13-SDMS-04

REV. 00

SPECIFICATIONS

FOR

NON-METALLIC, LOOSE TUBE, DUCT & BLOWN TYPE FIBER OPTIC CABLE

CONTENTS

1 Objectives

The aim of this document is to provide generic information on design & construction of Non-Metallic Fiber Optic Cable (duct type & "mini cable" blown type) with loose tube, to be used for Outdoor applications for SEC FTTX access network deployment by Distribution Department, Saudi Electricity Company (SEC), Saudi Arabia.

2 Scope

This document specifies the minimum technical requirements for design, engineering, construction, manufacture, inspection, testing and performance of Non-Metallic Fiber Optic Cable (duct type & "micro cable" blown type) to be used for Outdoor applications for SEC FTTX access network deployment by Distribution Department, Saudi Electricity Company (SEC), Saudi Arabia.

3 Applicable codes & standards

This Distribution Material Standard Specification shall be read in conjunction with the latest revision of Distribution General Specification titled "01-SDMS-01, Rev 01" which shall be considered as an integral part of this standard. This material standard specification shall also be read in conjunction with 48-TMSS-02 Rev. No. 01 as well as with the purchase order or contract schedules for the project, as applicable.

The latest revision/amendments of the following codes and standards shall be applicable for the equipment/material covered in this Distribution Material Standard Specification. In case of any conflict, the vendor/manufacturer may propose equipment/material conforming to one group of industry codes and standards quoted hereunder without jeopardizing the requirements of this standard specification.

- IEC 60793-1-1 Optical fibers – Part 1-1: Measurement methods and test procedures general and guidance
- IEC 60794-1 Optical fiber cables: Generic specifications
- IEC 60304 International standard color for insulation for low-frequency cables
- TIA-598-D Standard for optical fiber color coding
- EIA 440A Fiber optic terminology
- EIA/TIA 455 Standard test procedure for fiber optic cables, transducers, sensors, connecting & terminating devices, and other fiber optic components
- EIA 472 Sectional specification for fiber optic communication cables for underground and buried use
- IEEE 1222 All-dielectric self-supporting fiber optic cable

- IEEE 1428 Guide for installation methods for fiber optic cables in electric power generation stations and in industrial facilities
- IEEE 1594 Helically applied fiber optic cable systems (wrap cable) for use on overhead utility lines
- ITU-TG.652 Characteristics of single-mode fiber optic cables
- ITU-TG.657 Characteristics of Bend insensitive Single-Mode Optical Fiber

4 Design & construction requirement

4.1 General requirements

4.1.1 The underground fiber optic cable shall be Non-Metallic/Unarmoured and shall be suitable for underground installation in duct pipes both for conventional and blow type installation. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

4.1.2 The (NFOC) Non-Metallic Fiber Optic Cable Duct type (Pulling type & "mini cable" blown type) shall meet or exceed the requirements of this specification in all respect.

4.1.3 Manufacturer's drawings are required to show the outline of fiber optic cable, together with all pertinent dimensions. Tolerance of any variations in dimensions shall be according to relevant standards.

4.1.4 Sample of the proposed fiber optic cable shall be provided for SEC approval.

4.2 Design requirements

4.2.1 The minimum & maximum ambient temperature shall be between -10°C to +70°C, as specified in 48-TMSS-02, Rev. No. 01.

4.2.2 The fiber optic cable shall be strengthened, reinforced and sheathed to offer protection, rendering it suitable for installation in different environments.

4.3 Optical fiber requirements

4.3.1 The fiber used shall be in full compliance with ITU-T G.652D or ITU-T G.657 Recommendations. Main fiber requirements are summarized in the following table 1:

Table 1 – Optical fiber requirements

Parameter	Requirement
Material	Germanium doped silica glass or pure silica glass

Mode field eccentricity	≤ 1 μm
Cladding Outside Diameter	125 μm ± 2.0 μm
Cladding Non-circularity	≤ 2%
Nominal coating diameter	In the range of 250 μm for pulling type & to 200 μm for blown type
Maximum continuous operating temperature without optical degradation	+ 70°C
Maximum optical loss variation in temperature range of -10°C to +70°C	±0.05db/km

4.3.2 There shall be no joints or splices in any optical fiber in any reel length of the complete optical cable.

4.3.3 Optical fibers shall be free of material and manufacturing defects, which would prevent them from meeting the requirements of this specification.

4.3.4 Each group of fiber may be enclosed in a loose buffer tube or may be taped in a helical fashion to provide protection against mechanical stresses and environmental effects.

