CORNING OPTICAL COMMUNICATIONS GENERIC SPECIFICATION FOR FlexNAP™ DISTRIBUTION SYSTEMS: DISTRIBUTION TRUNK, TAP, AND TETHER

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Revision: Issue

Corning Optical Communications reserves the right to update this specification without prior notification.

1.0 FlexNAP Systems Distribution Trunk, Tap, Tether: General

The FlexNAP Distribution Systems for outside plant consists of a factory-tested distribution trunk cable, tether attachment points, tether assemblies, and multiport terminals that allow for a quick, reliable installation. The FlexNAP Distribution System utilizes standard optical fiber cables upon which tether attachment points (TAPs) are preinstalled at customer-specified locations along the length of the cable. The cable and tether attachment points are tested and shipped as a complete system.

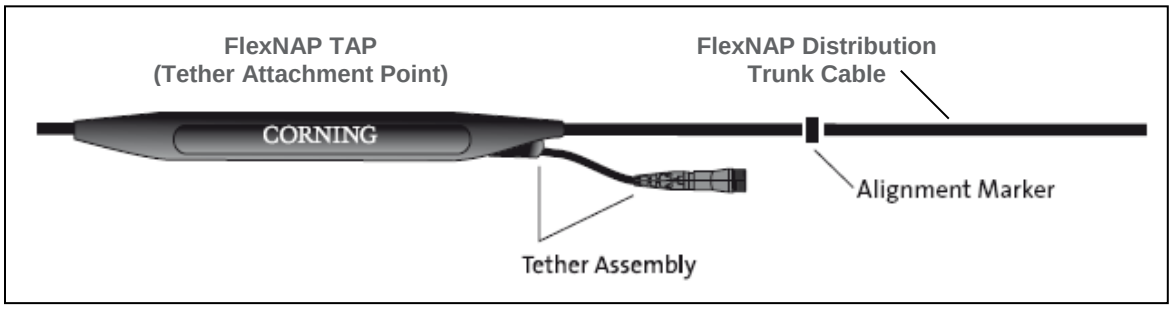

Figure 1: FlexNAP Distribution System Trunk components for outside plant

1.1 The FlexNAP Distribution System is designed to meet the applicable performance criteria of GR-3122 and S-87-640-1999.

2.0 Fiber Characteristics

2.1 Detailed information on the fiber types available for this cable design can be found in the following documents:

2.1.1 Dispersion Un-shifted and Non-zero Dispersion Shifted Single-mode Fiber: Generic Specification F1, “Generic Specification for Single-mode Optical Fiber in Loose Tube and Ribbon Cables.”

3.0 Distribution Trunk Cable Construction

3.1 Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 2.5 mm.

3.2 Each buffer tube shall contain up to 12 fibers.

3.3 The fibers shall not adhere to the inside of the buffer tube.

3.4 Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."

3.5 The fibers shall be colored with ultraviolet (UV) curable inks.

3.6 Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."

3.6.1 Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

3.7 For cables containing more than 12 buffer tubes, standard colors are used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.

3.8 In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and shall not be subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

3.9 The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.

3.10 Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm in outer diameter.

3.11 The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod (optional steel central member). The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be overcoated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

3.12 For gel-filled constructions each buffer tube shall be filled with either a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents. For gel-free construction each buffer tube shall contain water blocking material embedded in the inside wall of the buffer tube for water-blocking protection. The water blocking material shall be non-nutritive to fungus, electrically

non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This material will preclude the need for other water-blocking materials such as gels, yarns, foams, or tapes; the buffer-tube shall be gel-free.

3.13 The optical fibers shall not require cleaning before placement into a splice tray or fan-out kit.

3.14 Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process.

3.15 Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. Water blocking elements shall be applied uniformly throughout the buffer tube.

3.16 Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

3.17 For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

3.18 For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

3.19 Non-armored cables shall contain one ripcord under the sheath for easy sheath removal. Armored cables shall contain two ripcords under the steel armor for easy armor removal. Additionally, armored cables that have an inner sheath will also contain one ripcord under the inner sheath.

