-240, 264-576
DIELECTRIC SHEATHS:								
(F) AccuRibbon DuctSaver / Dielectric Crossply	2-96						12-216	264-576; 744-864 240
(1) Central Flex	2-48							
(D) Dielectric Drop	2-18			4-8	6-12			
(N) LXE-DE	2-96	24 - 144			6-36	8-96	12-216	240
(3) Modified LXE-DE			12-216					
(X) AccuRibbon TL							12-216	

Table 21 through Table 2830 give the diameter and weight of each completed cable with a *Lightpack*, XpressTube,*AccuRibbon, and AccuRibbon DC* cores, respectively. Tables for English and Metric units are provided.

Table 21: Nominal Diameters (in) and Cable Weights (lbm/kft) – OFS Standard Fiber Optic Cables with *Lightpack*® Core

METALLIC / ARMORED SHEATH TYPE	**FIBER COUNT**							
	1 - 18 (Mini/Drop)		2-24 (LXE)		26-48 (LXE) 2 - 48 (Primary RL, Primary Armor)		50-96	
	CORE OD (in)							
	0.16		0.20		0.24		0.31	
	CABLE DIAMETER AND WEIGHT							
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
- Mini-LXE (Armored Drop)	0.36	62						
- LXE-ME			0.45	88	0.51	120	0.61	150
- LXE-RL			0.45	88	0.51	120	0.61	150
- Primary Armor					0.51	105		
- Primary RL					0.43	90	0.51	115

DIELECTRIC SHEATH TYPE	**FIBER COUNT**							
	1 - 18 (Drop)		2-24 (Central Flex)		26-48 Central Flex 2 - 48 (LXE, Dielectric Crossply)		50-96	
	CORE OD (in)							
	0.16		0.20		0.24		0.31	
	CABLE DIAMETER AND WEIGHT							
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
- Central Flex			0.45	66	0.49	82		
- Dielectric Crossply					0.43	66	0.51	90
- Dielectric Drop	.30	30						
- LXE-DE					0.51	95	0.61	125

Table 22: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Standard Fiber Optic Cables with *Lightpack*® Core

METALLIC / ARMORED SHEATH TYPE	FIBER COUNT							
	1 - 18 (Mini/Drop)		2-24 (LXE)		26-48 (LXE) 2 - 48 (Primary RL, Primary Armor)		50-96	
	CORE OD (mm)							
	4.1		5.1		6.1		7.9	
	CABLE DIAMETER AND WEIGHT							
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
- Mini-LXE (Armored Drop)	9.1	92						
- LXE-ME			11.4	131	13.0	179	15.5	223
- LXE-RL			11.4	131	13.0	179	15.5	223
- Primary Armor					13.0	156		
- Primary RL					10.9	134	13.0	171

DIELECTRIC SHEATH TYPE	FIBER COUNT							
	1 - 18 (Drop)		2-24 (Central Flex)		26-48 Central Flex 2 - 48 (LXE, Dielectric Crossply)		50-96	
	CORE OD (mm)							
	4.1		5.1		6.1		7.9	
	CABLE DIAMETER AND WEIGHT							
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
- Central Flex			11.4	98	12.4	122		
- Dielectric Crossply					10.9	98	13.0	134
- Dielectric Drop	7.6	45						
- LXE-DE					13.0	141	15.5	186

Table 23: Nominal Diameters (in) and Cable Weights (lbm/kft) - OFS Standard Fiber Optic Cables: *XpressTube*™ Core

METALLIC / ARMORED SHEATH TYPE	**FIBER COUNT**					
	24 - 48		60 - 96		108 - 144	
	CORE OD (in)					
	0.24		0.31		0.41	
	CABLE DIAMETER AND WEIGHT					
	OD	Weight	OD	Weight	OD	Weight
	in	lbm/kft	in	lbm/kft	in	lbm/kft
LXE-ME	0.51	108	0.61	142	0.71	177
LXE-RL	0.51	108	0.61	142	0.71	177
DIELECTRIC SHEATH TYPE	**FIBER COUNT**					
			24 - 96		108 –144	
	CORE OD (in)					
			0.31		0.41	
	CABLE DIAMETER AND WEIGHT					
	OD	Weight	OD	Weight	OD	Weight
	in	lbm/kft	in	lbm/kft	in	lbm/kft
Modified LXE-DE	0.51	81	0.61	103	0.71	134

Table 24: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Standard Fiber Optic Cables: *XpressTube*™ Core

METALLIC / ARMORED SHEATH TYPE	**FIBER COUNT**					
	24 - 48		60 - 96		108 - 144	
	CORE OD (mm)					
	6.1		7.9		10.4	
	CABLE DIAMETER AND WEIGHT					
	OD	Weight	OD	Weight	OD	Weight
	mm	kg/km	mm	kg/km	mm	kg/km
LXE-ME	13.0	161	15.5	211	18.0	263
LXE-RL	13.0	161	15.5	211	18.0	263
DIELECTRIC SHEATH TYPE	**FIBER COUNT**					
			24 - 96		108 –144	
	CORE OD (mm)					
			7.9		10.4	
	CABLE DIAMETER AND WEIGHT					
	OD	Weight	OD	Weight	OD	Weight
	mm	kg/km	mm	kg/km	mm	kg/km
Modified LXE-DE	13.0	121	15.5	153	18.0	200

Table 25: Nominal Diameters (in) and Cable Weights (lbm/kft) - OFS Standard Fiber Optic Cables with 4/6/8-Fiber *AccuRibbon*® Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON					
	4 , 6		6 , 8		8	
	FIBER COUNT					
	4, 8 6, 12		6 - 36 8 - 40		48 - 96	
	CORE OD (in)					
	0.16		0.24		0.31	
	CABLE DIAMETER AND WEIGHT					
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
METALLIC ARMORED						
- Mini-LXE (Armored Drop)	0.36	62				
- LXE-ME			0.51	120	0.61	150
- LXE-RL			0.51	120	0.61	150
DIELECTRIC						
- Dielectric Drop	0.30	30				
-LXE-DE			0.51	95	0.61	115

Table 26: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Standard Fiber Optic Cables with 4/6/8-Fiber *AccuRibbon*® Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON					
	4 , 6		6 , 8		8	
	FIBER COUNT					
	4, 8 6, 12		6 - 36 8 - 40		48 - 96	
	CORE OD (mm)					
	4.1		6.1		7.9	
	CABLE DIAMETER AND WEIGHT					
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
METALLIC ARMORED						
- Mini-LXE (Armored Drop)	9.1	92				
- LXE-ME			13.0	179	15.5	223
- LXE-RL			13.0	179	15.5	223
DIELECTRIC						
- Dielectric Drop	7.6	45				
-LXE-DE			13.0	141	15.5	171

Table 27: Nominal Diameters (in) and Cable Weights (lbm/kft) - OFS Standard Fiber Optic Cables with 12/24-Fiber *AccuRibbon*® Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON									
	12		12		24		24		24	
	FIBER COUNT									
	12 - 144		156 - 216		240		264 - 576		744 - 864	
	CORE OD (in)									
	0.31		0.41		0.41		0.55		0.76	
	CABLE DIAMETER AND WEIGHT									
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
METALLIC ARMORED										
- AccuRibbon® DuctSaver							0.89	294		
- AccuRibbon® DuctSaver+									1.00	380
- LXE-ME	0.61	150	0.71	203	0.71	207				
- LXE-RL	0.61	150	0.71	203	0.71	207				
- Primary Armor							0.78	240		
- Primary RL	0.51	115	0.61	155	0.61	158	0.78	225		
DIELECTRIC										
- AccuRibbon® DuctSaver (Dielectric Crossply)	0.51	94	0.61	125	0.61	129	0.75	190	0.96	316
-LXE-DE	0.61	125	0.71	170	0.71	175				
-AccuRibbon TL	0.68	225	0.75	250						

Table 28: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Standard Fiber Optic Cables with 12/24-Fiber *AccuRibbon*® Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON									
	12		12		24		24		24	
	FIBER COUNT									
	12 - 144		156 - 216		240		264 - 576		744 - 864	
	CORE OD (mm)									
	7.9		10.4		10.4		14.0		19.3	
	CABLE DIAMETER AND WEIGHT									
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
METALLIC ARMORED										
- AccuRibbon® DuctSaver							22.6	437		
- AccuRibbon® DuctSaver+									25.4	565
- LXE-ME	15.5	223	18.0	302	18.0	308				
- LXE-RL	15.5	223	18.0	302	18.0	308				
- Primary Armor							19.8	335		
- Primary RL	13.0	171	15.5	231	15.5	235	19.8	335		
DIELECTRIC										
- AccuRibbon® DuctSaver (Dielectric Crossply)	13.0	140	15.5	186	15.5	192	19.0	283	24.4	471
-LXE-DE	15.5	186	18.0	253	18.0	260				
-AccuRibbon TL	17.3	335	19.0	372						

Table 29: Nominal Diameters (in) and Cable Weights (lbm/kft) - OFS Standard Fiber Optic Cables with 12-Fiber *AccuRibbon*® DC Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON					
	12		12		12	
	FIBER COUNT					
	12 - 48		56 – 144		156-216	
	CORE OD (in)					
	0.24		0.31		0.41	
	CABLE DIAMETER AND WEIGHT					
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
METALLIC ARMORED						
- LXE-ME	0.51	110	0.61	147	0.71	166
- LXE-RL	0.51	110	0.61	147	0.71	166
DIELECTRIC						
-Modified LXE-DE	0.51	78	0.61	110	0.71	134

Table 30: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Standard Fiber Optic Cables with 12-Fiber *AccuRibbon*® DC Core

SHEATH TYPE	NUMBER OF FIBERS /RIBBON					
	12		12		12	
	FIBER COUNT					
	12 - 48		56 – 144		156-216	
	CORE OD (mm)					
	6.1		7.9		10.4	
	CABLE DIAMETER AND WEIGHT					
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
METALLIC ARMORED						
- LXE-ME	13.0	163	15.5	218	18.0	248
- LXE-RL	13.0	163	15.5	218	18.0	248
DIELECTRIC						
-Modified LXE-DE	13.0	117	15.5	163	18.0	200

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5. SHEATHS (SPECIALTY APPLICATIONS)

The sheaths described in this section are:

METALLIC
C-Oversheath (C)
Wire Armored (SA, DA, or TA)

These sheaths (with their corresponding cable code designator in parenthesis) are described in detail below. They are intended for specialty applications, such harsh/distinctive environments. The available core/sheath combinations are given in Table 31. Cable diameters and weight, as well as other pertinent information, are given in Table 2 through Table . All sheaths may include water-blocking yarns or tapes, which for simplicity may not be specifically included in the descriptions which follow.

