Specification NO: RENKA/OFC/SM-DI/AR DEC 2000

SINGLE MODE OPTICAL FIBER CABLE

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1.0 INTRODUCTION TO RENKA SINGLE MODE OPTICAL FIBER CABLE

This document describes the Renka specifications for Single Mode Optical Fiber Cables, Dielectric and Armored.

Renka Single Mode Optical Fiber Cables are constructed with Dispersion Unshifted Single Mode Optical Fibers, with a matched cladding. Matched clad fibers feature a dual UV curable acrylate coating system that provides unparalleled performance in a wide range of environmental conditions. The advantage to this coating structure is the 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 strippable using mechanical methods.

Each fiber is proof-tested to 100kpsi, which ensures 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 (Bellcore, EIA/TIA, IEC, etc.) Excellent control of fiber geometry permits low loss splicing using either mechanical or fusion techniques. Only fusion splicing is to be performed in accordance with this specification. In addition, all Single Mode Fibers are manufactured to meet low polarization mode dispersion (PMD) specifications.

2.0 FIBER SPECIFICATIONS FOR SM OFC

2.1 The dispersion unshifted single mode fiber utilized in the cable is made to the following specifications:

2.1.1 Typical Core Diameter: 8.3µm

2.1.2 Cladding Diameter: 125.0 ± 1µm

2.1.3 Core-to-Cladding Offset: ≤0.8µm

2.1.4 Cladding Non-Circularity: ≤1% *[1–(min cladding dia / max cladding dia)]*100*

2.1.5 Coating Diameter: 245 ± 10µm

2.1.6 Colored Fiber Diameter: Nominal 250µm

2.1.7 Cutoff Wavelength: The cabled fiber cutoff wavelength is less than 1260nm.

2.1.8 Mode-Field Diameter: 9.30 ± 0.50µm at 1310nm
10.50 ± 1.00µm at 1550nm

2.1.9 Cabled Fiber Attenuation:

Wavelength	Maximum attenuation (dB/km)	Average attenuation (dB/km)
1310nm	0.38	0.35
1550nm	0.25	0.24

2.1.10 Attenuation Uniformity: No point discontinuity greater than 0.1dB at either 1310nm or 1550nm.

2.1.11 Attenuation at Water Peak: Attenuation at 1383 ± 3nm < 2.1dB/km

2.1.12 Maximum total dispersion: 1285–1330nm: ≤ 3.2ps / (nm * km)
1550nm: ≤ 18.0ps / (nm * km)

2.1.13 Zero Dispersion Wavelength: 1301.5nm ≤ ZDW ≤ 1321.5nm

2.1.14 Zero Dispersion Slope: ≤ 0.092ps / (nm^2 * km)

2.1.15 Fiber Polarization Mode Dispersion (PMD): ≤ 0.5ps / √ km

2.1.16 Fiber Curl: ≥ 4.0m radius of curvature

2.2 All fibers in the cable are usable fibers and meet required specifications.

2.3 Each optical fiber consists of a doped silica core surrounded by a concentric silica cladding. The fiber is a matched clad design.

2.4 The coating is a dual layered, UV-cured acrylate.

2.5 The coating is mechanically strippable. The force required to remove 30mm ± 3mm of fiber coating is $1.5N \leq F \geq 8.9N$.

3.0 CONSTRUCTION SPECIFICATIONS FOR SM OFC

3.1 Optical fibers are placed inside a loose buffer tube. The nominal outer diameter of the buffer tube is 2.8 ± 0.1mm. To ensure proper performance during handling, the minimum buffer tube wall thickness is 0.4mm.

3.2 Each buffer tube is filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel is free from dirt and foreign matter. The gel can be readily removed with conventional nontoxic solvents.