4.3.5 The buffer shall be easily removable. Buffer shall not need a shrink back tubing once installed in a closure box if special tools are recommended by the manufacture; these shall be provided.

4.4 Cable construction requirements

4.4.1 General

4.4.1.1 The non-metallic fiber optic cable (pullingt type & "mini cable" blown type) shall consist of a central fiber optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn.

4.4.1.2 The central fiber optic unit shall be designed to house and protect the fibers from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc.

4.4.1.3 The fiber optic unit shall be of loose tube construction.

4.4.1.4 The inner polyethylene jacket and outer sheath jackets shall be free from pinholes, joints, splits or any other defects.

4.4.1.5 All fiber optic cable shall have a minimum service life span of 25 years.

4.4.1.6 The cable shall consist of Single Mode fibers conforming to ITU-T G.652D or to G.657 and the Technical parameters stipulated in this document.

4.4.1.7 Documentary evidence in support of guaranteed life span of cable & fiber shall be submitted by manufacturer for SEC approval.

4.4.2 Cable types

4.4.2.1 Two different types of NFOC Duct cables are specified in this document:

a) Cables for pulling installation
b) Cables for blowing installation

4.4.2.2 Their characteristics are detailed in para. 4.4.10.2 in table 2 & table 3.

4.4.3 Strength member

4.4.3.1 The duct placement cables shall have a non-metallic central strength member covered by a suitable coating.

4.4.3.2 The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibers are not subject to excessive strain.

4.4.3.3 The central fiber optic unit should include a central strength member of Fiber Reinforced Plastic (FRP). FRP is good corrosion material, having good corrosion resistance to the atmosphere, water, and general concentration of acid, alkali, salt, and a variety of oils and solvents. Peripheral strength members and aramid yarns are also acceptable. The central FRP strength member should be cylindrical type with helical lay of fiber units.

4.4.4 Filling compound

4.4.4.1 The interstices of the central fiber optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within the fiber optic unit or along the fiber optic cable.

4.4.4.2 The water tightness of the cable shall meet or exceed the test performance criteria as per IEC60794-1-2-F5.

4.4.4.3 The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-nutritive to fungus.

4.4.4.4 The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

4.4.4.5 The filling compound shall remain stable for ambient temperature up to +70°C and shall not drip, flow or leak with age or at change of temperature.

4.4.4.6 Reference method to measure drip point shall be as per IEC 60811-5-1 and drip point shall not be lower than +70°C.

4.4.5 Sheath / inner jacket

4.4.5.1 The sheath shall be black, smooth, concentric, and shall be free from holes, splits, blisters and other surface flaws.

4.4.5.2 The sheath shall be extruded directly over the central fiber optic unit and shall also be non-hygroscopic.

4.4.5.3 The cable sheath design shall permit easy removal without damage to the optical fibers or fiber units.

4.4.5.4 The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethylene- HDPE).

4.4.5.5 The cable core shall be covered with a seamless black sheath mask of U.V. stabilised weather resistant polyethylene incorporating a moisture barrier (swellable components).

4.4.5.6 The outer sheath excluding moisture barrier shall have a minimum thickness of 0.5 mm.

4.4.6 Rip cord

4.4.6.1 Suitable rip cord(s) shall be provided to open the outer sheath of the cable.

4.4.6.2 The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

4.4.7 Loose tube protection

4.4.7.1 The cables shall be of the loose tube type construction. The material used (e.g. PBT) and the tubing process shall be fully described.

4.4.7.2 Loose tube duct type cables shall have 12 fibers per tube for (24, 36, 72, 96 & 144F) and 24 fibers per tube for 288F.

4.4.7.3 Loose tube blown type cables shall have 12 fibers per tube (24, 36, 72 & 96F) and 24 fibers per tube for (24 & 288F)

4.4.7.4 The interstices of the cable core shall be filled with a water swellable compound and the core covered with a plastic wrap.

4.4.7.5 The loose tubes shall be filled with a thixotropic jelly in pulling type FOC.

4.4.7.6 Any material coating on the fibers which required to be removed for splicing purposes shall be readily removable without hazard to either the fiber or personnel

4.4.8 Secondary protection

4.4.8.1 The cables shall be of the tight or semi-tight construction.

4.4.8.2 The method of removal of the secondary protection shall be clearly described by manufacturer including the specific tools, if required.