The tensile rating for the C-Oversheath cables is 2.7 kN (600lbf). Table 34 contains the relevant information about the Wire Armored Cables.

5.1 C-Oversheath

C-Oversheath is designed to provide maximum rodent and lightning protection within an exceptionally rugged structure. The oversheath construction adds a 0.13 mm (5 mil) corrugated stainless steel tape which is coated so that it bonds to the polyethylene jacket extruded over it. C-Oversheath is available over dielectric crossply and LXE sheaths. C-Oversheath is available over other sheaths on a special request basis.

5.2 Underwater Wire-Armored Cable Oversheath

The corrosion resistant wire-armored oversheath design, as illustrated in Figure 171, uses stainless steel armor wires in conjunction with plastic coatings to provide superior corrosion resistance and to prevent H_2-induced loss problems. The cable core shown in the figure is a Primary RL sheath; however, the oversheath can also be used with the Dielectric Crossply. Table lists the ultimate breaking load (UBL), permitted cable tension, and other pertinent specifications for single wire, double wire, and triple wire underwater oversheaths to be used with fiber optic cable cores.

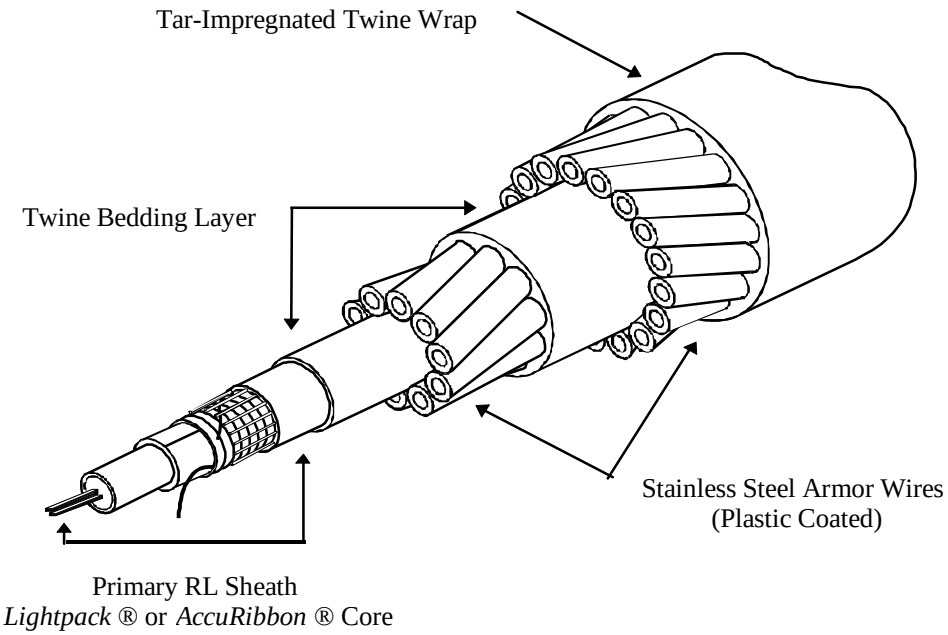

Figure 171: Underwater Wire-Armored Cable Oversheath

5.3 CORE/SHEATH COMBINATIONS

The following table lists all the available core/sheath combinations for specialty applications.

Table 31: Available Combinations for Sheath/Core – Specialty Applications

Sheath Type	Fiber Counts	
	Lightpack® Core	*AccuRibbon*® Core (12-Fiber Ribbon)
C-Oversheath	4 - 96	12 - 216
Wire Armored	4 - 48	12 - 216

Table 32 through Table 33 provide diameters and cable weights for the Specialty applications cables. Additional relevant information is provided in Table 34 for the Wire Armored Cables.

Table 32: Nominal diameters (in) and Cable Weights (lb/kft) - OFS Specialty Fiber Optic Cables with *Lightpack*® Core

SHEATH TYPE	FIBER COUNT					
	2 - 24 (LXE)		2- 48 26 - 48 (LXE)		50 - 96	
	CORE OD (in)					
	0.16		0.24		0.31	
	CABLE DIAMETER AND WEIGHT					
	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)	OD (in)	Weight (lbm/kft)
METALLIC ARMORED						
- C-Oversheath (Dielectric Crossply)			0.58	210	0.67	230
- C-Oversheath (LXE)	0.61	182	0.67	215	0.77	265

Table 33: Nominal Diameters (mm) and Cable Weights (kg/km) - OFS Specialty Fiber Optic Cables with *Lightpack*® Core

SHEATH TYPE	FIBER COUNT					
	2 - 24 (LXE)		2- 48 26 - 48 (LXE)		50 - 96	
	CORE OD (mm)					
	4.1		6.1		7.9	
	CABLE DIAMETER AND WEIGHT					
	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)	OD (mm)	Weight (kg/km)
METALLIC ARMORED						
- C-Oversheath (Dielectric Crossply)			14.7	312	17.0	342
- C-Oversheath (LXE)	15.5	271	17.0	320	19.6	394

Table 34: Fiber Optic Underwater Cable with Corrosion-Resistant Armor

	Single Armor	Double Armor	Triple Armor
Fiber Optic Cable OD (for up to 48 Fibers*)			
mm	10.9	10.9	10.9
(in)	(0.43)	(0.43)	(0.43)
Armor Wire Material	SS	SS	SS
Number of Armor Wires			
- Layer 1	11	11	11
- Layer 2		19	19
- Layer 3			28
Ultimate Breaking Load (UBL) of Armor,			
kN	44.5	115.6	204.6
(lbf)	(10,000)	(26,000)	(46,000)
Cable Tension to Produce 0.33% Strain			
kN	24.0	63.6	116
(lbf)	(5,400)	(14,300)	(26,100)
Final Diameter of the Armored Cable			
mm	29.0	41.4	56.9
(in)	(1.14)	(1.63)	(2.24)
Final Armor Weight			
kg/km	881	2196	4299
(lbm/kft)	(592)	(1,476)	(2889)
Weight in Water (Armor Only)			
kg/km	394	1143	2201
(lbm/kft)	(265)	(768)	(1479)
Minimum Bend Diameter			
mm	813	1067	1422
(in)	(32)	(42)	(56)

* Additional sizes are available for fiber counts greater than 48 and for *AccuRibbon* cores.

6. MECHANICAL, ENVIRONMENTAL, AND ELECTRICAL REQUIREMENTS

Certain mechanical, environmental and electrical requirements are necessary to ensure proper operation of fiber optic cables in their intended applications. It is intended that the storage, installation, and operation of standard outside plant fiber optic cables be limited to the following temperature ranges:

Operation:	-40°C to 70°C (-40°F to 158°F)
Installation:	-30°C to 60°C (-22°F to 140°F)
Storage/Shipping:	-40°C to 75°C (-40°F to 167°F)

6.1 GENERAL INFORMATION

This section covers the mechanical, environmental, and electrical requirements for completed cables. Table and Table 36 specify the requirements that all outside plant cables shall meet. The requirement type (i.e. IR, QR, or RR as defined in Section 1.3) and test method are also specified.

The allowed attenuation increases are for the mean of one full fiber unit of randomly selected fibers. Test wavelengths are 1310 ± 10 nm and 1550 ± 10 nm for single-mode fibers and 850 ± 10 nm and 1300 ± 10 nm for multimode fibers. There must be no evidence of cracking, splitting or other failure of the sheath components when examined under 5X magnification, and no fiber shall lose optical continuity because of the test.

The cable's minimum bending radius, in the “No Load” condition, is 10 times the cable diameter for cables of less than 264 fibers, and 20 times the cable diameter for those of 264 fibers and above. The minimum bending radius in the “Under Load” condition is 20 times the cable diameter. The "No Load" condition is defined as up to 30% of the maximum load rating and the "Under Load" condition is defined as any load over 30% of the load rating.

Table 35: Mechanical, Environmental, and Electrical Requirements for Single-Mode Fiber Optic Cables

Cable Test	Test Method *	Requirement	Notes
Tensile Loading and Bending	TIA/EIA-455-33 IEC 60794-1-E1	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
Cyclic Flexing	TIA/EIA-455-104 IEC 60794-1-E6	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
Cyclic Impact	TIA/EIA-455-25 IEC 60794-1-E4	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
Compressive Loading	TIA/EIA-455-41 IEC 60794-1-E3	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss 440 N/cm (250 lbf/in) Load	2
Twist	TIA/EIA-455-85 IEC 60794-1-E7	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
Low and High Temperature Bend	TIA/EIA-455-37 IEC 60794-1-E11	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
External Freezing	TIA/EIA-455-98 IEC 60794-1-F6	90% ≤ 0.05 dB Max. Added Loss 100% ≤ 0.15 dB Max. Added Loss	2
Cable Galloping Test — Self-Supporting	Bellcore TR-NWT-001121	0.10 dB Max. Added Loss	2
Fiber Strippability	TIA/EIA-455-178 No equiv IEC proc	≤9.0 N (2 lbf) on unaged and aged fiber ≥1.0N (0.2 lbf) on unaged and aged fiber	2
Temperature Cycling	TIA/EIA-455-3 IEC 60794-1-F1	≤ 0.05 dB/km Mean Added Loss ≤ 0.15 dB/km Max Added Loss	2
Cable Aging	TIA/EIA-455-3 IEC 60794-1-F1	≤ 0.10 dB/km Mean Added Loss ≤ 0.25 dB/km Max Added Loss	2
Water Penetration	TIA/EIA-455-82 IEC 60794-1-F5	No flow after 24 hours from one meter length of cable	1
Sheath-to-Ground Dielectric Strength		≥ 20 kV for all armored metallic sheaths	2
Compound Drip	TIA/EIA-455-81 IEC 60794-1-E14	70°C, 24 hours duration, no drip	2
Lightning Conduction	TIA/EIA-455-181 ITU-T K.25	ICEA** Category I for all armored metallic sheaths†	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR)

* OFS complies with the latest revision of the TIA/EIA Test Method (There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.). Telcordia Generic Requirements (GR) documents are currently identified under the "Bellcore" name.