3.20 All tensile strength shall be provided by the central member.

3.21 Non-armored cables shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.3 mm. Jacketing material shall be applied directly over cable core and water swellable tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

3.22 Armored cables without an inner jacket shall have an armor layer applied directly over the cable core and water swellable tape. The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied around cable core and water swellable tape with an overlapping seam with the corrugations in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer

jacket shall be a MDPE with a minimum nominal jacket thickness of 1.3 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

3.23 The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8.

3.24 The jacket or sheath shall be free of holes, splits, and blisters.

3.25 The cable jacket shall contain no metal elements and shall be of a consistent thickness.

3.26 Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

3.27 If the initial marking fails to meet the specified requirements (i.e., improper text statement, color, legibility, or print interval), the cable may be remarked using a contrasting alternate color. The numbering sequence will differ from the previous numbering sequence, and a tag will be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color will be yellow, with the secondary choice being blue.

3.28 The maximum pulling tension shall be 2700 N (600 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

3.39 The minimum bend radius shall be 15 times the cable outside diameter while under tension and 10 times the cable outside diameter installed.

3.30 The storage temperature range for the cable on the original shipping reel shall be -40 °C to +70 °C for all FlexNAP Trunk cable types. The installation temperature range for the cable shall be -30 °C to + 70 °C for Loose Tube cables and -18 °C to +70 °C for RPX Ribbon cables. The operating temperature range for the cable shall be -40 °C to + 70 °C for all FlexNAP Trunk cable types.

3.31 For RPX trunk designs the cable will be a flat profile with two dielectric or high strength steel central members on either side of a central cavity. The central cavity will house 24 fiber ribbons, separable by hand into 4 fiber ribbons. The ribbons will be surrounded by a protective water blocking tape and the overall cable construction will be gel-free.

3.32 For Figure-8 trunk designs, the optical cable and steel messenger shall be sheathed in medium density polyethylene (MDPE) with an MDPE web between the messenger and the optical cable. The web will couple the

cable to the messenger. The nominal thickness of the messenger sheath shall be 1.50 mm (0.06 inches). The web shall have a nominal height of 2.29 mm (0.09 inches) and a nominal thickness of 1.52 mm (0.06 inches).

3.33 For Figure-8 trunk designs, an internal steel messenger shall be incorporated into the cable jacket. The messenger shall be a nominal 6.4 mm (0.25 inch) in diameter, extra high strength (EHS), 7 strand, Class A galvanized steel conforming to ASTM A 640. The messenger shall be galvanized for corrosion resistance and asphalt flooded to prevent the ingress of moisture. The minimum rated breaking strength of the messenger shall be 29.58 kN (6,650 lbs).

4.0 Distribution Trunk Cable Assembly Construction

4.1 General

4.1.1 Distribution Trunks shall be constructed from a cable type specified in Section 3.

4.1.2 Operating temperature range for cable portion of the trunks shall be as indicated in Section 3.

4.1.3 Distribution Trunks made from non-armored cables shall be of an all-dielectric construction.

4.1.4 Distribution Trunk fiber count shall be specified as 12, 24, 36, 48, 72, 96, 144, or 216 for Loose Tube cables.

4.1.5 Distribution Trunk fiber count shall be specified as 24, 48, 72, 96, or 144 for RPX Ribbon cables.

4.2 Distribution Trunk cables pre-terminated with MTP Connectors on the Central Office (CO)/ Wire Center (WC).

4.2.1 CO / WC pre-terminated distribution trunk cable fiber counts shall be specified as 12, 24, 36, 48, 72, 96, and 144.

4.2.2 CO / WC pre-terminated distribution trunk cable types shall be specified as Single Mode Altos Dielectric Loose Tube cables only.

4.2.3 MTP connector furcation will begin with a 24” leg length and stagger 2 MTP connectors every 4”.

4.2.4 Each cable buffer tube will be connectorized with a Single Mode MTP connector on the CO / WC end of the cable and numbered with a #1 label through a #12 in accordance with the TIA/EIA-598-B, “Optical Fiber Cable Color Coding”.