4.4.9 Cable design & diagram

4.4.9.1 Manufacturer shall submit a detailed cable design & diagram for each type and size of cable. The detailed cable design & diagram shall contain the coding information used to identify the individual cable elements.

4.4.10 Cable mechanical /environmental characteristics

4.4.10.1 The cable temperature characteristics shall be as below:

- Operational - 10^{o}C to $+70^{o}$C
- Storage - 10^{o}C to $+70^{o}$C
- Installation - 10^{o}C to $+70^{o}$C

4.4.10.2 The mechanical characteristics of the pulling type cables and blowing-type cables shall be as per Tables 2 and 3 below:

Table 2 - Mechanical Characteristics for pulling-type cables

Fiber count	**24**	**36**	**96**	**144**	**288**
Fiber count in tube	12	12	12	12	24
Min bending radius: - during installation (mm) - installed (mm)	 200 100	 200 100	 240 120	 280 140	 320 160
Tensile load - short term (during Installation) (N) - long term (Installed) (N)	 1500 600	 1500 600	 1500 600	 1500 600	 2670 800
Crush load (N/10cm)	1000	1000	1000	1000	2200
Nominal Outer diameter (mm)	10	10	12	14	16

Table 3 - Mechanical Characteristics for blowing-type cables

Fiber count	24	36	96	144	288
Fiber count in tube	12	12	24	24	24
Min bending radius: - during installation (mm) - installed (mm)	120 60	120 60	170 85	190 95	240 120
Tensile load - short term (during Installation) (N) - long term (Installed) (N)	600 240	600 240	600 240	1000 400	1000 400
Crush load (N/10cm)	500	600	600	1000	1000
Nominal Outer diameter (mm)	5.8 ± 0.2	5.8 ± 0.2	6.8 ± 0.2	9.2 ± 0.2	11.3 ± 0.2

4.4.11 Colour coding and fiber identification

4.4.11.1 Loose tubes shall be individually coloured for ease of identification. Individual fibers shall also be colour coded.

4.4.11.2 The method used for colouring and tubing fibers shall be fully described.

4.4.11.3 The tube colouring shall follow the same colour code.

4.4.11.4 Fillers shall be of natural colour to fill up the cable core.

4.4.11.5 Individual optical fibers within a fiber unit, and fiber units shall be identifiable in accordance with international standard for fiber optic colour coding scheme TIA-598-D and international standard color for insulation for low-frequency cables IEC 60304/IEC 304 or RAL 9023.

4.4.11.6 The colour coding system shall be discernible throughout the design life of the cable. Colouring utilized for colour coding optical fibers shall be integrated into the fiber coating and shall be homogenous. The colour shall not bleed from one fiber to another and shall not fade during fiber preparation for termination or splicing.

4.4.11.7 Each cable shall have traceability of each fiber back to the original fiber manufacturer's fiber number and parameters of the fiber.

4.4.11.8 If more than the specified number of fibers are included in any cable, the spare fibers shall be tested by the cable manufacturer and any defective fiber shall be suitably bundled, tagged, and identified at the factory.

4.4.11.9 The colouring scheme shall be submitted along with the cable detailed design & drawing by manufacturer for SEC approval.

4.4.11.10 Fiber colours coding shall be as per Table 4 as follows.

Table-4 – Fiber Colour Coding

Fiber core no.	Fiber base colour	Group base colour
1	Blue	Group# 1 - Blue
2	Orange	Group# 1 - Blue
3	Green	Group# 1 - Blue
4	Brown	Group# 1 - Blue
5	Grey	Group# 1 - Blue
6	White	Group# 1 - Blue
7	Red	Group# 1 - Blue
8	Black	Group# 1 - Blue
9	Yellow	Group# 1 - Blue
10	Violet	Group# 1 - Blue
11	Pink	Group# 1 - Blue
12	Aqua	Group# 1 - Blue
13	Blue	Group# 2 - Orange
14	Orange	Group# 2 - Orange
15	Green	Group# 2 - Orange
16	Brown	Group# 2 - Orange
17	Grey	Group# 2 - Orange
18	White	Group# 2 - Orange
19	Red	Group# 2 - Orange
20	Black	Group# 2 - Orange
21	Yellow	Group# 2 - Orange
22	Violet	Group# 2 - Orange
23	Pink	Group# 2 - Orange
24	Aqua	Group# 2 - Orange
25	Blue	Group# 3 - Green
26	Orange	Group# 3 - Green
27	Green	Group# 3 - Green