** ICEA categories are equivalent to those of Telcordia GR-20

† Mini-LXE (Armored Drop) is Category 2; Primary RL, LXE-RL, LightPack® LXE-ME, XpressTube & AccuRibbon DC are not rated at time of spec

Table 36: Mechanical, Environmental, and Electrical Requirements for Multimode Fiber Optic Cables

Cable Test	Test Method*	Requirement	Notes
Tensile Loading and Bending	TIA/EIA-455-33 IEC 60794-1-E1	0.20 dB Max. Mean Added Loss	2
Cyclic Flexing	TIA/EIA-455-104 IEC 60794-1-E6	0.20 dB Max. Mean Added Loss	2
Cyclic Impact	TIA/EIA-455-25 IEC 60794-1-E4	0.40 dB Max. Mean Added Loss	2
Compressive Loading	TIA/EIA-455-41 IEC 60794-1-E3	0.20 dB Max. Mean Added Loss 440 N/cm (250 lbf/in) Load	2
Twist	TIA/EIA-455-85 IEC 60794-1-E7	0.20 dB Max. Mean Added Loss	2
Low and High Temperature Bend	TIA/EIA-455-37 IEC 60794-1-E11	0.40 dB Max. Mean Added Loss	2
External Freezing	TIA/EIA-455-98 IEC 60794-1-F6	0.20 dB Max. Mean Added Loss	2
Fiber Strippability	TIA/EIA-455-178 No equiv IEC proc	≤9.0 N (2 lbf) on unaged and aged fiber ≥1.0N (0.2 lbf) on unaged and aged fiber	2
Temperature Cycling	TIA/EIA-455-3 IEC 60794-1-F1	≤ 0.5 dB/km Max Added Loss 80 % ≤ 0.25 dB/km Added Loss	2
Cable Aging	TIA/EIA-455-3 IEC 60794-1-F1	≤ 1.0 dB/km Max Added Loss 80 % ≤ 0.5 dB/km Added Loss	2
Water Penetration	TIA/EIA-455-82 IEC 60794-1-F5	No flow after one hour from one meter length of cable	1
Compound Drip	TIA/EIA-455-81 IEC 60794-1-E14	70°C, 24 hour duration, no drip	2
Sheath-to-Ground Dielectric Strength		≥ 20 kV for all armored metallic sheaths	2
Lightning Conduction	TIA/EIA-455-181 ITU-T K.25	ICEA** Category I for all armored metallic sheaths†	2

Notes: 1. Routine Requirements (RR) 2. Qualification Requirement (QR)

* OFS complies with the latest revision of the TIA/EIA Test Method (There is not exact correspondence of TIA/EIA Fiber Optic Test Procedures (FOTPs) and IEC Test Methods.)

** ICEA categories are equivalent to those of Telcordia GR-20

† Mini-LXE (Armored Drop) is Category 2; Primary RL, LXE-RL, LightPack® LXE-ME, XpressTube & AccuRibbon DC are not rated at time of spec

6.2 TYPICAL ATTENUATION CHANGES WITH TEMPERATURE

Typical changes in attenuation are significantly less than the allowable limits in Section 6.1. For reference, typical values of attenuation changes seen during combined temperature cycling and temperature aging testing (with temperatures ranging between -40°C (-40°F) and 85°C (185°F) and measurements taken at -40°C and 70°C) are given in Table . These typical values may be more useful in estimating outside plant loss budgets than using worst case limits.

Table 37: Typical Attenuation Changes for *AccuRibbon*® or *Lightpack*® Cable - Combined Temperature Cycling & Aging Tests - 40°C to 70°C (-40°F to 158°F)

Temperature	Mean Added Loss
23°C - 70°C (73°F - 158°F)	0.00 dB/km
-9°C (15°F)	0.00 dB/km
-18°C (0°F)	≤0.01 dB/km
-40°C (-40°F)	≤0.03 dB/km

6.3 SHEATH LONGITUDINAL RESISTANCE

The metallic members of armored sheathed cables are primarily provided for the mechanical characteristics of the sheath design. On occasion, these metallic members are used for electrical testing, such as applying a tone for cable location. In this application, it is useful to know the electrical resistance of the metallic members to determine how far the cable location signal will travel. The following table of sheath resistances may be used as a guide to perform electrical testing:

Table 38: Fiber Optic Cable Sheath Longitudinal Resistance (ohms/km)

	Lightpack (Fiber Count)					AccuRibbon® (Fiber Count)			
	2 -18	2 - 24	2 - 48	26 - 48	50 - 96	12 - 144	156 - 240	264 - 432	864
Cable OD (mm)								22.6	
AccuRibbon **DuctSaver**								**13.4**	
Cable OD (mm)									25.4
AccuRibbon **DuctSaver+**									**12.2**
Cable OD (mm)	9.1								
Mini-LXE (Armored Drop)	**43.8**								
Cable OD (mm)		11.4		13.0	15.5	15.5	18.0		
LXE-ME		**31.4**		**24.5**	**21.5**	**21.5**	**19.1**		
LXE-RL		**68.1**		**46.9**	**44.3**	**44.3**	**42.2**		
Cable OD (mm)			13.0					19.0	
Primary Armor			**26.3**					**13.4**	
Cable OD (mm)			10.9		13.0	13.0	15.5	19.0	
Primary RL (SS)			**49.9**		**47.2**	**47.2**	**44.3**	**41.2**	
Primary RL (Bimetal)*			**4.8**		**3.9**	**3.9**	**3.5**	**2.5**	

Table 39: Fiber Optic Cable Sheath Longitudinal Resistance (ohms/mile)

	Lightpack (Fiber Count)					AccuRibbon® (Fiber Count)			
	2 -18	2 - 24	2 - 48	26 - 48	50 - 96	12 - 144	156 - 240	264 - 432	864
Cable OD (in)								0.89	
AccuRibbon DuctSaver								**21.6**	
Cable OD (in)									1.00
AccuRibbon **DuctSaver+**									**19.6**
Cable OD (in)	0.36								
Mini-LXE (Armored Drop)	**70.5**								
Cable OD (in)		0.45		0.51	0.61	0.61	0.71		
LXE-ME		**50.5**		**39.4**	**34.6**	**34.6**	**30.7**		
LXE-RL		**109.6**		**75.5**	**71.3**	**71.3**	**67.9**		
Cable OD (in)			0.51					0.75	
Primary Armor			**42.3**					**21.6**	
Cable OD (in)			0.43		0.51	0.51	0.61	0.75	
Primary RL (SS)			**80.3**		**76.0**	**76.0**	**71.3**	**66.3**	
Primary RL (Bimetal)*			**7.7**		**6.3**	**6.3**	**5.6**	**4.0**	

* Special Order Option

7. CABLE LENGTH, MARKING, AND SHIPPING REQUIREMENTS

7.1 CABLE LENGTH AND SHEATH MARKING

The length shipped is always equal to or greater than the ordered length. Marking is available in feet or meters. All cables have sequential length markings along the cable sheath, every two feet for cables marked in feet, or every meter for cables marked in meters. The cable length may be no shorter than the marked length, but may be up to 1% greater than the marked length. If the initial cable marking (white characters) fails to meet the marking requirements, the cable is remarked. The remarking is imprinted with yellow characters on a different portion of the cable sheath. Therefore, for any cable that contains two sets of cable marking, only the yellow marking should be used.

As required by the NESC, *ANSI* C2-1993, all cables manufactured after 1993 have a visual identifier resembling a telephone handset to identify them as telecommunications/data cables.

7.2 REELS

Each fiber optic cable longer than 300 feet is shipped on a strongly constructed reel (or other appropriate container authorized by the customer). The reels are designed to prevent damage to the cable during shipment and installation. Cable lengths less than 300 feet are shipped as coils.

7.2.1 Reel Dimensions

For steel or wood reel capacities, dimensions, and weights, see Section 10.

7.2.2 Cable End Fastening

To provide access for testing, the inner end may protrude through the inside of the drum. Alternatively, on a special order basis, a partition may be securely attached to the drum to create an area between the flanges for access to the inside end. The cable ends are securely fastened so as not to protrude beyond any portion of the reel in an unprotected manner and to prevent the cable from becoming loose in transport. Partitioned reels are denoted with the suffix “L” in the fourth character of the reel code (see Section 10).

7.3 INFORMATION ACCOMPANYING THE REEL

The following information is securely attached to the reel (as a tag).

Manufacturer’s Name and Address
Customer’s Name and Address
Bar Code Information:
- Package ID
- Customer Order Number
- Customer Product ID
- Quantity

Weight of Cable & Reel
OFS Reel Number
Beginning and Ending Length Markings
Termination

7.4 PRE-SHIPMENT END SEALING AND TERMINATION

The ends of all cables are sealed to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage, and installation. Closure instructions should be followed at installation for complete sealing of the cable end.

7.4.1 Unconnectorized Cable Termination

As a standard offering, both cable ends are terminated with epoxy plugs that bond the cable core and sheath components together. The diameter of the plug is less than the cable's outside diameter. *KELLEMS* ® grips may be ordered, for factory installation over epoxy plug terminations, on one or both ends.

7.5 THERMAL WRAP FOR CABLE ON REEL

A thermal protective wrap is securely applied over the outer turns of the cable on each reel. The wrap is weather resistant and limits solar heating of the cable such that cable surface temperatures do not exceed ambient by more than 9°C (15°F) under solar radiation loading of 1000 watts per square meter in still air. The wrap is labeled "Do Not Remove Wrap Until Cable Is Placed". (This wrap may be omitted when lags or other mechanical reel protection devices are provided, since they provide the needed protection.)

8. MATERIAL REQUIREMENTS

This section covers the design requirements for the raw and prefabricated materials used in the manufacture of outside plant fiber optic cables. These are organized into three categories: Fiber Materials, Cable Core Materials, and Sheath Materials.

All materials used in fiber optic cables are non-reclaimed, are free from foreign matter consistent with good manufacturing practice, and do not degrade cable components or OFS approved connectors, closures, tapes, and other materials used with fiber optic cable. All fibers, coatings, core tubes, metallic and dielectric members, and jackets are continuous, and are free of roughness, porosity, bubbles, splits, blisters, voids, and inclusions, consistent with good manufacturing practice.

8.1 OPTICAL FIBERS

8.1.1 Core and Cladding

The optical fibers consist of a doped cylindrical core surrounded by a concentric cladding. The refractive index of the core is higher than that of the cladding. The core and the cladding of a depressed cladding single-mode fiber are separated by a deposited inner cladding. (See Section 2 for additional information.)

8.1.2 Coatings

All fibers are coated with the *D-LUX*® dual coating system, protective polymers that preserve the intrinsic strength of the fibers. The coating is removable mechanically or chemically within the operating temperature range.

8.1.3 Color Coding Inks

The color of the inks applied to fibers are clearly distinguishable from one another, and remain distinguishable after standard OFS approved fiber cleaning and end preparation for splicing.

8.2 CABLE CORES

8.2.1 Filling Compound

The filling compound is used to prevent the ingress of water into the cable core. The compound is neutral in color, nontoxic, and dermatologically safe. It is homogeneous, uniformly mixed, and contains a suitable antioxidant.

8.2.2 *AccuRibbon*® Matrix Material

The matrix material used in *AccuRibbon* units is a polymer coating which bonds the fibers in the *AccuRibbon* structure. The polymer matrix can be removed by mechanical or chemical means within the operating temperature range.

