# वर्गीय आवश्यकताओं के लिए मानक

# टीईसी ८५२००:२०२२

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# STANDARD FOR GENERIC REQUIREMENTS

# TEC 85200:2022

(Supersedes No.: TEC/GR/TX/OFC-024/01/MAR-15)

# एरियल ड्रॉप ऑप्टिकल फाइबर केबल (लास्ट माइल एप्लिकेशन के लिए)

# Aerial Drop Optical Fibre Cable (For Last Mile Applications)

ISO 9001:2015


**दूरसंचार अभियांत्रिकी केंद्र**

**खुर्शीदलाल भवन, जनपथ, नई दिल्ली-110001, भारत**

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## Release 2: MAR, 2022

# FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata

# ABSTRACT

This document pertains to Standard for Generic Requirements of Aerial Optical Fibre Cable (Metal free) for Drop applications i.e. between two points on the aerial alignment (Pole to pole/ Pole to building) up to 100 meter of span length. This cable is used in the FTTH network for last mile applications.

# CONTENTS

# HISTORY SHEET

| *S.No.* | *GR No.* | *Title* | *Remarks* |
|---|---|---|---|
| 1. | TEC/GR/TX/OFC-024/01/MAR-15 | Generic Requirement for Aerial Drop Optical Fibre Cable with Installation Accessories (For Last Mile Applications) | Release 1 |
| 2. | Standard No. TEC 85200:2022 | Standard for Generic Requirement of Aerial Drop Optical Fibre Cable (For Last Mile Applications) | Release 2<br>• Renamed as Standard for GR<br>• GR format modified as per latest format for Standard for GR<br>• Renamed as Aerial Drop Optical Fibre Cable (For Last Mile Applications) and GR for Installation Accessories for cable (GR No. TEC/GR/TX/ OAF-001/03/MAR-17) referred<br>• G. 657 A2 fibre added<br>• Fibre Bundling design is replaced with Ring Marker<br>• Clause for “Installation Accessories for cable” deleted |

# REFERENCES

| *S.N.* | *Document No.* | *Title/Document Name* |
|---|---|---|
| 1. | TEC/GR/TX/OAF-001/03/MAR-17 | Generic Requirements for Installation Accessories & Fixture for Self Supporting Metal Free ADSS Optical Fibre Cable |
| 2. | GR/OFT-01/03. APR 2006 | Generic Requirements for Tools For Installation & Operating the OFC & for Assembly of the Optical Fibre Splice Closures |
| 3. | TEC/GR/TX/OJC-002/03/APR-2010 | Generic Requirements for Optical Joint Closure |
| 4. | TEC 89010:2021 | Standard for Generic Requirements for Raw Material for manufacturing Optical fibre cable |
| 5. | G/CBD-01/02 NOV'94 | Generic Requirements for Wooden Drums |
| 6. | IEEE 1222: 2019 | IEEE Standard for All Dielectric Self-Supporting Fibre Optic Cable |
| 7. | ITU-T Rec. G.657 | ITU-T Recommandation |
| 8. | GR-20 – July 2013, issue 4 | Generic Requirement for Optical Fibre cable (Telcordia document) |
| 9. | IEC 60793-1, IEC 60793-2-50 | Test method for Optical Fibres |
| 10. | ISO ISO 9001:2015 | International Quality Management System. |
| 11. | EIA 359-A<br>IEC Publication 304(4)<br>TIA 598D, IEC TR 63194 Latest Issue | Color Standards<br>Color Standards |
| 12. | EIA RS-455-37 | Test Methods |

| | | |
|---|---|---|
| 13. | IEC 60794-1-2- E1, IEC 60794-1-2-E2,<br>IEC 60794-1-2-E3, IEC 60794-1-2-E4,<br>IEC 60794-1-2-E6, IEC 60794-1-2-E7,<br>IEC 60794-1-2-E9, IEC 60794-1-2-E10,<br>IEC 60794-1-2-E11, IEC 60794-1-2-F1,<br>IEC 60794-1-2-F3, IEC 60794-1-2-F5,<br>IEC 60068-2-1, IEC 61395, IEC 189<br>IEC 60794-1-20, IEC 60794-1-21,<br>IEC 60794-1-22, IEC 60794-1-23 | Test Methods |
| 14. | IEC 60794-4 | Test Methods for Aerial Optical Fibre Cables along Electrical PowerLines |
| 15. | ASTM D 566, ASTM D-790,<br>ASTM D 1248, ASTM D 1693,<br>ASTM G-53-96, ASTM D 1603,<br>ASTM D 1693, ASTM D 638,<br>ASTM D 817, ASTM D 3895,<br>ASTM D 3349, ASTM D 746,<br>ASTM G 53, ASTM D 150,<br>ASTM D 149, ASTM D 257,<br>ASTM D 2303-85, | |
| 16. | FOTP-62, FOTP-89 | Test Methods |

# CHAPTER-1

## 1.0 Introduction:

This document describes the Standard for generic requirements of Metal Free Aerial Drop Optical Fibre Cable for installation between two points on the aerial alignment (Pole to pole/ Pole to building) up to 80 meters of span length with Ice loading and 100 meters without Ice loading. This cable can be used for the FTTH network for last mile application. The Metal Free Aerial Optical Fibre Cable shall have low weight, small volume and high flexibility. The optical fibre cable shall have good mechanical protection with stable temperature performance conditions, as it will be exposed to varying environmental conditions. The raw material used in the cable shall meet the requirements of the GR for raw materials (Standard No.TEC 89010:2021 (or latest release) and subsequent amendments, if any.