Fiber core no.	Fiber base colour	Group base colour
28	Brown	Group# 3 - Green
29	Grey	Group# 3 - Green
30	White	Group# 3 - Green
31	Red	Group# 3 - Green
32	Black	Group# 3 - Green
33	Yellow	Group# 3 - Green
34	Violet	Group# 3 - Green
35	Pink	Group# 3 - Green
36	Aqua	Group# 3 - Green
37	Blue	Group# 4 - Brown
38	Orange	Group# 4 - Brown
39	Green	Group# 4 - Brown
40	Brown	Group# 4 - Brown
41	Grey	Group# 4 - Brown
42	White	Group# 4 - Brown
43	Red	Group# 4 - Brown
44	Black	Group# 4 - Brown
45	Yellow	Group# 4 - Brown
46	Violet	Group# 4 - Brown
47	Pink	Group# 4 - Brown
48	Aqua	Group# 4 - Brown
49	Blue	Group# 5 - Grey
50	Orange	Group# 5 - Grey
51	Green	Group# 5 - Grey
52	Brown	Group# 5 - Grey
53	Grey	Group# 5 - Grey
54	White	Group# 5 - Grey
55	Red	Group# 5 - Grey
56	Black	Group# 5 - Grey
57	Yellow	Group# 5 - Grey
58	Violet	Group# 5 - Grey
59	Pink	Group# 5 - Grey
60	Aqua	Group# 5 - Grey
61	Blue	Group# 6 - White
62	Orange	Group# 6 - White
63	Green	Group# 6 - White

Fiber core no.	Fiber base colour	Group base colour
64	Brown	Group# 6 - White
65	Grey	Group# 6 - White
66	White	Group# 6 - White
67	Red	Group# 6 - White
68	Black	Group# 6 - White
69	Yellow	Group# 6 - White
70	Violet	Group# 6 - White
71	Pink	Group# 6 - White
72	Aqua	Group# 6 - White
73	Blue	Group# 7 - Red
74	Orange	Group# 7 - Red
75	Green	Group# 7 - Red
76	Brown	Group# 7 - Red
77	Grey	Group# 7 - Red
78	White	Group# 7 - Red
79	Red	Group# 7 - Red
80	Black	Group# 7 - Red
81	Yellow	Group# 7 - Red
82	Violet	Group# 7 - Red
83	Pink	Group# 7 - Red
84	Aqua	Group# 7 - Red
85	Blue	Group# 8 - Black
86	Orange	Group# 8 - Black
87	Green	Group# 8 - Black
88	Brown	Group# 8 - Black
89	Grey	Group# 8 - Black
90	White	Group# 8 - Black
91	Red	Group# 8 - Black
92	Black	Group# 8 - Black
93	Yellow	Group# 8 - Black
94	Violet	Group# 8 - Black
95	Pink	Group# 8 - Black
96	Aqua	Group# 8 - Black

5 Testing for complete NFOC

5.1 The general conditions for Type, Factory Acceptance Testing & Site Acceptance Testing shall be in accordance with SEC 48-TMSS-02, Rev.01, and the complete type test report shall be submitted for SEC review & approval.

5.2 SEC shall witness the type tests as required

5.3 All type tests shall be conducted on the SEC approved Labs

5.4 Type tests for NFOC

5.4.1 The manufacturer shall submit along with their detailed Design & Drawing Specification with the earlier carried out type test reports and/or Third Party Independent Testing laboratory certificates for the offered fiber optic cable meeting the specified technical requirement.

5.4.2 The manufacturer shall submit the previously carried out type test report for the same design of cable for the tests listed below. The fiber should have been type tested as per relevant International standards for the tests listed below.

5.4.3 All type (design) tests prescribed in the relevant EIA/TIA or equivalent IEC standard shall be performed on the representative unit or on the first unit of every new design or rating to be supplied for SEC approval.

5.4.4 In lieu of the actual type (design) tests, certified test reports of type (design) tests performed on an identical unit may be submitted for SEC review and approval during the prequalification stage.

5.4.5 The type (design) tests are as mentioned in section 5.4.5.1 - 5.4.5.8.

5.4.5.1 Cable cutoff wavelength tests:

a) The cutoff wavelength of the cabled fiber shall be less than or equal to 1250nm and 1450nm for dispersion un-shifted single-mode fiber and non-zero dispersion-shifted single-mode fiber respectively.

b) Measurement shall be as specified in the relevant standard or in accordance with EIA/TIA-455-170.