8.2.3 Core Tube Material

The core tube material is generally a plasticized polymer which is engineered for the cable design and application. The material is compounded, by the manufacturer, with a suitable antioxidant system.

8.3 SHEATHS AND OVERSHEATHS

8.3.1 Polyethylene Jacket Materials

The jacket material used in outside plant cables is black polyethylene, as specified in the sheath descriptions of Section 4 and Section 5. The jacket material contains a suitable antioxidant system and is either high density polyethylene in accordance with ASTM D 1248, Type III, Class C, Category 5, or medium density polyethylene in accordance with ASTM D 1248, Type II, Class C, Category 5. The carbon black content in the jacket when measured in accordance with ASTM D 1603 is 2.6% ± 0.25% by weight. The light absorption coefficient of the jacket is at least 400 when measured at a wavelength of 375 nm per ASTM D 3349.

These outer polyethylene jacket materials meet the tensile strength and elongation minimum requirements given below, for unaged and aged jacket samples.

Table 40: Polyethylene Jacket Requirements

Jacket Material	Minimum Tensile Strength, MPa (psi)	Minimum Elongation, %
Type I (LLDPE) Unaged	9.0 (1300)	400
Type I (LLDPE) Aged	6.7 (975)	375
Type II (MDPE) Unaged	16.5 (2400)	400
Type II (MDPE) Aged	13.8 (2000)	375
Type III (HDPE) Unaged	19.3 (2800)	400
Type III (HDPE) Aged	14.5 (2100)	375

The tensile strength and percent elongation of samples of aged and unaged cable jackets are tested in accordance with TIA/EIA-455-89A, "Fiber Optic Cable Jacket Elongation and Tensile Strength".

8.3.2 Cable Jacket Shrinkage

Cable jacket shrinkage is tested in accordance with TIA/EIA-455-86. This test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. The maximum shrinkback must be less than 5 percent for each test sample.

8.3.3 Strength Elements

The metallic sheath strength elements are spring quality music wire per ASTM A 228. The dielectric sheath strength elements are impregnated glass filaments.

8.3.4 Ripcords

Ripcords are typically provided in both armored and dielectric cable sheaths in order to provide a means for quick sheath removal. For example, there is one ripcord under the armor in the metallic LXE sheath, and two ripcords under the jacket. The ripcord material is either aramid or polyester.

8.3.5 Polymer Coated Steel Tapes

The stainless steel tape used in LXE-RL sheath, and Primary RL sheath is Type 304. The electrolytic chrome-coated steel (ECCS) used in the *AccuRibbon* DuctSaver, *AccuRibbon* DuctSaver+, LXE-ME, M- Sheath, Mini LXE, Primary Armor, XpressTube and AccuRibbon DC sheaths is per ASTM A 657. Either tape is electrically continuous. The tape coating is a polymeric adhesive capable of bonding the steel tape to the jacket.

8.3.6 Waterblocking Tapes, Yarns, and Powders

Waterblocking tapes, yarns, and/or powders are provided in all outside plant cable sheaths and introduce "dry" superabsorbent properties that swell and stop water ingress on demand. These materials operate in the full spectrum temperature range and are compatible with all sheath materials.

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9. FIBER OPTIC CABLE ORDERING CODE

9.1 HOW TO ORDER OUTSIDE PLANT CABLE

OFS's outside plant cables can be custom ordered in any length desired, up to maximum length limits (See Section 10 for maximum lengths). To order outside plant cable, specify the cable code (described below) and the required cable length. Cable length, by default, is specified in feet.

The customer specifies a particular fiber optic cable design, fiber count, and transmission parameter by a 12-character cable code. A 16-character code is required for RUS requested cable, 6 fiber (*Lightpack*) bundle configurations, and ribbon sub-units. The general format and description of the code is as follows:

Code Position:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Designator:	A	A	A	A	-	N	N	N	-	A	A	A	-	A	A	A
	↑					↑				↑				↑		
	Fiber Type and Core/Sheath Designators					Number of Fibers				Wavelength and Transmission Characteristics				Special Designators		

N = Numeric Value
A = Alpha-numeric Value

An example of a typical cable code is:

4DSX-024-BXD-FB6

This code specifies depressed cladding single-mode fiber, *Lightpack* core with LXE-Metallic sheath and no oversheath. The cable has 24 fibers with a default MIFL of 0.40 dB/km at 1310 nm and 0.30 dB/km at 1550 nm. The fibers are grouped into 6-fiber bundles.

Table 41 provides a description of each code position, the available cable code options, a description of each option, and the corresponding cable code designator.

Table 41: Outside Plant Fiber Optic Cable Code Description

Position	Description	Designator	Description
1	Fiber Design***	3	Multimode with 62.5 micron core
		4	Single-Mode, Depressed Cladding
		7	Single-Mode, Matched Cladding
		A	Single-Mode, AllWave® Fiber
		L	LaserWave™ Fiber (Multimode, 50 micron)
2	Cable Core Design	1	XpressTube™ Core
		3	AccuRibbon® DC, Dry Core, 12 fibers per ribbon
		D	Lightpack® , Filled Core
		F	*AccuRibbon* , Air Core
		G	*AccuRibbon* , Filled Core, 12 fibers per ribbon
		K	*AccuRibbon* , Filled Core, 4 fibers per ribbon
		L	*AccuRibbon* , Filled Core, 8 fibers per ribbon
		M	*AccuRibbon* , Filled Core, 6 fibers per ribbon
		R	*AccuRibbon* , Filled Core, 24 fibers per ribbon
3	Sheath Design	D	Dielectric Drop
		F	*AccuRibbon* DuctSaver (Dielectric) / Dielectric Crossply
		H	Primary RL
		L	PVC Crossply (Riser)
		M	Primary Armor (Requires RUS Designator for Lightpack Core Cables)
		N	LXE-DE
		R	LXE-RL
		S	LXE-ME
		V	Mini-LXE (Armored Drop)
		X	*AccuRibbon* TL (Outdoor/Indoor)
		Y	*AccuRibbon* DuctSaver (Metallic)
		1	Central Flex
		2	*AccuRibbon* DuctSaver+ (744 - 864-Fiber, Metallic)
		3	LXE-DE for XpressTube™ and AccuRibbon® DC
4	Oversheath Design	C	C-Oversheath (Stainless Steel)
		D	D-Oversheath (ECCS)
		X	No Oversheath
5		-	
6-8	Number of Fibers		
	—*Lightpack* Core (Mini-LXE, DE Drop)	1-18	All Fiber Counts
	—*Lightpack* Core	4-96	Fiber Count in Even Nos. Only
	—*AccuRibbon* Core , 4 fibers/ribbon	4 - 8 ◊	Fiber Counts in Multiples of 4
	—*AccuRibbon* Core, 6 fibers/ribbon	6-36	Fiber Count in Multiples of 6
	—*AccuRibbon* Core, 8 fibers/ribbon	8 - 96	Fiber Count in Multiples of 8
	—*AccuRibbon* Core, 12 fibers/ribbon	12 - 216	Fiber Count in Multiples of 12
	—*AccuRibbon DC* Core, 12 fibers/ribbon	12-216	Fiber Count in Multiples of 12
	—*AccuRibbon* Core, 24 fibers/ribbon	240 - 576, 744 - 864	Fiber Count in Multiples of 24
	—*Xpress Tube*™	12-144	Fiber Count in Multiples of 12
9		-	
10	Wavelength	B	Single-Mode, 1310/1550 nm
		C	Single-Mode *TrueWave*® RS Fibers, 1550 nm
		H	Multimode 850 nm, 1300 nm
11-12	MIFL Transmission Parameters †		
	—Single-Mode	XC	.35 dB/km at 1310 nm /.35 dB/km at 1385 nm/.25 dB/km at 1550 nm, Max
	AllWave®	XD	.40 dB/km at 1310 nm /.35 dB/km at 1385 nm/.30 dB/km at 1550 nm, Max
	—Single-Mode Depressed Cladding / Matched Cladding	XC XD	.35 dB/km at 1310 nm / .25 dB/km at 1550 nm, Max .40 dB/km at 1310 nm / .30 dB/km at 1550 nm, Max
	—Single-Mode *TrueWave*® RS***	XC	.25 dB/km at 1550 nm / .25 dB/km at 1600nm Max
	—62.5 µm Multimode	XM	3.4 dB/km, 200 MHz-km bandwidth at 850 nm 1.0 dB/km, 500 MHz-km bandwidth at 1300 nm
13		-	
14-16	RUS	RUS	Rural Utility Service (formerly Rural Electrification Administration)
	6-Fiber Bundles	FB6	Six Fiber Bundles in *Lightpack* Core
	Ribbon Sub-Units	U04	For X**L**XX only (8-fiber Ribbons Colored in Sub-Units of First 4 Colors)
		U06	For X**G**XX only (12-fiber Ribbons Colored in Sub-Units of First 6 Colors)

*** *TrueWave*® RS fibers are available on a special order basis

◊ Available only in DVX and DDX Cable Designs

† Additional Transmission Parameters are available upon request

9.2 CABLE PERFORMANCE DESIGNATORS ("MIFL")

OFS Fiber Optic Cable can be ordered by specifying the Maximum Individual Fiber Loss (MIFL). The required loss and bandwidth are specified by a Quality Designator (see format below). To order a cable, the customer specifies a Cable Code, the type of order (MIFL), and a Quality Designator.

For a cable ordered by Maximum Individual Fiber Loss (MIFL), the Quality Designator specifies the transmission performance of the individual fibers in the cable.

The format used to specify MIFL is as follows. Since attenuation can be specified in increments of 0.01 dB/km, and bandwidth in increments of 10 Megahertz-km, multiplication by 100 and division by 10 respectively are used to make the designator formats as compact as possible. Also, for uniformity, an "XXX" should be included in the designator to indicate any bandwidth or attenuation for which there is no specific requirement.

9.2.1 Multimode Cable Quality Designator Format

MIFL	**NNN**	**-**	**NNN**	**/**	**NNN**	**-**	**NNN**
	|		|		|		|
	850nm Attenuation (dB/km x 100)		| 850nm Bandwidth (MHz-km/10)		1300nm Attenuation (dB/km x 100)		| 1300nm Bandwidth (MHz-km/10)

9.2.2 Single-Mode Cable Quality Designator Format

MIFL	**NNN**	**-**	**XXX**	**/**	**NNN**	**-**	**XXX**
	|				|		
	1310 nm Attenuation (dB/km x 100)				1550 nm Attenuation (dB/km x 100)		

Note: Bandwidth is never specified for single-mode fiber.