## 2.0 Description:

Aerial Optical Fibre cables are very easy to deploy for drop application. Fig.1 shown below is a typical architecture of FTTH network.

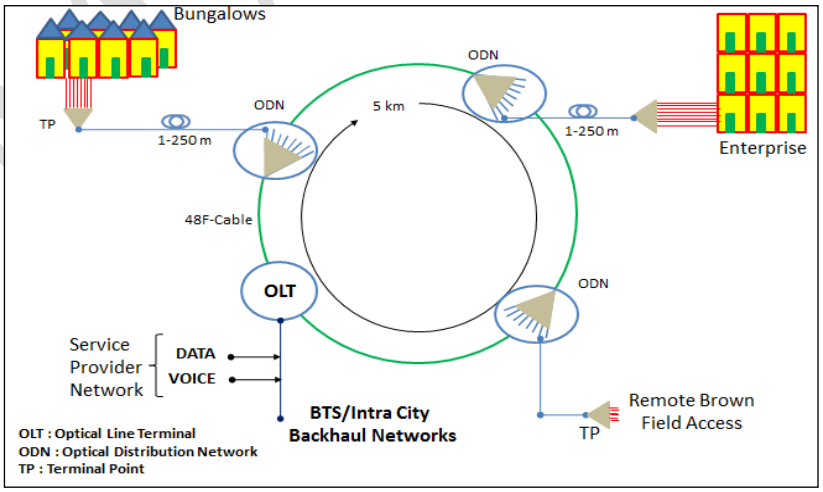



**Figure 1: FTTX Architecture**

## 3.0 Functional Requirements:

3.1 The design and construction of aerial metal free optical fibre cable shall be inherently robust and rigid under all conditions of installation, operation, adjustment, replacement, storage and transport.

3.2 The optical fibre cable shall be able to work in saline atmosphere in coastal areas and should be protected against corrosion.

3.3 Life of cable shall be at least 25 years. Necessary statistical calculations shall be submitted by the manufacturer, based upon life of the fibre and other component parts of the cable. The cable shall meet the cable aging test requirement.

**Note:** Each Raw Material manufacturer shall define the life and lifetime calculation of the individual raw material.

3.4 The Aerial Drop Optical Fibre Cable shall be suitable and compatible with the dimensions, fixing, terminating & splicing arrangement of the Splice closure supplied along with the cable & vice versa. The cable supplied shall also meet the other requirement of the splice closure GR No. TEC/GR/TX/OJC-002/03/APR-2010 & subsequent amendments, if any.

3.5 It shall be possible to operate and handle the Aerial Drop Optical Fibre Cable with tools as per GR No. GR/OFT-01/03. APR 2006 and subsequent amendment, if any. If any special tool is required for operating and handling this optical fibre cable, the same shall be provided along with the cable.

3.6 It shall be possible to install the Aerial Drop Optical fibre cable with Accessories and Fixtures as per the GR No. TEC/GR/TX/OAF-001/03/MAR-17 and subsequent amendments, if any. If any special Accessories and Fixtures are required for installation of the cable, the same shall be provided along with the cable. The accessories required for mounting the splice closure on towers shall also be supplied along with cable.

3.7 The manufacturer shall submit an undertaking that the optical and mechanical fibre characteristics shall not change during the lifetime of the cable against the manufacturing defects.

3.8 The Self Supporting Metal Free Aerial Optical Fibre cable shall be designed and manufactured to meet the following conditions of operation, installation and storage :

a) Maximum Span length : 100m without Ice loading
80m with Ice loading

b) Maximum ice loading : 1 Kg per meter

c) Operational wind velocity : 75 Kms per hour

d) Sag of the span length:-

i) Maximum Installation sag allowed : 1 % of the span length

ii) Maximum Operational sag allowed : 2 % of the span length

e) Temperature range: -

i) Operation : - 20° to + 70° C

ii) Installation : - 15° to + 50° C

iii) Storage : - 20° to + 70° C

f) Tensile force design parameter : 9.81 x 2.5 x W or 1000 N whichever is higher.

(Note: W is the mass of one kilometer length of the cable in Kg.)

g) Minimum bending Radius : 10 D (D-dia of the cable)

## 4.0 Technical Requirements:

Single Mode Optical Fibre is used in manufacturing optical Fibre Cables shall be as per ITU-T Rec. G 657 A1 or A2 (Optional). The specification of Optical fibre shall be as per Section-I (Type-V) of Standard No.TEC 89010:2021(or latest release) and subsequent amendments if any.

**4.1 Type of fibre** (Wavelength band optimized nominal 1310 nm):
Single mode (Section I (Type-V) of the TEC Standard No.TEC 89010:2021(or latest release) and subsequent amendments, if any.

**4.2 Geometrical Characteristics:**
(All the parametric values shall be as per latest Standard for GR of Raw Material for manufacturing Optical fibre cable)

4.2.1 Nominal MFD for matched clad (at 1310nm):

Table-I/V-1: Mode field diameter at 1310nm

| SN | Parameter | A1 Fibre | A2 Fibre |
|---|---|---|---|
| 1 | MFD at 1310nm | (8.8 - 9.2) ± 0.4 µm | 8.6 ± 0.4 µm |

4.2.2 Nominal Cladding Dia. : 125 µm ± 0.7µm

4.2.3 Cladding Non-circularity : ≤ 0.8 %

4.2.4 Core Clad concentricity error : ≤ 0.5 µm

4.2.5 Diameter over primary coated with double UV cured acrylate. : 242 ± 5 µm
(Shall be measured on un-colored fibre)

**Note:** The thickness of colour coating may be over and above the values specified above, if the manufacturer adopts separate UV cured colouring process (to colour the un-coloured fibres) other than the on line integrated colouring process (of secondary layer of primary coating) of the fibres, during fibre manufacturing.