4.2.5 CO / WC Distribution Trunk cables pre-terminated with Single Mode MTP Connectors shall include a 600lb, water resistant, metal sheath pulling grip with pulling eye.

4.3 Distribution Trunk cables pre-terminated with HMFOC on the Central Office (CO)/ Wire Center (WC).

4.3.1 CO / WC HMFOC pre-terminated distribution trunk cable fiber counts shall be specified as 12, 24, 36, and 48.

4.3.2 CO / WC HMFOC pre-terminated distribution trunk cable types shall be specified as Single Mode Altos Loose Tube cables and Single Mode RPX Ribbon cables.

4.3.3 HMFOC will be comprised of tether attachment points and tether assemblies, with the tether assemblies facing the CO/WC cable end.

4.3.4 Tether assembly lengths shall be 8 ft. for all applications.

4.3.5 Each cable buffer tube or ribbon will be connected to a HMFOC tether assembly on the CO / WC end of the cable and numbered with a label identifying its position within the distribution trunk.

4.3.6 CO / WC Distribution Trunk cables pre-terminated with HMFOC shall include a water resistant protective grip, and allow traditional cable installation methods to be used at the end of the cable.

4.4 Tether Attachment Point (TAP) & Tether Assembly

4.4.1 Tether attachment points shall include a FlexNAP Distribution System closure (overmold) and a tether assembly.

4.4.2 HMFOC Tether lengths shall be 5 ft. for Aerial applications and 15 ft. for Direct Buried, Duct / Buried Duct. HFOC Tether lengths shall be 10 ft. for Aerial applications and 15 ft. for Direct Buried and Duct applications.

4.4.3 TAP distances shall be specified as the distance between tether attachment points at each designated section of the distribution trunk cable as specified by the end Customer or Contractor.

4.4.4 The FlexNAP Distribution System Closure shall meet the following specifications:

4.4.4.1 The shipping, storage, and operating temperature range of the TAP shall meet or exceed the temperature ranges specified below: shipping, storage, and operating temperature range of -40°C to +70°C for Loose Tube and RPX Ribbon cables.

4.4.4.2 The TAP portion shall be flexible

4.3.4.3 The TAP shall meet or exceed GR-3122 and GR-771.

4.3.4.4 The dimensions of the premium Low Profile Overmold (28mm), All-Dielectric, Loose Tube TAP (Fiber count up to 72) will allow for installation into a 1.25 inch inside diameter duct. The TAP minimum bend radius shall be 24.2 cm (9.5 inches) during installation and 16.1 cm (6.4 inches) after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.3.4.5 The dimensions of the Standard Profile Overmold (36mm), All-Dielectric Loose Tube Cable TAP's (Fiber counts up to 72) will allow for installation into a 2 inch inside diameter duct. The TAP minimum bend radius shall be 24.2 cm (9.5 inches) during installation and 16.1 cm (6.4 inches) after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.3.4.6 The dimensions of the High Fiber Count Overmold (44mm), All-Dielectric, Loose Tube Cable TAP's (Fiber counts of 96,144 and 216) will allow for installation into a 2 inch inside diameter duct. The TAP minimum bend radius shall be 26.4 cm (10.4 inches) during installation and 17.6 cm (7.0 inches) after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.3.4.7 The dimensions of the standard Profile Overmold (44mm), Armor Lite, Loose Tube TAP's (Fiber count up to 72) will allow for installation into a 2 inch inside diameter duct. The TAP minimum bend radius shall be 18.2 cm (7.2 inches) during installation and 12.1 cm (4.8 inches) after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.3.4.8 The dimensions of the High Fiber Count Overmold (50mm), Armor Lite, Loose Tube TAP's (Fiber counts of 96, 144, and 216) will allow for installation into a 3 inch inside diameter duct. The TAP minimum bend radius shall be 20.7 cm (8.1 inches) for 96 fiber, 26.3 cm (10.4 inches) for 144 fiber, and 26.6 cm (10.5 inches) for 216 fiber during installation and 13.8 cm (5.4 inches) for 96 fiber, 17.5 cm (6.9 inches) for 144 fiber, and 17.7 cm (7.0 inches) for 216 fiber after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.3.4.9 The dimensions of the RPX Ribbon Overmold (33mm) TAP's (Fiber counts of 24, 48, 72, 96, and 144) is approved for Aerial or buried applications. The TAP minimum bend radius shall be 22.9 cm (9.0 inches) during installation and 22.9 cm (9.0 inches) after installation. The TAP maximum tensile load shall be 2700 N (600 lb_f) short term and 890 N (200 lb_f) long term.