9.2.3 Bandwidth Calculation for Multimode Fiber

The customer may determine the individual cable bandwidth requirement (62.5 µm core fiber) by using the following formulas:

@ 850 nm: $BWL = 1.3 \times BWS \times LT^{0.90}$ MHz-km

@ 1300 nm: $BWL = 1.4 \times BWS \times LT^{0.70} \times LC^{0.25}$ MHz-km

The above bandwidth formula terms are defined as follows:

BWL = Minimum bandwidth limit (MHz-km) for an individual cable.

BWS = Transmitter-to-receiver exit bandwidth (MHz) required to support the transmission system at its ultimate length.

LT = Total transmitter-to-receiver section ultimate length in kilometers.

LC = Average cable length in kilometers. The average length is LT/n, where n is the number of cables in the section. The default minimum value for LC is 0.4 km.

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10. FIBER OPTIC CABLE SHIPPING REELS

OFS's order entry system will automatically specify the smallest steel reel available for your cable order. Cable lengths less than 300 feet are normally shipped in coils (no reels). Wood reels are also available; however, they are subject to additional charges. Fiberboard is wrapped around the cable for protection; wood lagging is an option for wood reels. If you require a specific size and weight reel, please note this when ordering.

Table 42 indicates the specific reel options available. An "L" in the fourth character of the reel code indicates that the reel contains a partition.

Additional options are available for wood reels. These are indicated in the first and fourth characters of the reel code and are defined as follows:

- First character - refers to wood treatment and design for inside end protection
  - 3 = Standard, untreated reel
  - T = Treated reel
  - G = Untreated reel with circular groove cut in the outside of the inside end (ISE) slotted flange for protection of the cable ISE
  - H = Treated reel with circular groove cut in the outside of the ISE slotted flange for protection of the cable ISE
- Fourth character refers to the use of a partition and/or lagging
  - P = Reel with wood lagging
  - B = Reel with both a partition and wood lagging

Table 42: Steel and Wood Reel Options

Steel Reel	Wood Reel Option	Partitioned Steel Reel	Partitioned Wood Reel Option
413	3L3 / TL3 / GL3 / HL3 3L3P / TL3P / GL3P / HL3P	413L	3L3L / TL3L / GL3L / HL3L 3L3B / TL3B / GL3B / HL3B
414	3L4 / TL4 / GL4 / HL4 3L4P / TL4P / GL4P / HL4P	414L	3L4L / TL4L / GL4L / HL4L 3L4B / TL4B / GL4B / HL4B
415	3L5 / TL5 / GL5 / HL5 3L5P / TL5P / GL5P / HL5P	415L	3L5L / TL5L / GL5L / HL5L 3L5B / TL5B / GL5B / HL5B
416	3L6 / TL6 / GL6 / HL6 3L6P / TL6P / GL6P / HL6P	416L	3L6L / TL6L / GL6L / HL6L 3L6B / TL6B / GL6B / HL6B
417	N/A	417L	N/A
419	N/A	419L	N/A
420	3L0 / TL0 / GL0 / HL0 3L0P / TL0P / GL0P/ HL0P	420L	3L0L / TL0L / GL0L / HL0L 3L0B / TL0B / GL0B / HL0B
487	N/A	487L	N/A
488	N/A	488L	N/A
490	N/A	490L	N/A
496	N/A	496L	N/A

Table 43 and Table 44 list the dimensions and weights for steel reels.

Table 43: Standard Shipping Reel Dimensions (in) and Weights (lb) - STEEL REELS

Reel Size	Diameter (in)			Width (in)		Reel weight (lbm)	Partitioned Reel Weight (lbm)
	Overall	Drum	Arbor Hole	Overall	Between Heads		
413	48	30	$2^{11}/_{16}$	24	18	216	229
414	50	30	$2^{11}/_{16}$	$31^{3}/_{8}$	$25^{3}/_{8}$	250	263
415	56	30	$2^{11}/_{16}$	$31^{3}/_{8}$	$25^{3}/_{8}$	288	301
416	66	36	$2^{11}/_{16}$	$31^{5}/_{8}$	$25^{3}/_{8}$	360	376
417	78	42	$2^{11}/_{16}$	$32^{3}/_{8}$	$25^{3}/_{8}$	550	566
419	78	42	$2^{11}/_{16}$	37	30	635	651
420	83	42	$3^{5}/_{8}$	$46^{3}/_{4}$	$39^{3}/_{4}$	795	811
487	96	42	4	$52^{7}/_{8}$	$44^{1}/_{2}$	1400	1416
488	96	62	4	$52^{7}/_{8}$	$44^{1}/_{2}$	1523	1550
490	96	42	4	75	$65^{1}/_{2}$	1459	1475
496	96	64	4	75	$65^{1}/_{2}$	1832	1860

Table 44: Standard Shipping Reel Dimensions (mm) and Weights (kg) - STEEL REELS

Reel Size	Diameter (mm)			Width (mm)		Reel Weight (kg)	Partitioned Reel Weight (kg)
	Overall	Drum	Arbor Hole	Overall	Between Heads		
413	1219	762	68	610	457	98	104
414	1270	762	68	797	644	113	119
415	1422	762	68	797	644	131	137
416	1676	914	68	803	644	163	171
417	1981	1067	68	822	644	249	257
419	1981	1067	68	940	762	288	295
420	2108	1067	92	1187	1010	361	368
487	2438	1067	102	1343	1130	635	642
488	2438	1575	102	1343	1130	691	703
490	2438	1067	102	1905	1664	662	669
496	2438	1626	102	1905	1664	831	843

Table 45 and Table list the dimensions and weights for wood reels.

Table 45: Standard Shipping Reel Dimensions (in) and Weights (lbm) - WOOD REELS

Reel Size	Diameter (in)			Width (in)		Reel Weight (lbm)	Partitioned Reel Weight (lbm)	Additional Weight for Wood Lag (lbm)
	Overall	Drum	Arbor Hole	Overall	Between Heads			
3L3	48	30	$3^1/_2$	24	18	276	289	95
3L4	50	30	$3^1/_2$	32	26	319	332	142
3L5	56	30	$3^1/_2$	32	26	380	393	158
3L6	66	36	$3^1/_2$	32	26	511	527	188
3L1	70	35	$3^1/_2$	36	30	574	590	255
3L0	84	42	$3^1/_2$	45	39	878	894	361

Table 46: Standard Shipping Reel Dimensions (mm) and Weights (kg) - WOOD REELS

Reel Size	Diameter (mm)			Width (mm)		Reel Weight (kg)	Partitioned Reel Weight (kg)	Additional Weight for Wood Lag (kg)
	Overall	Drum	Arbor Hole	Overall	Between Heads			
3L3	1219	762	89	610	457	125	131	43
3L4	1270	762	89	813	660	145	151	64
3L5	1422	762	89	813	660	172	178	72
3L6	1676	914	89	813	660	232	239	85
3L1	1778	889	89	914	762	260	268	116
3L0	2134	1067	89	1143	991	398	406	164

Table 47 through 49 list the capacities of the available reels as well as the maximum single-mode fiber cable lengths available per sheath type. Maximum multimode fiber cable lengths are noted in Table . **Please note that the reel capacity may exceed the maximum standard cable length.**

Table 47: Steel Reel Capacities* (feet) for Mini-LXE, Dielectric Drop, DuctSaver FX and Central Flex Fiber Optic Cables

Reel Size	Cable Diameter (in)					Reel Size	Cable Diameter (in)				
	.23	0.30	0.36	0.45	0.49		.23	0.30	0.36	0.45	0.49
	Cable Length (feet)						Cable Length (feet)				
413	23197	13600	9590	5928	5124	**413L**	17881	10483	7392	4570	3950
414	39512	22720	15778	10098	8346	**414L**	33089	19026	13213	8456	6989
415		34319	23832	15253	12507	**415L**		28740	19958	12773	10474
416		47851	33365	21484	17937	**416L**		40072	27941	17991	15021
417			49126	30824	26185	**417L**			39204	24599	20896
419			58080	36442	30957	**419L**			48158	30217	25669
420			76956	48286	41019	**420L**			67034	42061	35731
487			150286	95181	79744	**487L**			132978	84219	70560

Table 48: Wood Reel Capacities* (feet) for Mini-LXE, Dielectric Drop, DuctSaver FX and Central Flex Fiber Optic Cables

Reel Size	Cable Diameter (in)					Reel Size	Cable Diameter (in)				
	.23	0.30	0.36	0.45	0.49		.23	0.30	0.36	0.45	0.49
	Cable Length (feet)						Cable Length (feet)				
3L3	21538	12384	8600	5504	4739	**3L3L**	16602	9546	6629	4243	3653
3L4	36956	21441	14677	9700	7970	**3L4L**	31093	18040	12349	8161	6706
3L5		33081	22743	14335	12152	**3L5L**		27833	19135	12061	10224
3L6		46548	32188	20468	17584	**3L6L**		39163	27081	17221	14795
3L1			46142	29845	25245	**3L1L**			38260	24747	20932
3L0			91113	58065	48787	**3L0L**			79140	50435	42376

***Reel capacity may exceed Maximum Cable Length: see** Table **49 for maximum cable lengths.**

Table 49: Maximum Cable Lengths (feet) for Central Flex, Dielectric Drop, DuctSaver FX and Mini-LXE Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	# of SM Fibers	Cable Diameter (in)			
				0.30	0.36	0.45	0.49
D1X	Central Flex	Lightpack®	2 - 24			92000	
			26 - 48				77000
DDX	Dielectric Drop	Lightpack	2 - 18	40000			
DVX	Mini-LXE	Lightpack	2 - 18		95000		
KDX	Dielectric Drop	4-Fiber AccuRibbon®	4, 8	40000			
MDX	Dielectric Drop	6-Fiber AccuRibbon	6, 12	40000			
KVX	Mini-LXE	4-Fiber AccuRibbon	48		40000		
M4X	DuctSaver FX	6-fiber AccuRibbon	48	30000			
MVX	Mini-LXE	6-Fiber AccuRibbon	6,12		40000		

Table 50: Steel Reel Capacities* (meters) for Mini-LXE, Dielectric Drop, DuctSaver FX and Central Flex Fiber Optic Cables

Reel Size	Cable Diameter (mm)					Reel Size	Cable Diameter (mm)				
	5.8	7.6	9.1	11.4	12.4		5.8	7.6	9.1	11.4	
	Cable Length (meters)						Cable Length (meters)				
413	7070	4145	2923	1807	1562	**413L**	5450	3195	2253	1393	1204
414	12043	6925	4809	3078	2544	**414L**	10086	5799	4027	2577	2130
415		10460	7264	4649	3812	**415L**		8760	6083	3893	3192
416		14585	10170	6548	5467	**416L**		12214	8516	5484	4578
417			14974	9395	7981	**417L**			11949	7498	6369
419			17702	11107	9435	**419L**			14678	9210	7824
420			23455	14717	12502	**420L**			20431	12819	10891
487			45807	29011	24306	**487L**			40532	25670	21507