4.2.6 Colored fibre coating diameter : 252 ± 10µm

4.2.7 Coating/Cladding Concentricity : ≤ 12 µm

## 4.3 Transmission Characteristics:

All the parametric values shall be as per latest Standard for GR of Raw Material for manufacturing Optical fibre cable.

4.3.1 Attenuation:

a) Fibre attenuation before Cabling

Table-I/V-2: Fibre attenuation before cabling

| SN | Parameter | A1 Fibre | A2 Fibre |
|---|---|---|---|
| I | At 1270 nm | ≤ 0.40 dB/Km | ≤ 0.40 dB/Km |
| ii | Between 1285 to 1360 nm | ≤ 0.37 dB/Km | ≤ 0.38 dB/Km |
| iii | At 1310 nm | ≤ 0.34 dB/Km | ≤ 0.35 dB/Km |
| iv | Between 1360 – 1480 nm | ≤ 0.34 dB/Km | ≤ 0.35 dB/Km |
| v | At 1490 nm | ≤ 0.24 dB/Km | ≤ 0.24 dB/Km |
| vi | Between 1480 to 1525 nm | ≤ 0.34 dB/Km | ≤ 0.34 dB/Km |
| vii | At 1550 nm | ≤ 0.20 dB/Km | ≤ 0.21 dB/Km |
| viii | Between 1525 to 1625 nm | ≤ 0.24 dB/Km | ≤ 0.24 dB/Km |
| ix | At 1625 nm | ≤ 0.23 dB/Km | ≤ 0.23 dB/Km |

b) Fibre attenuation after Cabling

Table-I/V-3: Fibre attenuation after cabling

| SN | Parameter | A1 Fibre | A2 Fibre |
|---|---|---|---|
| i | At 1310 nm | ≤ 0.36 dB/km | ≤ 0.37 dB/km |
| ii | At 1383 nm | ≤ attenuation at 1310 nm | ≤ attenuation at 1310 nm |
| iii | At 1490nm | ≤ 0.26 dB/Km | ≤ 0.26 dB/Km |
| iv | At 1550 nm | ≤ 0.22 dB/Km | ≤ 0.23 dB/Km |
| v | At 1625 nm | ≤ 0.25 dB/Km | ≤ 0.25 dB/Km |

**Note:**

1. Attenuation in the band 1380-1390nm shall be checked at every 2nm after Hydrogen aging as per IEC 60793-2-50. Hydrogen ageing test is to be carried out by CACT, Bangalore or any other recognized laboratory for type test.
2. Sudden irregularity in attenuation shall be less than 0.1 dB
3. The spectral attenuation shall be measured on un-cabled fibre in the 1250 nm–1625 nm band at an interval of 10nm shall be measured and the test results shall be submitted.

### 4.3.2 Dispersion:

a) Total Dispersion

i) In 1285-1330 nm band : ≤ 3.5 ps/nm.km

ii) In 1270-1340 nm band : ≤ 5.3 ps/nm. Km

iii) At 1550 nm. : ≤ 18.0 ps/nm. Km

iv) At 1625 nm. : ≤ 22.0 ps/nm.Km

**Note:** The dispersion in the 1250 nm–1625 nm band shall be measured at an interval of 10nm and the test results shall be submitted.

b) Polarization mode dispersion at 1310 & 1550 nm.

i) Un-cabled Fibre : ≤ 0.15ps/√km (A1)

: ≤ 0.2ps/√km (A2)

ii) Cabled Fibre : ≤ 0.3 ps/√ 'km

iii) Link design value for cabled fibre : ≤ 0.2 ps/√km

iv) Link design value for un-cabled fibre : ≤ 0.06ps/√km

**Note:** Measurement on un-cabled fibre may be used to generate cabled fiber statistics and correlation is established.

c) Zero Dispersion Slope : ≤ 0.092 ps/(nm 2 Km)

d) Zero dispersion wave length range : 1300 -1324 nm

4.3.3 Cable cut off wavelength : 1260 nm Max.

**Note:** The above cut off wavelengths is w.r.t. 22M sample length of fibre

## 4.4 Mechanical Characteristics:

All the parametric values shall be as per latest Standard for GR of Raw Material for manufacturing Optical fibre cable.

4.4.1 Proof test for minimum strain level : 1%
(Test method IEC-60793-1-30)

4.4.2 Stripability force to remove primary coating of the Un-aged and Aged fibre (Water aged and Damp heat aged) (Test method IEC- 60793 - 1 - 32)

i) Peak strip force: 1≤ N ≤ 8.9N

ii) Average strip force: 1≤ N ≤ 5N

**Note**: The force required to remove 30 mm ± 3 mm of the fibre coating shall not exceed 8.9 N and shall not be less than 1N for 250 µm fibre and 0.4 N for 200 µm fibre.