5.4.5.2 Fluid penetration test:

a) Water ingress tests for cables designed for water blocking shall be performed for one meter cable sample for one hour in accordance with the requirements of EIA-455-82B or IEC 60794-1-FSB.

b) No water shall leak through the open end of 1 m sample. If the first sample fails, one additional 1m sample, taken from a section of cable adjacent to the

first sample may be tested for acceptance. Water leakage from second sample shall constitute failure.

5.4.5.3 Compound flow (drip) test:

a) A 0.3 m sample of NFOC shall be tested in accordance with EIA/TIA-455-81b.
b) The sample shall be prepared per method A of EIA/TIA-455-81b. The filling and flooding compound shall not flow (drip or leak) at 65°C.

5.4.5.4 Vibration test:

a) Vibration test shall be carried out in accordance with EIA-455-11D.
b) Any significant damage to any component of the composite NFOC, permanent or temporary increase in optical attenuation greater than 1.0dB/km at 1310 nm or 1550 nm for single –mode fibers shall constitute failure.

5.4.5.5 Crush test and impact test:

a) A crush and an impact tests shall be performed in accordance with EIA-455-25C and EIA-455-41A or IEC 60794-1-E3 and IEC60794-1-E4.
b) A permanent or temporary increase in optical attenuation value greater than 0.1 dB change in sample at 1310 nm or 1550 nm for single mode fibers shall constitute failure.

5.4.5.6 Rated strength test on completed NFOC:

a) The breaking strength of the completed NFOC shall not be less than the specified rated breaking strength of the NFOC unless the failure occurs in the gripping device.
b) If the failure occurs in the grip, the test value must not be less than 95% of the specified rated breaking strength.

5.4.5.7 Tensile loading and bending test:

a) Tensile loading and bending tests shall be performed on cable sample in accordance with ITU-T G62D, EIA/TIA-455-33B or IEC 60794-1-E1 and IEC 60794-1-E6.
b) Any visual damage to the conductor strands or permanent or temporary increase in optical attenuation greater than 0.2 dB/km at 1310 nm or 1550nm for single mode fibers shall constitute failure.

5.4.5.8 Micro-bending:

a) Micro bending measurement shall be made in accordance with EIA/TIA-455 or equivalent IEC standards.

5.5 Cable routine (production) tests

5.5.1 All routine (production) tests prescribed in the relevant EIA/TIA or equivalent IEC standards shall be performed on all units prior to delivery for SEC approval..

5.5.2 Tests for mechanical and physical properties of messenger support or strength member shall be made before assembly.

5.5.3 The routine tests consists of the optical acceptance test:

a) Attenuation test shall be performed on each fiber of each individual reel in accordance with EIA/TIA 455-61A or IEC 60793-I-CIC.

b) Measurement shall be made from both directions if accessible and the results shall be averaged. Attenuation loss values exceeding those specified shall constitute failure.

5.6 Fiber type tests

5.6.1 All type (design) tests prescribed in the relevant EIA/TIA or equivalent ICE standards shall be performed on the representative unit or on the first unit of every new design or rating to be supplied for SEC approval..

5.6.2 In lieu of the actual type (design) tests, certified test reports of type (design) tests performed on an identical unit shall be submitted, or the cable manufacturer shall submit reports in the form of batch test reports furnished by the core manufacturer, provided that the core supplied for SEC approval. is out of the same batch and the core manufacturer is listed in the SEC approved list.

5.6.3 All the required test reports shall be submitted for SEC review and approval during the bidding stage.

5.6.4 The Type (design) tests are as follows in Sections 5.6.4.1 – 5.6.4.10.

5.6.4.1 Attenuation variation with wavelength:

a) The measurement shall be made in accordance with EIA/TIA 455-78B or IEC 60793-1-CIA.

b) The spectral width of the source shall be less than 10 nm.

c) The attenuation coefficient of un-shifted single mode fibers for wavelength between 1285 nm and 1310nm shall not exceed the attenuation coefficient at 1330 by more than 0.1dB/km.

5.6.4.2 Attenuation with bending:

a) Attenuation with bending measurements shall be made in accordance with EIA/TIA 455-62A or IEC 60793-1-c11.

b) The two attenuation with bending requirements are measured by winding 100 turns of fiber on a collapsible reel or removable mandrel of 75mm ± 2 mm diameter and by wrapping a single turn of fiber around a 32 ± 0.5 mm diameter mandrel.
c) Attenuation shall not exceed 0.35 dB at 1310 nm.
d) Attenuation shall not exceed 0.5 dB at 1550 nm

5.6.4.3 Temperature cycling test:
a) Temperature cycling measurement shall be made in accordance with EIA/TIA 455-3B or IEC 60793-1-D1, using test condition A, -10°C to + 70 °C, 2 cycles.
b) The change in attenuation between extreme operational temperatures for single mode fibers shall not be greater than 0.05dB/km at 1310nm and 1550nm.