4.4.5 Tether Assemblies shall be terminated with a pinned Hardened MT connector or Hardened SC connector for aerial and direct buried/duct applications. For Façade FlexNAP applications or CO preterminated locations the tether assemblies shall be terminated with a non-pinned Hardened MT connector.

4.4.6 Operating temperature range of the terminated portion of the tether assembly (terminated with Hardened connector) shall be -40 °C to + 70 °C.

4.4.7 Single Tether Assembly fiber count shall be specified as 1, 2, 4, 6, 8, or 12 fibers for Loose Tube cables and 4, 8 or 12 for RPX Ribbon cables.

4.4.8 Tether Attachment Points can support a maximum of two single tether assemblies for a maximum of 24 fibers per TAP for non Premium Low Profile overmolds. Premium Low Profile overmolds closures can only support one, 12 fiber tether assembly per access point. Dual access points are required for 24 fibers per location.

4.4.9 Tether Assembly Hardened connectors will meet specifications in Table 1 below:

Connector Type	Fiber Count	Insertion Loss	Reflectance	Polish
Hardened single-mode MT Connector	2, 4, 6, 8,12	0.35 dB typical 0.62 dB max	< -65 dB	8º
Hardened single-mode SC Connector	1	0.15 dB typical 0.4 dB max	< -65 dB	8º

Table 1: Hardened Connector Specifications

5.0 General Hardened MT Connector Specifications

5.1 The hardened MT connector shall be available in fiber counts of 2, 4, 6, 8 and 12 for Loose Tube cables and 4, 8, and 12 fiber count connectors for RPX Ribbon cables.

5.2 The hardened MT connector shall have an 8º angled end face for single – mode and shall always mate “key up” to “key down. The connector

housings shall be keyed to ensure proper connector mating relative to the end face angle.

5.3 The largest diameter of the connector housing shall be 17.5 mm, and the assembly terminated with this connector shall be designed to fit through 1.25” duct.

5.4 Connector alignment shall be achieved through 2 alignment pins located in the “pinned” hardened MT connector.

5.5 The hardened MT connector is designed to meet the applicable performance criteria of GR-3152, IP 69K, and IP 68.

5.6 When tested in accordance with FOTP-1, "Cable Flexing for Fiber Optic Connectors", the assembly shall be mounted to a cable tension test device with a weight of 0.9kg. Each assembly is rotated through the angles of +90 to –90 degrees for a total of 100 cycles. Measurements of loss and reflectance are made at the beginning and at the end of the test. At the end of the test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.7 The assembly shall not become uncoupled when subjected to the following series of the tests. The test sample shall undergo a series of straight pulls (4.5 kgf (10 lbf) 0° for ≥5 sec, wait 10 sec to measure, then 6.8 kgf (15 lbf) at 0° ≥5 sec, wait 10 sec to measure) and 90° side pulls (2.3 kgf (5 lbf) 0° for ≥5 sec, wait 20 sec to measure, then 3.4 kgf (7.5 lbf) at 0° for 5 sec, wait 20 sec to measure). At the end of the test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.8 When tested in accordance with FOTP-2, "Impact Test Measurements for Fiber Optic Devices", each assembly is subjected to eight impact cycles by being dropped from a height of 1.5m. Each connector was cleaned after the test and re-mated. Measurements of maximum loss and reflectance were measured before and after the impacts. At the end of the test each connector shall maintain a maximum insertion loss of ≤0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤0.30 dB, a maximum reflectance of ≤-40 dB, and a reflectance change of ≤5 dB.