4.4.3 Dynamic Tensile Strength (Test method IEC- 60793-1-31)

a) Un-aged : ≥ 550 KPSI (3.80 GPa)

b) Aged (Damp heat aged) : ≥ 440 KPSI (3.00 GPa)

4.4.4 Dynamic Fatigue (Test method IEC- 60793 –1-33)

a) Un-aged : ≥ 20

b) Aged (Damp heat aged) : ≥ 20

4.4.5 Fibre Macro bend

(Test method FOTP–62/ IEC- 60793-1–47)

a) Change in attenuation when fiber is coiled : ≤ 0.25dB at 1550nm(A1)
with 10 turns on 15 mm radius mandrel : ≤ 1.0dB at 1625nm (A1)
≤ 0.03dB at 1550nm(A2)
≤ 0.1dB at 1625nm (A2)

b) Change in attenuation when fiber is coiled : ≤ 0.75dB at 1550nm(A1)
1 turn around 10 mm radius mandrel ≤ 1.5 dB at 1625nm (A1)
≤ 0.1 dB at 1550nm (A2)
≤ 0.2 dB at 1625nm (A2)

c) Change in attenuation when fibre is coiled ≤ 0.5dB at 1550nm (A2)
1 turn around 7.5 mm radius mandrel ≤ 1.0 dB at 1625nm (A2)

4.4.6 Fibre Curl (Test method IEC- 60793 – 1- 34) : ≥ 4 Meter radius of Curvature

## 4.5 MATERIAL PROPERTIES:

(As per latest Standard for GR of Raw Material for manufacturing Optical fibre cable)

4.5.1 Fibre Materials:

a) The substances of which the fibres are made : To be indicated by the manufacturer

b) Protective material requirement:

i) The physical and chemical properties: of the material used for the fibre primary coating and for single jacket fibre. It shall meet requirement of fibre stripping force as per clause No. 4.4.2

ii) The best way of removing protective coating material. : To be indicated by the manufacturer

c) Group refractive Index of fibre : To be indicated by the manufacturer

**Note:** The manufacturer shall indicate the variation in group refractive index of fibre during bulk production.

d) Fibre materials shall be RoHS (Restriction of Hazardous Substance) complied.

## 4.6 Environmental Characteristic of Fibre:

(As per latest Standard for GR of Raw Material for manufacturing optical fibre cable)

4.6.1 Operating Temperature

(Test Method IEC – 60793 – 1)

Temperature Dependence of Attenuation : - 60° C to +85° C

Induced Attenuation at 1550 nm & 1625nm

at -60°C to +85° C : ≤ 0.05 dB/km

4.6.2 Temperature – Humidity Cycling

(Test method IEC- 60793 – 1)

Induced Attenuation at 1550 nm & 1625nm

at -10°C to +85°C and 95% relative humidity : ≤ 0.05 dB/km

4.6.3 Water Immersion 23°C
(Test method IEC- 60793 – 1)
Induced Attenuation at 1550 nm & 1625nm
due to Water Immersion at 23 ± 2°C : ≤ 0.05 dB/km

4.6.4 Accelerated Aging (Temperature) 85°C
(Test method IEC- 60793 – 1)
Induced Attenuation at 1550 nm & 1625nm
due to Temperature Aging at 85 ± 2°C : ≤ 0.05dB/km

4.6.5 Retention of Coating Color
(Test method IEC- 60793 – 1)
Coated Fiber shall show no discernible with change in color, when aged for relative humidity : 30 days at 85°C 95% Humidity & then 20 days in 85°C dry

4.6.6. High Temperature and High Humidity (Damp Heat)
(Test Method IEC 60793-2-50)
Induced attenuation at 1550nm & 1625nm at 85°C and 85% Relative Humidity for 30 days : ≤ 0.05dB/km

**4.7 Colour Qualification and Primary Coating Test :**

(As per latest Standard for GR of Raw Material for manufacturing Optical fibre cable)

4.7.1 Colour Qualification Test:

a. MEK Rub Test (Methyl Ethyl Ketone):
To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No colour traces shall be observed on the tissue paper after testing.

b. Water immersion Test (Type Test):

To be tested for coloured fiber for 30 days. After the test Colour qualification, Attenuation measurement & Strippability test are to be taken.

4.7.2 Primary coating Test (Type Test):

a) Fourier Transform Infrared Spectroscopy (FTIR) Test:

To be tested to check the curing level of coating on the surface of natural fibre. The curing level shall be better than 90%.

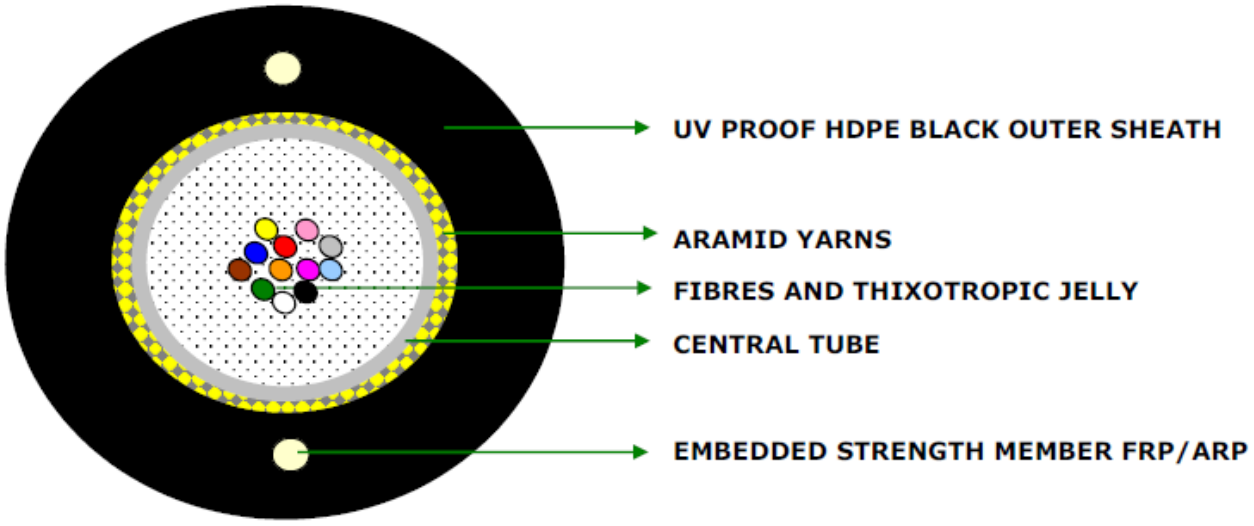
b) Adhesion Test:

To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No coating shall be observed on the tissue paper after testing.