Table 51: Wood Reel Capacities* (meters) for Mini-LXE, Dielectric Drop, DuctSaver FX and Central Flex Fiber Optic Cables

Reel Size	Cable Diameter (mm)					Reel Size	Cable Diameter (mm)				
	5.8	7.6	9.1	11.4	12.4		5.8	7.6	9.1	11.4	12.4
	Cable Length (meters)						Cable Length (meters)				
3L3	6564	3775	2621	1678	1444	**3L3L**	5060	2910	2020	1293	1113
3L4	11154	6535	4473	2956	2429	**3L4L**	9477	5498	3764	2487	2044
3L5		10083	6932	4369	3704	**3L5L**		8483	5832	3676	3116
3L6		14188	9810	6238	5359	**3L6L**		11936	8254	5249	4509
3L1			14063	9096	7694	**3L1L**			11662	7543	6380
3L0			27770	17697	14870	**3L0L**			24121	15372	12916

*** Reel capacity may exceed Maximum Cable Length: see Table 52 for maximum cable lengths.**

Table 52: Maximum Cable Lengths (km) for Central Flex, Dielectric Drop and Mini-LXE Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	# of SM Fibers	Cable Diameter (mm)				
				5.8	7.6	9.1	11.4	12.4
D1X	Central Flex	Lightpack®	2 - 24				28.0	
			26 - 48					23.5
DDX	Dielectric Drop	Lightpack	2 - 18		12.2			
DVX	Mini-LXE	Lightpack	2 - 18			29.0		
KDX	Dielectric Drop	4-Fiber AccuRibbon®	4, 8		12.2			
MDX	Dielectric Drop	6-Fiber AccuRibbon	6, 12		12.2			
KVX	Mini-LXE	4-Fiber AccuRibbon	48			12.2		
M4X	DuctSaver FX	6-Fiber AccuRibbon	48	9.1				
MVX	Mini-LXE	6-Fiber AccuRibbon	6,12			12.2		

Table 53: Steel Reel Capacities* (feet) for LXE Fiber Optic Cables

Reel Size	Cable Diameter (in) 0.45	0.51	0.61	0.71	Reel Size	Cable Diameter (in) 0.45	0.51	0.61	0.71
	Cable Length (feet)					Cable Length (feet)			
413	5928	4615	3344		**413L**	4570	3558	2578	
414	10098	7573	5214		**414L**	8456	6342	4367	
415	15253	11536	8037		**415L**	12773	9661	6731	
416	21484	16659	11526		**416L**	17991	13950	9653	
417	30824	24478	17054	12210	**417L**	24599	19534	13610	9744
419	36442	28940	20163	14436	**419L**	30217	23996	16718	11970
420	48286	38345	26716	19127	**420L**	42061	33401	23271	16661
487	95181	73670	51738	38101	**487L**	84219	65185	45779	33712
490**		108435	76153	56081			99951	70194	51693

** Special handling equipment may be required for 490 Reels

Table 54: Wood Reel Capacities* (feet) for LXE Fiber Optic Cables

Reel Size	Cable Diameter (in) 0.45	0.51	0.61	0.71	Reel Size	Cable Diameter (in) 0.45	0.51	0.61	0.71
	Cable Length (feet)					Cable Length (feet)			
3L3	5504	4249	3045		**3L3L**	4243	3276	2347	
3L4	9700	7207	5272		**3L4L**	8161	6064	4436	
3L5	14335	11189	7728		**3L5L**	12061	9414	6502	
3L6	20468	16312	11203		**3L6L**	17221	13724	9425	
3L1	29845	22869	16223		**3L1L**	24747	18962	13452	
3L0	58065	44694	30987	22708	**3L0L**	50435	38820	26915	19724

*** Reel capacity may exceed Maximum Cable Length: see Table 55 for maximum cable lengths.**

Table 55: Maximum Cable Lengths (feet) for LXE Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of Single-Mode Fibers	Cable Diameter (in)						
				0.45	0.51		0.61		0.71	
					487 Reel	490 Reel*	487 Reel	490 Reel*	487 Reel	490 Reel*
13X	LXE-DE	XpressTube™	24-48 60-96 108-144		20000		20000		20000	
1SX	LXE-ME	XpressTube™	24-48 60-96 108-144		20000		20000		20000	
33X	LXE-DE	12-fiber AccuRibbon® DC	12-48 60-144 156-216		41000		41000		35000	41000
3SX	LXE-ME	12-fiber AccuRibbon® DC	12-48 60-144 156-216		41000		41000		35000	41000
D3X	LXE-DE	Lightpack®	2-48 50-96		72000	95000	50000	68550		
DNX	LXE-DE	Lightpack®	2 - 48		72000	95000				
			50 - 96				50000	68550		
DRX	LXE-RL	Lightpack	2 -24	92000						
			26 - 48		72000	95000				
			50 - 96				50000	68550		
DSX	LXE-ME	Lightpack	2 - 24	92000						
			26 - 48		72000	95000				
			50 - 96				50000	68550		
G3X	LXE-DE	12-Fiber AccuRibbon®	12-48 60-144 156-216		41000		41000		35000	41000
R3X		24-Fiber AccuRibbon	240						35000	45000
GNX	LXE-DE	12-Fiber AccuRibbon®	12-48		41000					
			60- 144				41000			
			156 - 216						35000	41000
RNX		24-Fiber AccuRibbon	240						35000	45000
GRX	LXE-RL	12-Fiber AccuRibbon®	12-48		41000					
			60- 144				41000			
			156 - 216						35000	41000
RRX		24-Fiber AccuRibbon	240						35000	45000
GSX	LXE-ME	12-Fiber AccuRibbon®	12-48		41000					
			60- 144				41000			
			156 - 216						35000	41000
RSX		24-Fiber AccuRibbon	240						35000	45000

Table 56: Steel Reel Capacities* (meters) for LXE Fiber Optic Cables

Reel Size	Cable Diameter (mm) 11.4	13.0	15.5	18.0	Reel Size	Cable Diameter (mm) 11.4	13.0	15.5	18.0
	Cable Length (meters)					Cable Length (meters)			
413	1807	1407	1019		**413L**	1393	1084	786	
414	3078	2308	1589		**414L**	2577	1933	1331	
415	4649	3516	2450		**415L**	3893	2945	2052	
416	6548	5078	3513		**416L**	5484	4252	2942	
417	9395	7461	5198	3722	**417L**	7498	5954	4148	2970
419	11107	8820	6145	4400	**419L**	9210	7314	5096	3648
420	14717	11687	8143	5830	**420L**	12819	10180	7093	5078
487	29011	22455	15770	11613	**487L**	25670	19868	13953	10275
490**		33051	23211	17093			30465	21395	15756

** Special handling equipment may be required for 490 Reels

Table 57: Wood Reel Capacities* (meters) for LXE Fiber Optic Cables

Reel Size	Cable Diameter (mm) 11.4	13.0	15.5	18.0	Reel Size	Cable Diameter (mm) 11.4	13.0	15.5	18.0
	Cable Length (meters)					Cable Length (meters)			
3L3	1678	1295	928		**3L3L**	1293	998	715	
3L4	2956	2197	1607		**3L4L**	2487	1848	1352	
3L5	4369	3410	2355		**3L5L**	3676	2869	1982	
3L6	6238	4972	3414		**3L6L**	5249	4183	2873	
3L1	9096	6970	4945		**3L1L**	7543	5780	4100	
3L0	17697	13622	9444	6921	**3L0L**	15372	11832	8203	6011

*** Reel capacity may exceed Maximum Cable Length: see**

Table **for maximum cable lengths.**

Table 58: Maximum Cable Lengths (km) for LXE Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of Single-Mode Fibers	Cable Diameter (mm)						
				11.4	13.0		15.5		18.0	
					487 Reel	490 Reel	487 Reel	490 Reel*	487 Reel	490 Reel*
13X	LXE-DE	XpressTube™	24-48 60-96 108-144		6.1		6.1		6.1	
1SX	LXE-ME	XpressTube™	24-48 60-96 108-144		6.1		6.1		6.1	
33X	LXE-DE	12-fiber AccuRibbon® DC	12-48 60-144 156-216		12.5		12.5		10.7	12.5
3SX	LXE-ME	12-fiber AccuRibbon® DC	12-48 60-144 156-216		12.5		12.5		10.7	12.5
D3X	LXE-DE	Lightpack®	2-48 50-96		22.0	29.0	15.2	20.9		
DNX	LXE-DE	Lightpack®	2 - 48		22.0	29.0				
			50 - 96				15.2	20.9		
DRX	LXE-RL	Lightpack	2 -24	28.0						
			26 - 48		22.0	29.0				
			50 - 96				15.2	20.9		
DSX	LXE-ME	Lightpack	2 - 24	28.0						
			26 - 48		22.0	29.0				
			50 - 96				15.2	20.9		
G3X	LXE-DE	12-Fiber AccuRibbon®	12-48 60-144 156-216		12.5		12.5		10.7	12.5
R3X		24-Fiber AccuRibbon	240						10.7	13.7
GNX	LXE-DE	12-Fiber AccuRibbon®	12-48		12.5					
			60- 144				12.5			
			156 - 216						10.7	12.5
RNX		24-Fiber AccuRibbon	240						10.7	13.7
GRX	LXE-RL	12-Fiber AccuRibbon®	12-48		12.5					
			60- 144				12.5			
			156 - 216						10.7	12.5
RRX		24-Fiber AccuRibbon	240						10.7	13.7
GSX	LXE-ME	12-Fiber AccuRibbon®	12-48		12.5					
			60- 144				12.5			
			156 - 216						10.7	12.5
RSX		24-Fiber AccuRibbon	240						10.7	13.7

Table 59: Steel Reel Capacities* (feet) for Primary Armor, and Primary RL Fiber Optic Cables

Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.78	Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.78
	Cable Length (feet)					Cable Length (feet)			
413	6569	4615	3344		**413L**	5063	3558	2578	
414	11096	7573	5214		**414L**	9291	6342	4367	
415	16532	11536	8037		**415L**	13844	9661	6731	
416	23165	16659	11523		**416L**	19399	13950	9653	
417	33871	24478	17054	10225	**417L**	27030	19534	13610	8160
419	40044	28940	20163	12089	**419L**	33203	23996	16718	10024
420	53059	38345	26716	16018	**420L**	46218	33401	23271	13953
487		73670	51738	31791	**487L**	92775	65185	45779	28130
488				20029					17722
490**				46794					43132
496**				26557					24479