5.6.4.4 Attenuation at the water peak:
a) For un-shifted single mode fiber, the attenuation coefficient at the water peak found within 1383 nm shall not exceed 3 dB/km.
b) The attenuation coefficient of un-shifted single mode fibers for wavelength between 1285 nm and 1310nm shall not exceed the attenuation coefficient at 1330 by more than 0.1dB/km.

5.6.4.5 Mode field diameter:
a) Mode field diameter shall be measured in accordance with EIA-455-174.
b) The measurement wavelength as a minimum shall be 1310 + 20 nm for dispersion un-shifted single mode fibers.
c) The nominal mode field diameter (MFD) for dispersion-un shifted single-mode fibers shall be 9-10μm ± 5% at 1300-1323nm.

5.6.4.6 Concentricity error:
a) Core-to-Clad concentricity error measurements shall be mad in accordance with EIA/TIA 455 or ICE 60793-1-A2.
b) Concentricity error- the offset between the center of the core and the center of the cladding shall be < 1.0 micron.

5.6.4.7 Cladding diameter:
a) Cladding Diameter and non-circularity error measurements shall be in accordance with EIA/TIA 455 or IEC 60793-1-A2.
b) Cladding diameter - the cladding outside diameter shall be 125.0 microns ± 2.0% microns. Cladding non circularity – the cladding non circularity shall be <2%.

5.6.4.8 Fiber tensile proof test:

a) Individual fibers shall be proof tested in accordance with EIA/TIA 455-31C, or IEC 60793-1-B1.
b) All fibers shall be subjected to a minimum proof stress of 0.35 GN/m2 for one second equivalent by the fiber manufacturer (100% testing).

5.6.4.9 Chromatic dispersion:

a) Dispersion measurements shall be made in accordance with EIA/TIA 455-168B or IEC 60793-1-C5C.

5.6.4.10 Coating diameter:

a) Coating diameter measurements shall be made in accordance with EIA/TIA 455-55c, or IEC60793-1-A3 as a sample test for each contract.
b) Coating diameter - the nominal coating diameter for loose buffer shall be 250 microns

5.7 Fiber routine (production) tests

5.7.1 All routine (productions) tests prescribed in the relevant EIA/TIA or equivalent IEC standards shall be performed on all units prior to delivery to SEC.

5.7.2 The routine tests are as follows in Sections 5.7.2.1 – 5.7.2.2

5.7.2.1 Attenuation coefficient:

a) Single mode fiber attenuation measurements shall be made in accordance with EIA/TIA 455-78B.
b) Spectral attenuation shall be modeled according to ITU-T-G.652 if OTDRs are used, measurements shall be made from both directions and the results shall be averaged if accessible.
c) The attenuation coefficient shall be 0.45 dB/km or less at 1300 nm and 0.25 dB/km or less at 1550 nm wavelength.
d) All the traces (hard copies) shall provide at least the following information other than the standard data provided by the OTDR.
   i. For the graphical representation of the trace, sufficient acquisition time shall be set OTDR for the straight line of the graph. Hazy lines due to insufficient acquisition time shall constitute failure.
   ii. All traces shall clearly identify fiber number, binder colour (group identifier) and fiber colour.
   iii. All traces shall be furnished with the fiber-ID and the drum/reel number and physical length of the cable ordered for cross reference.

5.7.2.2 Fiber point defects:

a) Attenuation uniformity shall be measured in accordance with EIA/TIA 455-59 or IEC 60793-1-C1C. Measurement shall be made bi-directionally, if accessible and there results shall be averaged.
b) The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no discontinuities in excess of 0.1 dB for single mode fiber.

5.8 Field acceptance testing

5.8.1 Upon receipt of the NFOC from the manufacturer, the purchaser shall at his option, perform acceptance tests in order to verify that the optical characteristics of the fiber meet the order requirements and to determine if optical fibers have been damaged during shipment.

5.8.2 The results of these tests and the manufacture's certified quality control information, which is attached to each reel, shall be compared to the fiber requirements specified in the purchase order.

5.8.3 The tests shall be performed and documented by the use of optical time domain reflectometer (OTDR). The end of the cable shall be sealed after completion of these tests in order to prevent entry of moisture into the optical fiber. Tests shall be performed from both ends and results shall be averaged.