## 4.8 Aerial Drop Optical Fibre Cable Construction Specifications:

The cable shall be designed to the parameters mentioned in Annexure–A. The manufacturer shall submit designed calculation and the same shall be studied and checked.

TYPICAL STRUCTURAL DRAWING FOR 12 FIBRE OF CABLE




### 4.8.1 Secondary Protection (Buffer tube):

The primary coated colored fibres shall be protected by loose packaging within a tube which shall be filled with thixotropic jelly. Ring marking shall be used in the cable with more than 12 fibres.

**4.8.2 Number of fibres** : Up to 12 & 24

(Approval for a cable shall be issued depending upon the no. of fibres in the cable)

### 4.8.3 Reinforcement:

The cable shall be helically reinforced with Aramid Yarn in the periphery over the loose tube. The Aramid Yarn shall be uniformly and equally

distributed on the entire periphery (circumference) of the buffer tube. The quantity of the Aramid Yarn used per kilometer length of the cable shall be as per requirement in Annexure I. The Aramid Yarn shall be as per Section XVII of Standard No.TEC 89010:2021 (or latest Issue) and the subsequent amendments, if any.

### 4.8.4 Filling compound:

The filling compound used in the buffer tube shall be compatible to fibre, secondary protection of fibre etc. The drip point shall not be lower than +70º C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. The test method to measure drop point shall be as per ASTM D 566. The filling jelly compound shall be as per TEC Standard No.TEC 89010:2021(or latest issue) and the subsequent amendments, if any.

### 4.8.5 Outer Jacket:

A circular and uniform tough weather resistant UV Stabilized polyethylene compound HDPE material sheath/Jacket, black in colour, shall be provided over and above the reinforcement of Aramid Yarn. The thickness of the outer sheath/Jacket shall be minimum1.8mm. The sheath shall be free from pin holes, joints, scratches, mended pieces and other defects etc. and it shall have smooth finish.

**Note:**

HDPE material (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per TEC GR No. Standard No.TEC 89010:2021(or latest issue) and the subsequent amendments, if any:

i) Density
ii) Melt Flow Index

iii) Carbon Black Content

iv) Carbon Black Dispersion

v) ESCR

vi) Moisture Content

vii) Tensile Strength and Elongation at break

### 4.8.6 Strength Member (Embedded):

Solid FRP/ARP non-metallic strength member embedded in the outer jacket. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. This shall also keep the fibre strain within permissible values.

### 4.8.7 Rip Cord:

a. Two suitable ripcords shall be provided in the cable which shall be used to open the outer sheath of the cable. The ripcords shall be placed diametrically opposite to each other. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature.

b. The rip cord used in the cable shall be readily distinguishable from any other components (e.g. Aramid Yarn, Glass Yarns etc.) utilized in the cable construction. The rip cord shall be as per Section XVII of the GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and the subsequent amendments, if any.

### 4.8.8 Cable parameter:

The manufacturer shall define all the cable parameters. The parameters of finished cable shall be as per Annexure-A.

## 4.9 Mechanical Characteristics and Tests on Optical Fibre Cable:

### 4.9.1 Tensile strength:

A load of value T(N) = 9.81 x 2.5 W Newton (where, W-mass of 1 Km of cable in Kg) or 1000N whichever is higher on cable sustained for 10 minutes shall not produce a strain exceeding 0.25 % in the fibre and shall not cause any permanent physical or optical damage to the cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-21-E1.

### 4.9.2 Abrasion Test:

The cable surface abraded for 100 cycles with needle (wt. 150 gm) having diameter of 1 mm with 500 grams weight (Total weight more than or equal to 650gms) for 1 minute shall not cause any perforation and loss of legibility of the marking on the sheath.

**Test Method:** IEC-60794-1-21-E2

### 4.9.3 Crush Test (Compressive Test):

A compressive load of 2000 Newton applied, between the plates of dimension 100 x 100 mm for 60 seconds shall not damage the cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-21-E3

### 4.9.4 Impact Test:

Impact caused by a weight of 25 Newton, dropped 10 times from a height of 0.5 meters on a surface of radius 300 mm shall be withstood by cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method** : IEC 60794-1-21-E4.

### 4.9.5 Repeated Bending Test:

**Parameters:**

| | |
|---|---|
| Length of Cable sample | : 5 M (minimum) |
| Weight | : 5 Kg |
| Minimum distance from Pulley centre to holding device | : 216 mm |
| Minimum distance from Wt. to Pulley centre | : 457 mm |
| Pulley Diameter | : 20D (D–cable diameter) |
| Angle of Turning | : 90° |
| No. of cycles | : 30 |
| Time required for 30 cycles | : 2 min |

The fibre shall not break during repeated bending of cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** EIA-455-104 / IEC 60794-1-2-E7

### 4.9.6 Torsion Test:

**Parameters:**

| | | |
|---|---|---|
| Length of sample | : | 2 M |
| Load | : | 100N |
| No. of cycles | : | 10 |

The cable shall withstand the 100N load for 10 cycles and there shall be no cracks and tearing on the outer sheath of the cable. The fibres and other component parts of the cable shall not be damaged. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-21-E7.