** Special handling equipment may be required for 490 and 496 Reels

Table 60: Wood Reel Capacities* (feet) for Primary Armor, and Primary RL Fiber Optic Cables

Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.78	Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.78
	Cable Length (feet)					Cable Length (feet)			
3L3	6120	4249	3045		**3L3L**	4718	3276	2347	
3L4	10151	7207	5272		**3L4L**	8540	6064	4436	
3L5	16156	11189	7728		**3L5L**	13593	9414	6502	
3L6	22802	16312	11203		**3L6L**	19184	13724	9425	
3L1	32877	22869	16223		**3L1L**	27261	18962	13451	
3L0	63352	44694	30987	19244	**3L0L**	55027	38820	26915	16715

*** Reel capacity may exceed Maximum Cable Length: see** Table **61 for maximum cable lengths.**

Table 61: Maximum Cable Lengths (feet) for Primary Armor, and Primary RL Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of Single-Mode Fibers	Cable Diameter (in) 0.43	0.51	0.61	0.78 487 Reel	0.78 490 Reel*	0.78 488 Reel	0.78 496 Reel*
DHX	Primary RL	Lightpack®	2 - 48	51000						
			50 - 96		51000					
DMX	Primary Armor	Lightpack	2-48		51000					
GHX	Primary RL	12-Fiber AccuRibbon®	12 - 144		41000					
			156 - 216			41000				
RHX	Primary RL	24-Fiber AccuRibbon	240			45000				
			264 - 480				31500	44000		
			504 - 576						20000	26500
RMX	Primary Armor	24-Fiber AccuRibbon	264 - 480				31500	44000		
			504 - 576						20000	26500

Table 62: Steel Reel Capacities* (meters) for Primary Armor, and Primary RL Fiber Optic Cables

Reel Size	Cable Diameter (mm) 10.9	13.0	15.5	19.8	Reel Size	Cable Diameter (mm) 10.9	13.0	15.5	19.8
	Cable Length (meters)					Cable Length (meters)			
413	2002	1407	1019		**413L**	1543	1084	786	
414	3382	2308	1589		**414L**	2832	1933	1331	
415	5039	3516	2450		**415L**	4220	2945	2052	
416	7061	5078	3513		**416L**	5913	4252	2942	
417	10324	7461	5198	3117	**417L**	8239	5954	4148	2487
419	12205	8820	6145	3685	**419L**	10120	7314	5096	3055
420	16172	11687	8143	4882	**420L**	14087	10180	7093	4253
487		22455	15770	9690	**487L**	28278	19868	13953	8574
488				6105					5402
490**				14263					13147
496**				8095					7461

** Special handling equipment may be required for 490 and 496 Reels

Table 63: Wood Reel Capacities* (meters) for Primary Armor, and Primary RL Fiber Optic Cables

Reel Size	Cable Diameter (mm) 10.9	13.0	15.5	19.8	Reel Size	Cable Diameter (mm) 10.9	13.0	15.5	19.8
	Cable Length (meters)					Cable Length (meters)			
3L3	1865	1295	928		**3L3L**	1438	998	715	
3L4	3094	2197	1607		**3L4L**	2603	1848	1352	
3L5	4924	3410	2355		**3L5L**	4143	2869	1982	
3L6	6950	4972	3414		**3L6L**	5847	4183	2873	
3L1	10020	6970	4945		**3L1L**	8309	5780	4100	
3L0	19309	13622	9444	5866	**3L0L**	16771	11832	8203	5094

*** Reel capacity may exceed Maximum Cable Length: see** Table **64 for maximum cable lengths.**

Table 64: Maximum Cable Lengths (km) for Primary Armor, and Primary RL Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of Single-Mode Fibers	Cable Diameter (mm) 10.9	13.0	15.5	19.0 487 Reel	19.0 490 Reel*	19.0 488 Reel	19.0 496 Reel*
DHX	Primary RL	Lightpack®	2 - 48	15.5						
			50 - 96		15.5					
DMX	Primary Armor	Lightpack	2-48		15.5					
GHX	Primary RL	12-Fiber AccuRibbon®	12 - 144		12.5					
			156 - 216			12.5				
RHX	Primary RL	24-Fiber AccuRibbon	240			13.7				
			264 - 480				9.6	13.4		
			504 - 576						6.1	8.1
RMX	Primary Armor	24-Fiber AccuRibbon	264 - 480				9.6	13.4		
			504 - 576						6.1	8.1

Table 65: Steel Reel Capacities* (feet) for Dielectric Crossply, *AccuRibbon* DuctSaver, & DuctSaver+ FO Cables

Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.75	0.89	0.96	1.00	Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.75	0.89	0.96/1.00
	Cable Length (feet)								Cable Length (feet)					
413	6569	4615	3344					**413L**	5063	3558	2578			
414	11096	7573	5214					**414L**	9291	6342	4367			
415	16532	11536	8037					**415L**	13844	9661	6731			
416	23165	16659	11526					**416L**	19399	13950	9653			
417	33871	24478	17054	11097	7793			**417L**	27030	19534	13610	8855	6218	
419	40044	28940	20163	13119	9213			**419L**	33203	23996	16718	10878	7639	
420		38345	26716	17383	12207			**420L**	46218	33401	23271	15142	10633	
487		73670	51738	34065	24485			**487L**		65185	45780	30142	21665	11200/10750
488				21988	15603	12657	12151					19455	13806	
490**				50140	36039							46217	33220	
496**				29346	20365	17532	16831					27050	18772	16160/15514

** Special handling equipment may be required for 490 and 496 Reels

Table 66: Wood Reel Capacities* (feet) for Dielectric Crossply, *AccuRibbon* DuctSaver & DuctSaver+ FO Cables

Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.75	0.89	0.96/1.00	Reel Size	Cable Diameter (in) 0.43	0.51	0.61	0.75	0.89	0.96/1.00
	Cable Length (feet)							Cable Length (feet)					
3L3	6120	4249	3045				**3L3L**	4718	3276	2347			
3L4	10151	7207	5272				**3L4L**	8540	6064	4436			
3L5	16156	11189	7728				**3L5L**	13593	9414	6502			
3L6	22802	16312	11203				**3L6L**	19184	13724	9425			
3L1	32877	22869	16223				**3L1L**	27261	18962	13452			
3L0	63352	44694	30987	20755	14367		**3L0L**	55027	38820	26915	18028	12479	

*** Reel capacity may exceed Maximum Cable Length: see** Table **67 and** Table **68 for maximum cable lengths.**

Table 67: Maximum Cable Lengths (feet) for Dielectric Crossply Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	# of SM Fibers	Cable Diameter (in) 0.43	0.51	0.61
DFX	Dielectric Crossply	Lightpack®	2 - 48	40000		
			50 - 96		40000	
GFX	Dielectric Crossply	12-Fiber AccuRibbon®	12 - 144		40000	
			156 - 216			40000
RFX		24-Fiber AccuRibbon	240			40000

Table 68: Maximum Cable Lengths (feet) for *AccuRibbon* DuctSaver, & DuctSaver+ Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of SM Fibers	Cable Diameter (in) 0.75 487 Reel	0.75 488 Reel	0.75 496 Reel*	0.89 487 Reel	0.89 490 Reel*	0.89 488 Reel	0.89 496 Reel*	0.96 488 Reel	0.96 496 Reel*	1.0 488 Reel	1.0 496 Reel*
RFX	DE DuctSaver	24-Fiber AccuRibbon®	264 - 480	32500										
			504 - 576		21000	29000								
			744 - 864								11500	16000		
RYD	ME DuctSaver	24-Fiber AccuRibbon	264 - 480				24000							
			504 - 576						15000	20000				
R2X	DuctSaver+	24-Fiber AccuRibbon	744 - 864										11500	16000

Table 69: Steel Reel Capacities* (meters) for Dielectric Crossply, *AccuRibbon* DuctSaver,&DuctSaver+ FO Cables

Reel Size	Cable Diameter (mm)							Reel Size	Cable Diameter (mm)					
	10.9	13.0	15.5	19.0	22.6	24.4	25.4		10.9	13.0	15.5	19.0	22.6	24.4/25.4
	Cable Length (meters)								Cable Length (meters)					
413	2002	1407	1019					**413L**	1543	1084	786			
414	3382	2308	1589					**414L**	2832	1933	1331			
415	5039	3516	2450					**415L**	4220	2945	2052			
416	7061	5078	3513					**416L**	5913	4252	2942			
417	10324	7461	5198	3382	2375			**417L**	8239	5954	4148	2699	1895	
419	12205	8820	6145	3999	2808			**419L**	10120	7314	5096	3315	2328	
420		11688	8143	5298	3721			**420L**	14087	10180	7093	4615	3241	
487		22455	15770	10383	7463			**487L**		19868	13953	9187	6603	
488				6702	4756	3858	3704					5930	4208	3414/3277
490**				15283	10985							14087	10125	
496**				8945	6207	5344	5130					8245	5722	4926/4729

* Special handling equipment may be required for 490 and 496 Reels

Table 70: Wood Reel Capacities*(meters) for Dielectric Crossply, *AccuRibbon* DuctSaver,&DuctSaver+ FO Cables

Reel Size	Cable Diameter (mm)						Reel Size	Cable Diameter (mm)					
	10.9	13.0	15.5	19.0	22.6	24.4/25.4		10.9	13.0	15.5	19.0	22.6	24.4/25.4
	Cable Length (meters)							Cable Length (meters)					
3L3	1865	1295	928				**3L3L**	1438	998	715			
3L4	3094	2197	1607				**3L4L**	2603	1848	1352			
3L5	4924	3410	2355				**3L5L**	4143	2869	1982			
3L6	6950	4972	3414				**3L6L**	5847	4183	2873			
3L1	10020	6970	4945				**3L1L**	8309	5780	4100			
3L0	19310	13622	9444	6326	4379		**3L0L**	16772	11832	8203	5495	3803	

*** Reel capacity may exceed Maximum Cable Length: see** Table **71 and** Table **72 for maximum cable lengths.**

Table 71: Maximum Cable Lengths (km) for Dielectric Crossply Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	# of SM Fibers	Cable Diameter (mm)		
				10.9	13.0	15.5
DFX	Dielectric Crossply	Lightpack®	2 - 48	12.2		
			50 - 96		12.2	
GFX	Dielectric Crossply	12-Fiber AccuRibbon®	12 - 144		12.2	
			156 - 216			12.2
RFX		24-Fiber AccuRibbon	240			12.2

Table 72: Maximum Cable Lengths (km) for *AccuRibbon* DuctSaver, & DuctSaver+ Fiber Optic Cables