5.9 When tested in accordance with FOTP-21, "Mating Durability for Fiber Optic Interconnecting Devices", each assembly is disconnected and then reconnected 200 times. The assemblies are cleaned after every 25th mating. Measurements of loss and reflectance are made before and after each cleaning cycle. At the end of the durability test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤

0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.10 The HMFOC assembly shall show no evidence of water leakage as a result of the applied Seal Under Load Test method. The side load applied shall be 2.5 lbs while being placed under 10 feet of waterhead.

5.11 The HMFOC assembly shall not permanently deform more than 10%, nor temporarily deform more than 20%, when it is compressed by a uniformly distributed load. In addition, application of the compressive load shall not cause any mechanical damage to the closure or its contents. The applicable compressive loads are 300 lbs for the buried/underground environment and 100 lbs for all other deployment environments.

5.12 The HMFOC shall meet the Rockwell R87 material hardness specification to meet the rodent resistance requirement.

5.13 When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components", each assembly is subjected to test conditions ranging from 23 °C to 75 °C to -40 °C for 500 hrs. Measurements of loss and reflectance are made at the beginning, at each temperature plateau and at the end of the test or other interim measurements such as 50, 100, 168, 220, 310, 425, and 500 hour intervals. At the end of the temperature cycling each connector shall maintain a maximum insertion loss of ≤ 0.75 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.14 When tested in accordance with FOTP-4, "Fiber Optic Component Temperature Life Test", each assembly is subjected to test conditions of 85 °C and < 40% RH for 2000 hrs. Measurements of loss and reflectance are made at the beginning, at 168 hr., at 500 hr., at 1000 hr. and at the end of the test. At the end of the temperature life test each connector shall maintain a maximum insertion loss of ≤ 0.75 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.15 When tested in accordance with FOTP-5 "Humidity Test Procedure for Fiber Optic Components", test type 1, each connector assembly is subjected to test conditions of 75 °C and 90% relative humidity for 1000 hrs. Measurements of loss and reflectance are made at the beginning of the test, at 100 hrs, at 168 hrs, at 500 hrs, and at the end of the test. At the end test each connector shall maintain a maximum insertion loss of ≤0.75 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.16 When tested in accordance with FOTP-16, “Salt Spray Test", each connector assembly shall subjected to a 5% (±1%) NaCl by weight dissolved in distilled water solution over a period of 168 hrs. (7 days). At

the beginning and end of the test each connector shall maintain a maximum insertion loss of ≤ 0.75 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

5.17 When tested in accordance with ASTM B827-92, “Airborne Contaminants Test”, each connector assembly shall be subjected each of the following gases over a period of 20 days individually: 20ppb Cl_2, 100ppm H_2S, 200ppm NO_2, and 200ppb SO_2. At the end of the test and before cleaning each connector shall maintain a maximum insertion loss of ≤ 0.75 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB with no visible corrosion.

5.18 When tested in accordance with ASTM G21, “Fungus Resistance Test”, each connector assembly shall achieve a rating of 0.

5.19 When tested in accordance with UL-94 and ASTM D-2863-87, “Flammability Test”, each connector assembly shall have a material rating of V-1 or better and an oxygen index of 28 percent or better respectively.

5.20 The connector assemblies shall show no evidence of cracking when exposed over a period of 24 hrs. to the following: WD-40 Water Displacing Lubricant, 10% IGEPAL, Cable Filling Compound, as used in the field, Splice Encapsulating Compound, Isopropyl Alcohol Grade HPLC, and Wasp & Hornet Spray.

5.21 Each connector assembly shall show no change in sealing ability and shall not experience a reduction in either tensile strength or elongation properties greater than 20% after submersion in a specified chemical test fluid for 7 days. The chemicals to be used are: Sulfuric Acid (3% H2SO4 by weight), Sodium Hydroxide (0.2 NaOH), IGEPAL (10%), and Kerosene (having flash point > 160°F).