3.3 The number of buffer tubes and filler rods for 1-288 count fiber is as follows:

CSM OD (mm)	Fiber Count	Fibers per Tube	Max # of tubes & filler rods	Cable OD OD Dielectric	Cable Weight (kg/km) Dielectric	Cable OD OD Armored	Cable Weight (kg/km) Armored
2.0	6-20	6	5	11.2	120	13.5	180
2.0	21-60	12	5	11.2	120	13.5	180
2.8	61-72	12	6	12.1	135	14.8	210
4.5	73-96	12	8	14.0	170	16.8	260
6.7	97-120	12	10	16.3	220	18.5	320
8.0	121-144	12	12	17.7	270	20.0	380
7.7	145-216	24	9	19.3	300	20.8	410
11.5	217-288	24	12	23.2	360	24.8	500

3.4 Buffer tubes containing fibers are color-coded with distinct and recognizable colors in accordance with TIA/EIA-598A, "Optical Fiber Cable Color Coding".

3.5 The loose tube cable core consists of color-coded Polybutylene Terephthalate (PBT) buffer tubes. Positive identification is provided by color-coding both the optical fibers and the buffer tubes. All buffer tubes have a filling compound to provide water penetration resistance and to cushion the fibers during installation and operation.

3.6 Each fiber is distinguishable by means of color-coding in accordance with TIA/EIA-598A, " Optical Fiber Cable Color Coding". All fibers and buffer tubes are color coded to facilitate individual fiber identification. The individual fiber colors used in loose tube cable are given in the following table:

Tube #	**Color**		**Tube #**	**Color**	
1.	Blue	(BL)	7.	Red	(RD)
2.	Orange	(OR)	8.	Black	(BK)
3.	Green	(GR)	9.	Yellow	(YW)
4.	Brown	(BR)	10.	Violet	(VI)
5.	Slate	(SL)	11.	Rose	(RS)
6.	White	(WH)	12.	Aqua	(AQ)

3.7 For 24 fiber tubes, two bundles of 12 fibers each are identified by the color of the binding thread; blue or orange are used.

3.8 The buffer tubes are resistant to external forces and meet the buffer tube cold blend and shrink-back requirements of RUS 7 CFR 1755.900

3.9 The buffer tubes do not kink when a 360º loop is freely bent to a diameter of 10Dmm, where D is the diameter of the tube.

3.10 The fibers are colored with ultraviolet (UV) curable inks.

3.11 The fibers do not adhere to the inside of the buffer tube.

3.12 In buffer tubes containing multiple fibers, the colors are stable across the specified storage and operating temperature range (-40ºC to +70ºC) and are not subject to fading or smearing onto each other or into the gel filling material. Colors will not cause fibers to stick together.

3.13 The central anti-bucking member consists of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent bucking of the cable. The GRP rod is over coated with a medium/high density (black colored) polyethylene thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

3.14 Water-blocking technology is used to impede migration of water through the cable core. Dry binder threads are impregnated with the Super Absorbent Polymers (SAP). The water-blocking threads are applied about the central strength element to block water along that path.

3.15 To ensure a dry cable core, the individual buffer tubes are stranded around the dielectric central member. The stranding process, Reverse Oscillating Lay (ROL, S-Z) technique, which periodically reverses the rotation of stranding, is employed to facilitate cable mid-span entry. The water blocking Aramid yarn is applied longitudinally along the central strength member during stranding. Two counter-helical non-wicking binders hold the buffer tubes in place without crushing the buffer tube. The binders are non-hygroscopic, non-wicking and dielectric with low shrinkage.

3.16 Fillers are included in the cable core to lend symmetry to the cable cross-section when needed. Fillers are placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers are placed in the inner layer. Fillers are nominally 2.8mm in outer diameter.

3.17 A water blocking tape is applied longitudinally around the outside of the stranded tubes / fillers. The tape is held in place by polyester binder yarn. The water blocking tape is non-nutritive to fungus, electrically non-conductive and homogenous. It is also be free from dirt and foreign matter.

3.18 High tensile strength dielectric yarns are helically stranded evenly around the cable core. Tensile strength is provided by these dielectric yarns.