Sheath Type	Sheath Description	Core Type	Number of SM Fibers	Cable Diameter (mm)										
				19.0			22.6				24.4		25.4	
				487 Reel	488 Reel	496 Reel*	487 Reel	490 Reel*	488 Reel	496 Reel*	488 Reel	496 Reel*	488 Reel	496 Reel*
RFX	DE DuctSaver	24-Fiber AccuRibbon®	264 - 480	9.9										
			504 - 576		6.4	8.8								
			744 - 864								3.5	4.9		
RYD	ME DuctSaver	24-Fiber AccuRibbon	264 - 480				7.3							
			504 - 576						4.6	6.1				
R2X	DuctSaver+	24-Fiber AccuRibbon	744 - 864										3.5	4.9

Table 73: Maximum Multimode Fiber Optic Cable Lengths

Sheath Type	Core	Description	Maximum Length	
			Feet	Km
D1X	*Lightpack*®	Central Flex	27559	8.4
DDX	*Lightpack*	Dielectric Drop	27559	8.4
DFX	*Lightpack*	Dielectric Crossply	27559	8.4
DHX	*Lightpack*	H-Sheath	27559	8.4
DNX	*Lightpack*	LXE-DE	27559	8.4
DRX	*Lightpack*	LXE-RL	27559	8.4
DSX	*Lightpack*	LXE-ME	27559	8.4
DVX	*Lightpack*	Mini-LXE	27559	8.4
GFX	12-f *AccuRibbon*®	Dielectric Crossply	27559	8.4
GHX	12-f *AccuRibbon*	H-Sheath	27559	8.4
GNX	12-f *AccuRibbon*	LXE-DE	27559	8.4
GRX	12-f *AccuRibbon*	LXE-RL	27559	8.4
GSX	12-f *AccuRibbon*	LXE-ME	27559	8.4

11. EXTERNAL REFERENCES

ASTM A 228	*Standard Specification for Steel Wire, Music Spring Quality*
ASTM A 640	*Standard Specification for Zinc-Coated Steel Strand for Messenger Support of Figure-8 Cable*
ASTM A 657	*Standard Specification for Tin Mill Products, Black Plate Electrolytic Chromium-Coated, Single and Double Reduced (R 1992)*
ASTM D 1248	*Standard Specification for Polyethylene Plastics Molding and Extrusion Materials*
ASTM D 1603	*Standard Test Method for Carbon Black in Olefin Plastics*
ASTM D 1765	*Standard Classification System for Carbon Blacks Used in Rubber Products*
ASTM D 3349	*Standard Test Method for Absorption Coefficient of Carbon Black Pigmented Ethylene Plastic*
ASTM E 29	*Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*
Bellcore (currently Telcordia) GR-20-CORE	*Issue 2, July 1998* *Generic Requirements for Optical Fiber and Fiber Optic Cable*
ICEA S-87-640-2000	*Standard for Optical Fiber Outside Plant Communications Cable*
TIA/EIA-455-3	*Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components*
TIA/EIA-455-24	*Water Peak Attenuation Measurement of Single-Mode Fibers*
TIA/EIA-455-25	*Impact Testing of Fiber Optic Cables and Cable Assemblies*
TIA/EIA-455-28	*Method for Measuring Dynamic Tensile Strength of Optical Fibers*
TIA/EIA-455-29	*Refractive Index Profile Transverse Interference Method*
TIA/EIA-455-30	*Frequency Domain Measurement of Multimode Optical Fibers Information Transmission Capability*
TIA/EIA-455-31	*Fiber Tensile Proof Test Method*
TIA/EIA-455-33	*Fiber Optic Cable Tensile Loading and Bending Test*
TIA/EIA-455-37	*Low or High Temperature Bend Test for Fiber Optic Cable*
TIA/EIA-455-41	*Compressive Loading Resistance of Fiber Optic Cable*
TIA/EIA-455-46	*Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers*
TIA/EIA-455-47	*Output Far-Field Radiation Pattern Measurement*
TIA/EIA-455-51	*Pulse Distortion Measurement of Multimode Glass Optical Fibers Information Transmission Capacity*
TIA/EIA-455-58	*Core Diameter Measurement of Graded-Index Optical Fibers*
TIA/EIA-455-59	*Measurement of Fiber Point Discontinuities Using an OTDR*
TIA/EIA-455-61	*Measurement of Fiber or Cable Attenuation Using an OTDR*
TIA/EIA-455-62	*Measurement of Optical Fiber Macrobend Attenuation*
TIA/EIA-455-76	*Method for Measuring Dynamic Fatigue of Optical Fibers by Tension*
TIA/EIA-455-78	*Spectral Attenuation Cutback Measurement for Single-Mode Optical Fibers*
TIA/EIA-455-80	*Measuring Cutoff Wavelength of Uncabled Single-Mode Fiber by Transmitted Power*
TIA/EIA-455-81	*Compound Flow (Drip) Test for Filled Fiber Optic Cable*
TIA/EIA-455-82	*Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable*
TIA/EIA-455-85	*Fiber Optic Cable Twist Test*
TIA/EIA-455-86	*Fiber Optic Cable Jacket Shrinkage*
TIA/EIA-455-89	*Fiber Optic Cable Jacket Elongation and Tensile Strength*
TIA/EIA-455-97	*Procedure for Measuring Static Fatigue of Optical Fibers in Two-Point Bending*
TIA/EIA-455-98	*Fiber Optic Cable External Freezing Test*
TIA/EIA-455-104	*Fiber Optic Cable Cyclic Flexing Test*
TIA/EIA-455-111	*Procedure for the Measurement of Optical Fiber Curl*
TIA/EIA-455-113	*Polarization-Mode Dispersion Measurement for Single-Mode Optical Fibers by Wavelength Scanning*

TIA/EIA-455-122	*Polarization-Mode Dispersion Measurement for Single-Mode Optical Fibers by Jones Matrix Eigenanalysis*
TIA/EIA-455-124	*Polarization-Mode Dispersion Measurement for Single-Mode Optical Fibers by Interferometric Method*
TIA/EIA-455-141	*Twist Test for Optical Fiber Ribbons*
TIA/EIA-455-164	*Single-Mode Fiber, Measurement of Mode Field Diameter by Far-Field Scanning*
EIA/EIA-455-167	*Mode Field Diameter Measurement - Variable Aperture Method in the Far Field*
TIA/EIA-455-168	*Chromatic Dispersion Measurement of Multimode Graded-Index and Single-Mode Optical Fibers by Spectral Group Delay Measurement in the Time Domain*
TIA/EIA-455-170	*Cable Cutoff Wavelength of Single-Mode Fiber by Transmitted Power*
TIA/EIA-455-173	*Coating Geometry Measurements, Side View*
TIA/EIA-455-175	*Chromatic Dispersion Measurement of Single-Mode Optical Fibers by the Differential Phase Shift Method*
TIA/EIA-455-176	*Method for Measuring Optical Fiber Cross-Sectional Geometry by Automated Grey-Scale Analysis*
TIA/EIA-455-177	*Numerical Aperture Measurement of Graded-Index Optical Fibers*
TIA/EIA-455-178	*Measurements of Strip Force Required for Mechanically Removing Coatings from Optical Fibers*
TIA/EIA-455-181	*Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components*
TIA TSB-62-9 (ITM 9)	*Method for Evaluating Optical Fiber Ribbon Strip Performance*
IEC 60793-1	*International Standard (Optical Fibers) - Part 1: Generic Specification*
--A1A	*Refractive Index Profile*
--A2	*Near Field Light Distribution*
--B1	*Optical Fiber Prooftest*
--B2A	*Tensile Strength for short lengths of optical fibres*
--B2B	*Tensile Strength for long lengths of optical fibres*
--B6	*Strippability*
--B7A	*Dynamic fatigue parameters of optical fibres by axial tension*
--B7D	*Static fatigue parameters of optical fibres by two-point bending*
--B8A	*Fiber Curl*
--C1A	*Cut-back Technique*
--C1C	*Insertion Loss Technique*
--C2A	*Impulse response*
--C5C	*Chromatic Dispersion Measurement of Optical Fibers by the Differential Phase Shift Method*
--C7B	*Cable Cut-off Wavelength Measurement of Single-Mode Fibre*
--C9A	*Mode Field Diameter Measurement Direct Far-Field Scanning Method*
--C9B	*Mode Field Diameter Measurement - Variable Aperture Method in the Far-Field*
--C11	*Macrobending Sensitivity*
IEC 60794-1	*International Standard (Fiber Optic Cables) - Part 1: Generic Specification*
--E1	*Tensile Performance*
--E3	*Crush*
--E4	*Impact*
--E6	*Repeated Bending*
--E7	*Torsion*
--E11	*Cable Bend*
--E14	*Compound Flow (drip)*
--F1	*Temperature Cycling*
--F5	*Water Penetration*
--F6	*Freezing*

12. GLOSSARY

°C	-	Degrees Celsius
°F	-	Degrees Fahrenheit
µm	-	Micron
ANSI	-	American National Standards Institute
ASTM	-	American Society for Testing and Maintenance
dB	-	Decibels
dB/km	-	Decibels per Kilometer
DE	-	Dielectric
DWDM	-	Dense Wavelength Division Multiplexing
ECCS	-	Electrolytic Chrome Coated Steel
EDFA	-	Erbium-Doped Fiber Amplifiers
EIA	-	Electronic Industries Association
ft	-	Feet
Gb	-	Gigabits
GPa	-	GigaPascal
HDPE	-	High Density Polyethylene
IEC	-	International Electrotechnical Commission
in	-	Inches
IOR	-	Index of Refraction
ITU	-	International Telecommunications Union
kg	-	Kilograms
km	-	Kilometers
kpsi	-	Thousand Pounds pre Square Inch
lb	-	Pounds
lbf	-	Pounds-force
lbm	-	Pounds-Mass
LLDPE	-	Linear Low Density Polyethylene
LXE	-	Lightguide Express Entry
m	-	Meters
Mb	-	Megabits
MDPE	-	Medium Density Polyethylene
ME	-	Metallic
MHz-km	-	MegaHertz-kilometer
MIFL	-	Maximum Individual Fiber Loss
mm	-	Millimeters
N	-	Newtons
NEC	-	National Electric Code
NESC	-	National Electrical Standards Committee
nm	-	Nanometers
OTDR	-	Optical Time Domain Reflectometer
PMD	-	Polarization Mode Dispersion
ps	-	Picoseconds
psi	-	Pounds per Square Inch
PVC	-	Polyvinyl Chloride
RL	-	Rodent-Lightning
RUS	-	Rural Utilities Service (formerly REA - Rural Electrification Administration)
TIA	-	Telecommunications Industry Association
UBL	-	Ultimate Breaking Load
UL	-	Underwriters Laboratories
WDM	-	Wavelength Division Multiplexing

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13. INDEX