5.8.4 The following tests shall be performed in accordance with EIA/TIA-455 or equivalent IEC standards.

5.8.4.1 Fiber continuity: Continuity checks of each fiber may be made to determine if any fiber is broken or any attenuation irregularities exist.

5.8.4.2 Attenuation: Total attenuation for the entire reel length and attenuation per kilometer should be measured on each fiber. Attenuation uniformity shall meet the requirements of section 5.6.4.4.

5.8.4.3 Fiber length: The fiber length may be measured using the OTDR. The index factor to be used in this measurement should be furnished by the fiber manufacturer. A check should be made to verify received reel numbers and lengths correspond to ordered quantities.

6 Packing and shipping

6.1 In addition to the applicable items of 01-SDMS-01, Rev 01, the following packing and shipping instructions are applicable in accordance with SEC 48-TMSS-02, Rev.01

6.2 Progressive length on the cable shall be marked at 1 m (one meter) intervals.

6.3 The NFOC ends shall be sealed with a waterproof, heat shrinkable plastic or elastomeric end cap with adhesive type sealing compound. NFOC ends shall be properly secured to the reel.

6.4 The NFOC shall be delivered without splices, on standard sized non-returnable wood drums properly packed and lagged externally to prevent the cable from possible damage during transportation. Wood lagging shall be used and have a minimum thickness of 19 mm.

6.5 For all NFOC purchases, the standard order length shall be 2000 meters. For NFOC intended for turnkey projects, the order length shall be as specified by SEC.

6.6 Cable sheath marking

6.6.1 Cable sheath shall be marked in white colour with Hot Foil Indentation method. Marking details can be customized. Below mentioned details are generally marked on the cable sheath. Telephone Symbol, Laser Symbol, Number of Fibers, Type of Fiber (G 652 D), Duct, Month & Year of Manufacturer, Customer Name, Sequential Meter Marking & Drum Number.

6.7 Reel markings

6.7.1 NFOC reels/drums shall be marked in legible and indelible letters giving the following particulars:

a) Number of optical fibers
b) Non-metallic fiber optic cable description
c) Length and weight of NFOC on reel
d) Gross weight
e) Dimensions of reel
f) Manufacturer’s name and country of origin
g) SEC purchase order number/contract number
h) Serial number of reel
i) SEC stock number in 10 cm high bold numerals
j) Direction of rolling of reel

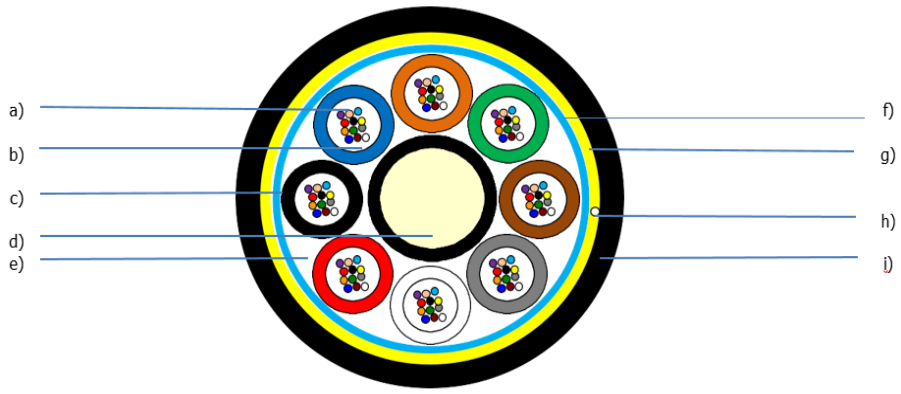
6.7.2 All markings shall appear on both sides of the reel. Reel marking locations shall be shown in Specified Figure.

6.7.3 NFOC reel identification shall include any additional information & labelling as required by SEC shipping instructions.