5.22 The connector endface shall meet the geometry requirements as stated in IEC 61755 Part 3-3.

6.0 General Single Fiber Hardened Fiber Optic Connector Performance Specifications

6.1 The connector will be free of any defects such as burrs that may present a hazard safety or otherwise to the user.

6.2 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 connector shall be put through 21 cycles (168hrs) with a temperature range -40 ^{o}C to 75 ^{o}C for each cycle. At the end of the temperature cycling the connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB,

and a reflectance change of ≤ 5 dB. The loss measurements are done before and after every cycle and at each temperature plateau.

6.3 When tested in accordance with FOTP-4, "Fiber Optic Component Temperature Life Test" ", the connector shall be placed in an 85 °C environment with uncontrolled humidity for 168hrs. At the end of the temperature life test the connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB. The measurement is done before and after the test.

6.4 When tested in accordance with FOTP-5, "Humidity Test Procedure for Fiber Optic Components", each connector undergoes two tests: a Humidity Aging Test and a Humidity/Condensation test. For the Humidity Aging test each connector is subjected to test conditions of 75 °C and 95% relative humidity for 7 days. Measurements of loss and reflectance are made at the beginning of the test, at a minimum of six-hour intervals during the test, and at the end of the test. For the Humidity/ Condensation test each connector is subjected to the temperature cycle of –10oC to 65oC, with relative humidity of 90 to 100%, for a period of 7 days. Measurements of loss and reflectance are made at every temperature plateau, and at 23°C at the end of the test, at least thirty minutes after the start of each plateau interval. At the end of either test the connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB. The loss measurements are done at the beginning and end of the test and every six hours during the test.

6.5 When tested in accordance with FOTP-12, "Fluid Immersion Test for Fiber Optic Components", the connector shall be submersed in groundwater for 168 hrs. At the end of the groundwater submersion test the connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB. The loss measurements are done at the beginning and end of the test.

6.6 When tested in accordance with FOTP-12, the connectors shall be submerged in the following chemicals: Kerosene, IGEPAL 10%, Sodium Hydroxide, and Sulfuric Acid. The connectors shall only be smeared with the following chemicals: WD-40, Wasp & Hornet Spray, Isopropyl Alcohol, Cable-filling compound, Splice Encapsulating compound, and IGEPAL 10%. After being submerged or smeared for the required time, the connectors will be cleaned with water then checked for cracks or any other physical deformations.

6.7 When tested in accordance with FOTP-1, "Cable Flexing for Fiber Optic Connectors", the assembly shall be mounted to a cable tension test device with a weight of 0.9kg. Each assembly is rotated through the angles of +90 to –90 degrees for a total of 100 cycles. Measurements of loss and reflectance are made at the beginning and at the end of the test. At the end of the test each connector shall maintain a maximum insertion loss of

≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.8 When tested in accordance with FOTP-2, "Impact Test Measurements for Fiber Optic Devices", each assembly is subjected to eight impact cycles by being dropped from a height of 1.5 m. Each connector was cleaned after the test and re-mated. Measurements of maximum loss and reflectance were measured before and after the impacts. At the end of the test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.9 When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components", each assembly is subjected to test conditions ranging from 23 °C to 75 °C to -40 °C for 7 days and a total of 21 cycles. Measurements of loss and reflectance were made at the beginning, at each temperature plateau and at the end of the test. At the end of the temperature cycling each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.10 When tested in accordance with FOTP-4, "Fiber Optic Component Temperature Life Test", each assembly is subjected to test conditions of 85 °C for 7 days. Measurements of loss and reflectance are made at the beginning of the test and at the end of the test. At the end of the temperature life test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.11 When tested in accordance with FOTP-5 "Humidity Test Procedure for Fiber Optic Components", each cable assembly undergoes two tests: a Humidity Aging Test and a Humidity/Condensation test. For the Humidity Aging test each connector assembly is subjected to test conditions of 75 °C and 95% relative humidity for 7 days. Measurements of loss and reflectance are made at the beginning of the test, at a minimum of six-hour intervals during the test, and at the end of the test. For the Humidity/ Condensation test each assembly is subjected to the temperature cycle of –10oC to 65oC, with relative humidity of 90 to 100%, for a period of 7 days. Measurements of loss and reflectance are made at every temperature plateau, and at 23°C at the end of the test, at least thirty minutes after the start of each plateau interval. At the end of either test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB. The loss measurements are

done at the beginning and end of the test and every six hours during the test.