### 4.9.7 Kink Test:

**Parameters:**

| | | |
|---|---|---|
| Length of sample | : | 10 R (R – Minimum bending radius) |
| Minimum Bend radius | : | 20D (D- Diameter of cable) |

The loop to the minimum bend radius shall not form any kink on the cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-21-E10.

### 4.9.8 Cable Bend Test:

The cable shall withstand repeated flexing when wrapped and unwrapped 10 times with 4 complete turns around a mandrel having diameter of 20 D, where D is the diameter of the cable and there shall be no cracks on the

outer sheath of the cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-21-E11 (Procedure-I).

### 4.9.9 Cable bend Test at High & Low Temp. :

| | |
|---|---|
| Test Temperature | : - 20°and + 70° C |
| Mandrel Diameter | : 20D (D- Diameter of cable). |
| No. of turns | : 4 |
| Conditioning Time Duration | : 24 hours at each temperature |

There shall be no permanent physical damage to the cable. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** EIA RS-455-37/ IEC 60794-1-22-F1

### 4.9.10 Temperature Cycling:

**Parameters:**

| | | |
|---|---|---|
| Standard cable length of drum | : | 4Km/2 Km + 5 % |
| Temperature Range for Storage | : | 20°C |
| Temperature Range for Operation | : | -40°C to +70°C. |
| Rate of change of temperature | : | 1° per minute |
| Temperature Cycling | : | 12 hrs. each at temp. given below:<br>TA2 temp. : - 20°C<br>TA1 temp. : - 10°C.<br>TB1 temp. : + 60°C.<br>TB2 temp. : + 70°C. |
| Nos. of temperatures cycle | : | 2 |

The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength for the entire range of temperature.

**Test Method:** IEC 60794-1-22-F1.

### 4.9.11 Cable Aging test (Type Test):

After Temperature cycle test, the cable shall be exposed to 85 + 2 degree C for 168 hours. The change in attenuation of each fibre after the test shall be ≤ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

**Test Method:** IEC 60794-1-2-F9

**Note:** The attenuation measurement to be made after stabilization of the test cable at ambient temperature for 24 hours. The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

### 4.9.12 Water Penetration Test (Type Test):

A circumferential portion of the cable end (loose tube) shall be supported horizontally facing the one meter water head, containing sufficient quantity of water soluble fluorescent dye, for seven days at ambient temperature. No dye shall be detected at the end of 3m cable length when examined with ultraviolet light detector.

**Test Method:** IEC 60794-1-22-F5 (Fig. B) 1999.

### 4.9.13 Test of Figure of 8 (Eight) on the cable (Type Test):

It shall be possible to make figure of 8 (Eight) of minimum 1000 meter length of the cable uncoiled from the cable reel, without any difficulty. The diameter

of each loop of the figure of 8 shall be maximum 2 meters. There shall be no visible damage.

### 4.9.14 Flexural Rigidity Test (Type Test):

The cable shall withstand the Flexural Rigidity test as per the method and no cracks shall be visible on sheath of cable. The change in attenuation of the each fibre after the test shall be ≤ 0.05 dB at both 1310 nm and 1550 nm wavelengths

**Test Method:** ASTM D 790

### 4.9.15 Cable Jacket Yield Strength and Ultimate Elongation:

**Parameters:**

| Jacket Material | Minimum Yield Strength | | Minimum Elongation (%) |
|---|---|---|---|
| | (Mpa) | (psi) | |
| HDPE unaged | 16.5 | 2400 | 400 |
| HDPE aged | 12.4 | 1800 | 375 |

The aged sample taken from a completed cable conditioned at 100 + 2°C for 120 hours before testing at cross-head speed of 50 mm per minute.

**Test Method:** FOTP-89 or ASTM D1248 Type III Class.

### 4.9.16 Drip Test:

**Test Method:** IEC 60794-1-22-F16 or IEC60794-1-21-E14

**Parameters:**

Length of cable sample : 30 cm

Length of open end of cable sample : 5 cm

| | | |
|---|---|---|
| Temperature | : | 70° C |
| Period | : | 24 hours |

The cable sample shall be 30 cm with one end sealed. Outer sheath, Aramid yarn and FRP shall be removed for 5 cm from open end of sample. The paper placed below the cable sample, kept vertically inside the oven for 24 hours at 70° C, shall be examined for dripping of the jelly after 24 hours and there shall be no jelly drip or oil impression on the paper

### 4.9.17 ESCR (Environmental Stress Cracking Resistance) Test:

The Outer sheath of the optical fibre cable shall be checked and tested for ECSR. There shall not be any visible cracks on the surface of the outer sheath, when examined with the help of a magnifying glass at the end of 48 hours in a 10% Igepal solution.

**Test Method:** ASTM D 1693

### 4.9.18 UV radiation Test

The effect of UV radiation shall be checked on the following:

i) On the Outer Sheath material (HDPE).
ii) On the meter and other legend markings.

**Parameters:**

| | | |
|---|---|---|
| Type of Lamp | : | 40 Watt UV-B lamp with a peak emission at 313nm. |
| Duration | : | 2000 hours |

There shall be no fading or change in the colour of the Markings and that of Outer sheath.