3.19 Ripcords are provided in the cables for easy sheath removal.

3.19.1 Dielectric cables contain two ripcords under the outer sheath.

3.19.2 Armored cables contain two ripcords under the steel armor.

3.20 The outer jacket of the cables is a black High Density Polyethylene (HDPE) extruded over the cable core to protect the strength elements from environmental stresses experienced during operation.

3.20.1 Dielectric cables are sheathed with HDPE. The minimal outer jacket thickness is 1.4mm. The jacketing material is applied directly over the tensile strength members. The polyethylene is carbon black to provide ultraviolet light protection and does not promote the growth of fungus.

3.20.2 Armored cables contain a corrugated steel tape, plastic coated on both sides for corrosion resistance. It is applied around the outside of the water-blocking tape over the dielectric tensile strength members, with an overlapping seam with the corrugations in line. The outer jacket is applied over the corrugated steel tape armor. The outer jacket / sheath is HDPE. The minimal outer jacket thickness is 1.4mm. The polyethylene contains carbon black to provide ultraviolet light protection and does not promote the growth of fungus.

3.21 The cable jacket on both dielectric and armored cables contains no metal elements and is a consistent thickness.

3.22 For fiber counts 2 to 60, the cable diameter remains the same. The overall cable diameter does not exceed ± 0.5mm the diameter of the nominal.

3.23 The maximum pulling tension is 2700N (608lbf) during installation and 890N (200lbf) after installation / during use.

3.24 The shipping, storage, and operating temperature range of the cable is -40ºC to +70ºC. The installation temperature range of the cable is -30ºC to +70ºC.

3.25 Cable Sheath Marking

All cables have sequential length markings along the cable sheath. The cable is marked in white print every three feet, and is marked in foot measurement. At the customer's request, the cable can be marked in meters. The height of the marking is approximately 2.5mm.

As required by Section 350 G of the NESC, ANSI C2-1993, all cables have a visual identifier resembling a telephone hand-set to identify them as telecommunications / data-communications cables.

The marking on the sheath contains the following information:

SmartLITE
SM XXXF where XXX is the number of fibers
Renka Corp
Telephone Symbol
Sequential foot marking

4.0 PERFORMANCE SPECIFICATIONS FOR SM OFC

4.1 When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and other Passive Fiber Optic Components", the change in attenuation within operational temperature range (-40ºC to +70ºC) is ≤0.05 dB/km at 1550 or 1310nm.

4.2 When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable", a one-meter length of unaged cable can withstand a one-meter static head or equivalent continuous pressure of water for twenty four hours without leakage through the open cable end.

4.3 When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", the cable exhibits no flow (drip or leak) of filling and/or flooding material at 65ºC

4.4 When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables", a minimum compressive load is applied uniformly over the length of the cable at the rate of 3mm to 20mm per minute and maintained for ten minutes. Dielectric cables withstand a load of 220N/cm (125lbf/in). Armored cables withstand a load of 440N/cm (250lbf/in). The change in attenuation does not exceed 0.4dB during loading and 0.2dB after loading at 1550nm.

4.5 When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test", the cable can withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation does not exceed 0.1dB at 1550nm.

4.6 When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies", the cable can withstand 25 impact cycles. The change in attenuation does not exceed 0.2dB at 1550nm.

4.7 When tested in accordance with FOTP-33, "Fiber Optic Tensile Loading and Bending Test", using a maximum mandrel and sheave diameter of 560mm, the cable can withstand a tensile load of 2700N (608lbf). The change in attenuation does not exceed 0.2dB during loading and 0.1dB after loading at 1550nm. The load does not produce a strain exceeding 0.25% in fiber and does not cause any permanent physical or optical damage to any component of cable.

4.8 When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test", a length of cable no greater than 4 meters can withstand 10 cycles of mechanical twisting. The change in attenuation does not exceed 0.1dB at 1550nm.

4.9 When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable", after conditioning for four hours at test temperatures of -30ºC and +60ºC: dielectric cables can withstand four full turns around a mandrel ≤10 times the cable diameter and armored cables can withstand four full turns around a mandrel ≤20 times the cable diameter. Neither the inner nor the outer surfaces of the jacket exhibit visible cracks, splits, tears, or other openings. Optical continuity is maintained throughout the test.