7 Appendix

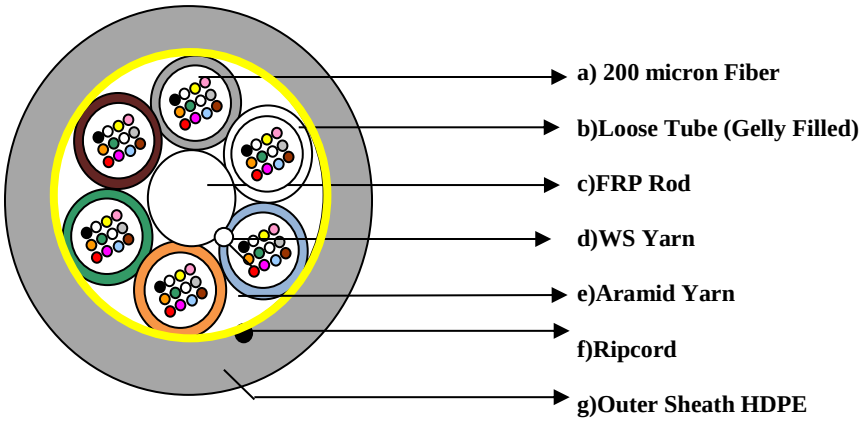
7.1 Typical cross section for Conventional FO cable for Pulling Installation:

Legend: a) 250 Micron Colored fiber b) Water Blocking Jell filling c) Loose tube jelly filled d) Central Strength Member e) Water swellable yarn f) binder g) Peripheral Strength Member h) Ripcord i) Outer Jacket HDPE



7.2 Typical cross section for Mini FO cable for Blowing Installation:

Legend: a) 200 Microns Colored fiber b) Loose tubes with Filling Gelly c) Central Strength Member (FRP rod) d)Water Swellable yarn e) Aramid yarn f) Ripcord g) Outer Jacket HDPE



8 Data schedule

<Blank data schedule provided here. To be updated by vendor>

Technical data shedule of xx/xx/xx fiber (G.652d)

Multi loose tube design, single sheath, unarmoured optical fiber cable suitable for duct installation

Fiber optic cable containing xx-SMF in full compliance with ITU-T G 652 D. The offered cables should be fully compliant to the relevant IEC specifications.

- Upto xxx enhance low water peak single mode fibers in full compliance with ITU-T-G652D.
- Non-metallic and anti-buckling element FRP rod used as Central Strength Member.
- Central Strength Member upcoated by HDPE Black
- Loose buffer tubes fully filled Thixotropic Jelly
- Loose buffer tubes S-Z Stranded
- Cable core is fully filled with Thixotropic Jelly
- Aramid yarn used as peripheral strength member.
- Cable core is wrapped with Polyester Tape
- Outer Sheath UV Stabilised HDPE Black
- Application:
    - Inside Duct pulled or blown
    - In areas with particularly high mechanical loads
- Special features:
    - Single layer stranded construction
    - Flexible buffer tubes provide easy fiber routing inside closure

Description	Unit	Specified values	Vendor proposed values
Mechanical characteristics:			
Temperature Range (IEC 60794-1-2-F1)			
Laying and Installation			
Operation			
Transport and Storage			
Cable Bending Radius (IEC 60794-1-2-E11A)			
During Installation (Full Load)			
Installed (No Load)			
Repeated Bending (IEC 60794-1-2-E6)			
Tensile Force (IEC 60794-1-2-E1)			

Torsion Resistance (IEC 60794-1-2-E7)			
Crush Resistance (IEC 60794-1-2-E3)			
Impact Resistance (IEC 60794-1-2-E4)			
Kink Resistance (IEC 60794-1-2-E10)			
Water Penetration (IEC 60794-1-2-F5B)			
Optical characteristics:			
Fiber used in the cable manufacturing fully comply to ITU-T-Rec G 652 D			
at 1310 nm			
at 1550 nm			
Color coding (for 36F to 144F)			
Colour of Fibers in a Loose Tube			
Colour of Loose Tubes (36F) :			
Colour of Loose Tubes (48F) :			
Colour of Loose Tubes (72F) :			
Colour of Loose Tubes (96F) :			
Colour of Loose Tubes (144F) :			
Cable construction details			
Primary Coated Fiber			
Tube Filling Compound			
Loose Tube(s) (D= 2.4mm, Nom)			
Central Strength Member (D= 2.5mm, Nom)			
Cable Filling Compound			
Core Wrapping			
Perephral Strength Member			
Rip Cords			
Outer Sheath (T = 1.6 mm Nom)			
Delivery information			
Nominal Cable Weight (Kg/Km)			
Nominal Cable Diameter (mm)			
Standard Length per Drum (Mtr)			
Cable sheath marking			
Sheath marking as per Section 6.6.1			
Cable drum packing			
Length delivered as per Section 6.4, 6.5			

Arrow with direction for rolling the drum			
Country of origin			
The manufacturer's name			
Number of fibers			
Nominal cable length in meters			
Net and gross weight			
Drum number			
Customer's name and destination			