**Test Method:** ASTM G-53 – 96 (ASTM G 154)

### 4.9.19 Check of the quality of the loose tube (containing optical fibre)

#### a) Embrittlement Test of loose Tube

**Parameters:**

Minimum length of sample : 85 mm

Outside diameter of Tube : ≤2.5 mm

Speed of movable jaw : 50 mm per minute

Safe bend diameter of tube : 15 D (D -Outside dia. of the loose tube.

The minimum length of the test sample depends on the outside diameter of the loose tube and shall be 85 mm for tubes up to 2.5 mm outside dia. The length of the bigger tubes should be calculated by using the following equation:

$$Lo > 100 \times \sqrt{(D2 + d2) / 4}$$

Where Lo = Length of tube under test.

D = Outside dia. of loose tube.

d = Inside dia. of loose tube.

Example :-

Fibre optic tube, D = 5mm, d = 3mm

$Lo > 100 \times \sqrt{(52 + 32) / 4} = 100 \times 5.83/4 = 145.8$

The tube shall not get embrittled. No ink shall be appeared on the tube up to 15 D. There shall also not be any physical damage or mark on the tube surface.

#### b) Kink resistance Test on the loose Tube

**Parameters:**

Tube sample : Long loose tube with fibre & gel

Min. bend radius of tube: 15 D (D -Outside diameter of the loose tube.

No. of times : 4

No damage or kink shall be appeared on the surface of the tube.

### 4.9.20 Drainage Test for loose Tube:

**Parameters:**

| | | |
|---|---|---|
| Sample Size | : | 30 cm tube length |
| Tube in horizontal position | : | 24 hrs. at ambient temperature |
| Tube in vertical position | : | 24 hrs. at 70° C |

There shall be no gel or oil in the beaker.

### 4.9.21 Check of easy removal of sheath:

300mm sheath shall be removed easily by using normal sheath removal tool and no undue extra force shall be applied to remove the sheath. No component part of cable shall be damaged.

### 4.9.22 Check of the effect of aggressive media on the cable

**Parameters:**

| | | |
|---|---|---|
| Aggressive media solution | : | PH - 4 & PH-10 |
| Length of sample of finished cable: | | 600 mm |
| Duration of test: | | 30 days |

Effect of aggressive media shall be checked by solution of PH4 and PH10 on test samples of the finished cable, each of 600mm in length with sealed ends for 30 days. There shall be no corrosion on the sheath and other markings of the cables.

**Test Method** : ISO175

## 5.0 Engineering Requirements:

### 5.1 Cable Marking:

5.1.1 A long lasting suitable marking shall be applied in order to identify this cable from other cables. The cable marking shall be imprinted (indented). The marking on the cable shall be indelible of durable quality and at regular intervals of one meter length. Alternatively, permanent printing with the laser shall also be acceptable. In case of laser printing method; the impression shall not exceed the depth of 0.15 mm. The accuracy of the sequential marking must be within -0.25% to +0.5% of the actual measured length. The markings on the cable must not rub off during normal installation and in life time of optical fibre cable.

5.1.2 The marking shall be of clearly contrast colour (White)on the black HDPE sheath and shall be done by hot foil indentation method. The colour used must withstand the environmental influences experienced in the field. The marking on the cable shall be permanent, insoluble in water and shall be legible for duration of cable life.

5.1.3 The type of legend marking on OF cable shall be as follows:

a) Company Legend
b) Legend containing telephone mark & international acceptable Laser symbol
c) Type of cable i.e. Loose Tube --- UNITUBE
d) Type of Fibre
e) Number of Fibres
f) Year of manufacture
g) Sequential length marking
h) User's Identification
i) Cable ID

## 5.2 Cable Ends:

5.2.1 Both cable ends (the beginning end and end of the cable reel) shall be sealed and readily accessible. Minimum 5 meter of the cable of the beginning end of the reel shall be accessible for testing. Both ends of the cable shall be kept inside the drums and shall be located so as to be easily accessible for the test. The drum (conforming to GR No. G/CBD-01/02 Nov. 94 and subsequent amendments, if any) should be marked to identify the direction of rotation of the drum. Both ends of cable shall be provided with cable pulling (grip) stocking and the anti-twist device (free head hook). The diameter of the cable shall also be marked on the cable drum.

5.2.2 Anti-twist device (Free head hook) shall be provided attached to the both end of the cable pulling arrangement. The arrangement of the pulling eye and its coupling system, along with the anti-twist system, shall withstand the prescribed tensile load applicable to the cable.

## 5.3 The nominal drum length:

5.3.1 Length of OF Cable in each drum shall be 2 Km ± 10 % / 4Km ± 5% / 6Km ± 5% / 8Km ± 5% and shall be supplied as per the order. The variation in length of optical fibre cable, as specified above (in each drum), shall be acceptable.

5.3.2 The fibres in cable length shall not have any joint.

5.3.3 The drum shall be marked with arrows to indicate the direction of rotation.

5.3.4 Packing list supplied with each drum shall have at least the following information:

a) Drum No.
b) Type of cables: UNITUBE
c) Physical Cable length

d) No. of fibres

e) Length of each fibre as measured by OTDR

f) The Cable factor - ratio of fibre / cable length

g) Attenuation per Km. of each fibre at 1310 & 1550 nm

h) User's / Consignee's Name

i) Manufacturer's Name, Month, Year and Batch No.

j) Group refractive index of fibres

k) Purchase Order No.

l) Cable ID

## 5.4 Colour coding in the OF Cable:

5.4.1 The colorant applied to individual fibres shall be readily identifiable throughout the life time of the cable and shall match and conform to the MUNSELL color standards (For EIA standard EIA-598C) and also IEC Publication 304 (4).