4.10 When tested in accordance with FOTP-181, “Lightning Damage Susceptibility Test for Optic Cables with Metallic Components”, Armored cables can withstand a simulated lightning strike with a peak value of the current pulse equal to 105kA without loss of fiber continuity. A dampened oscillatory test current is used with a maximum time-to-peak value of 15µs, which corresponds to a minimum frequency of 16.7kHz and a maximum frequency of 30kHz. The time to half-value of the waveform envelope is between 40 and 70ºs.

5.0 SHIPPING SPECIFICATIONS FOR SM OFC

5.1 Reels

Each fiber optic cable is shipped on a separate, strongly constructed new wooden reel. The reels are designed to prevent damage to the cable during shipment and installation.

5.1.1 Reel Dimensions: The maximum reel width is 1.2m. The maximum outside reel diameter is 1.8m. The drum diameter is at least 30 times the cable outer diameter.

5.1.2 Cable End Fastening: To provide access for testing, the inner end of the cable protrudes through the inside of the drum. The end is wound between wooden rings located on the side of the flange to protect it during transport and storage. The length of the inner end is 3.0m. 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. Both ends of the cable are available for testing.

5.2 Information Accompanying the Reel:

The following information is securely attached to each reel:

Renka Corporation
Renka Part Number
Customer Part Number
Cable Description
Index of Refraction
Weight of Cable and Reel
Reel ID
Ship Length
Beginning and Ending Length Markings
Certified Test Data Sheet (Attenuation Measurements)

* a durable weatherproof label shows the actual length of cable on the reel

5.3 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. As a standard offering, both cable ends are terminated with plastic end caps. If requested, kellem grips can be factory installed on one or both ends of the cable.

5.4 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 9ºC (15ºF) above ambient temperature 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”.

5.5 Reel Lagging

A composite board wrap lagging is used for domestic shipments with flange diameters less than or equal to 68 inches. This composite lagging completely covers the cable from inside flange to inside flange. The composite board is high strength and exhibits very good puncture resistance. Three steel bands are strapped about the lagging to help secure the lagging boards to the reel.

6.0 QUALITY ASSURANCE AND TESTING FOR SM OFC

6.1 Routine Testing: Critical dimensions are monitored during the production of the cable and the Renka Final Inspection Laboratory performs the routine tests found in section 4.1.2 of IEEE P1222 on 100% of the cables, including the following specific quality assurance checks:

6.1.1 Jacket Thickness: Section 4.1.2.1.1 in the IEEE P1222 draft document mandates that the thickness of the outer jacket at any cross-section may not be less than 70% of the nominal thickness.

6.1.2 Cable Outer Diameter: The IEEE P1222 draft document also states that the cable outer diameter must be ± 5% of the nominal outer diameter.

6.1.3 Optical Acceptance Test: Section 4.1.2.2 of IEEE P1222 requires that optical tests be performed on each reel. This section states that single-mode fiber attenuation measurements are in accordance with EIA/TIA-455-78, "Spectral Attenuation Cutback Measurement for Single-Mode Fibers" or with EIA/TIA-455-61, "Measurement of Fiber or Cable Attenuation using an OTDR". These attenuation measurements are made from both ends of the cable, and then averaged. The maximum allowed step in attenuation at Renka Final Inspection is ± 0.1dB.

6.2 All cabled optical fibers greater than 1000m in length are 100% attenuation tested. The attenuation of each fiber is provided with each cable reel.

6.3 All optical fibers are proof tested to a minimum load of 0.7 GN/m² (100kpsi).

Renka reserves the right to improve, enhance, or modify the cable features or specifications. Renka Optical Fiber Cable products are designed for optimum performance and ease of installation, and support applicable industry technical specifications, standards and references including Telcordia (Bellcore) GR-20, ICEA-640, RUS PR-90, GTE Int'l, ITU-T recommendations G650 series, IEC 793 and EN 18800 requirements, and ISO 9001 & TIA/EIA quality standards.