6.12 When tested in accordance with FOTP-6, “Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices," each assembly is mounted onto a text fixture device, and tension is then applied at 0o and 90o offset from the boot of the connector. The tension applied starts at 0.25 and is gradually increased to 0.7kg, 1.5kg, and finally 2.0kg. At the end of the test each connector shall maintain an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB. The loss measurements are made while the tensile load is applied.

6.13 When tested in accordance with FOTP-11, "Vibration Test Procedures for Fiber Optic Components and Cables", each connector assemblies is tested with a vibration amplitude of 1.5 mm (peak-to-peak), with a frequency range sweeping from 10 to 55 Hz at a rate of 45 Hz per minute. The test is conducted for 2 hours in each of three planes. Measurements of loss and reflectance are made at the beginning of the test and after vibration in each of the three planes. At the end of the vibration test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.14 When tested in accordance with FOTP-21, “Mating Durability for Fiber Optic Interconnecting Devices", each assembly is disconnected and then reconnected 200 times. The assemblies are cleaned after every 25th mating. Measurements of loss and reflectance are made before and after each cleaning cycle. At the end of the durability test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

6.15 When tested in accordance with FOTP-36, "Twist Test for Fiber Optic Connecting Devices", each assembly is mounted to a cable tension test device with a weight of 1.35 kg. The assembly is then twisted +2.5 revolutions to –2.5 revolutions (from the starting point) about the axis of the cable (10 cycles in total). After that, it was rotated + 5Y revolutions in one direction, then was reversed direction and rotated another + 5Y revolutions, for a total of 10 cycles. Measurements of loss and reflectance are made at the beginning and at the end of the test. At the end of the twist test each connector shall maintain a maximum insertion loss of ≤ 0.50 dB, a mean insertion loss of ≤ 0.30 dB, an insertion loss increase of ≤ 0.30 dB, a maximum reflectance of ≤ -40 dB, and a reflectance change of ≤ 5 dB.

7.0 General Cable Performance Specifications

7.1 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 at extreme operational temperatures (-40°C and +70°C) shall not exceed 0.15 dB/km at 1550 nm for single-mode fiber.

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

7.3 When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 70°C.

7.4 When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fibers.

7.5 When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

7.6 When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," except that the number of cycles shall be two at three locations along a one meter cable length and the impact energy shall be atleast 4.4 Nm (in accordance with ICEA S-87-640)", the change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

7.7 When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a rated tensile load of 2670N (601 lbf) and residual load of 30% of the rated installation load. The axial fiber strain shall be $\leq$ 60% of the fiber proof level after completion of 60 minute conditioning and while the cable is under the rated installation load. The axial fiber strain shall be $\leq$ 20% of the fiber proof level after completion of 10 minute conditioning and while the cable is under the residual load. The change in attenuation at residual load and after load removal shall not exceed 0.15 dB at 1550 nm for single mode fiber.

7.8 When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.15 dB at 1550 nm for single-mode fiber.

7.9 When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 55 kA without loss of fiber continuity. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 μs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 to 70 μs.

7.10 When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable," the cable shall withstand four full turns around a mandrel of ≤ 20 times the cable diameter after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears, or other openings. The change in attenuation shall not exceed 0.30 dB at 1550 nm for single mode fiber.

8.0 Quality Assurance Provisions

8.1 All cable assemblies of any length shall be 100% attenuation tested.

8.2 All cable assemblies shall be tested in from both ends of each link within the cable.

8.3 The cable manufacturer shall be ISO 9001 registered.

9.0 Packaging

9.1 The completed cable shall be packaged for shipment on varying size plastic, composite and wooden reels.

10.0 Miscellaneous

10.1 At the request of the customer, the cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.