### 5.4.2 Colour Coding Scheme:

The individual Optical Fibre shall be colour coded as per Table –I below:

**Table – I**

| Fiber No. | Fiber Colour | Fiber No. | Fiber Colour |
|---|---|---|---|
| 1 | Blue | 13 | Blue with Black Ring Marking |
| 2 | Orange | 14 | Orange with Black Ring Marking |
| 3 | Green | 15 | Green with Black Ring Marking |
| 4 | Brown | 16 | Brown with Black Ring Marking |
| 5 | Slate | 17 | Slate with Black Ring Marking |
| 6 | White | 18 | White with Black Ring Marking |
| 7 | Red | 19 | Red with Black Ring Marking |
| 8 | Black | 20 | Natural |
| 9 | Yellow | 21 | Yellow with Black Ring Marking |
| 10 | Violet | 22 | Violet with Black Ring Marking |

| | | | |
|---|---|---|---|
| 11 | Pink | 23 | Rose/Pink with Black Ring Marking |
| 12 | Aqua | 24 | Aqua with Black Ring Marking |

**Note:**

The individual ring marking shall be at regular interval of every 50 mm or lesser and shall be legible. The ring marking on the fibre shall be of durable quality and shall be compatible with coating of the fibre and thixotropic Jelly (filled in the loose tube of the cable).

## 6.0 Quality Requirements:

6.1 The cable shall be manufactured in accordance with the international quality standards ISO 9001-2015 for which the manufacturer should be duly accredited. The Quality Manual shall be submitted by the manufacturer.

## 6.2 Raw Material:

6.2.1 The cable shall use the raw materials approved against the Standard No. TEC 89010:2021(or latest release) and the subsequent amendment issued, if any.

6.2.2 Any other material used shall be clearly indicated by the manufacturer. The detailed technical specifications of such raw materials used shall be furnished by the manufacturer at the time of type approval testing.

6.2.3 The raw materials used from multiple sources is permitted and the source/sources of raw materials (Type and grade) from where these have been procured shall be submitted by the manufacturer.

6.2.4 The manufacturer can change the raw material from one approved source to other approved source with the approval of QA wing of purchaser The change of source/grade of SM Optical Fibre and/or design of cable shall call for fresh type approval.

6.2.5 The HDPE Black in colour used for outer sheath shall be UV stabilized and shall withstand UV test for 2000 hours (minimum).

**Note:** A test certificate from a recognized laboratory or institute may be acceptable for the UV stability of the sheath material

6.2.6 The material used in optical fibre cable must not evolve hydrogen that will affect the fibre loss.

**Note:** Test certificate from a recognized laboratory or institute may be acceptable.

## 6.3 Cable Material Compatibility:

Optical fibre, buffers/core tubes, and other core components shall meet the requirements of the compatibility with buffer/core tube filling material(s) and/or water-blocking materials that are in direct contact with identified components within the cable structure (This shall be tested as per clause no. 6.3.3 of Telcordia document GR-20-CORE issue 4, July 2013) or as per IEC 60794-1-219).

**Note:** The tests may be conducted in house (if facility exist) or may be conducted at CACT or any other recognized laboratory. The test certificate may be accepted and the tests may not be repeated subsequently, in next type approvals, if the raw material used is of same make and grade.

## 7.0 Safety Requirement:

The material used in the manufacturing of the Self-supporting OFC shall be non- toxic and dermatologically safe in its life time and shall not be hazardous to health. The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of optical fibre cable to substantiate the statement.

**Note:** Latest issue of the Standards mentioned in the GR, may be referred.

# CHAPTER – 2

## 8.0 Documentation:

8.1 Complete technical literature in English with detailed cable construction diagram of various sub-components with dimensions, weight & test data and other details of the cable shall be provided.

8.2 All aspects of installation, operation, maintenance and fibre splicing shall also be covered in the handbook. The pictorial diagrams of the accessories (with model no. and manufacturer name) supplied along with the cable as package shall be also be submitted. A hard as well as soft copy of the manuals shall be provided.

## 9.0 Information for the Procurer of product:

9.1 Purchaser may ask for Aerial drop cable with G.657.A1 fibre or G.657.A2 fibre, as per their requirements. Technical comparison of G.657.A1 fibre and G.657.A2 fibre as per TEC standard, is given as below:

**Technical Comparison between G.657 A1 Fibre & G.657 A2 Fibre**

| Attribute | G.657.A1 | G.657.A2 |
|---|---|---|
| Mode field diameter at 1310nm | 8.8-9.2 (± 0.4) µm | 8.6 ± 0.4 µm |
| Attenuation at 1310nm | ≤ 0.34 dB/km | ≤ 0.35 dB/km |
| Attenuation at 1550nm | ≤ 0.20 dB/km | ≤ 0.21 dB/km |
| Attenuation at 1490nm | ≤ 0.24 dB/km | ≤ 0.24 dB/km |
| Attenuation at 1625nm | ≤ 0.23 dB/km | ≤ 0.23 dB/km |
| Attenuation at 1383 nm ± 3nm | ≤ 0.34 dB/km | ≤ 0.35 dB/km |
| Macrobend loss, 10 turns, 15 mm radius, 1550 nm | ≤0.25 dB | ≤0.03 dB |

| | | |
|---|---|---|
| Macrobend loss, 10 turns, 15 mm radius, 1625 nm | ≤1.0dB | ≤0.1 dB |
| Macrobend loss, 1 turn, 10 mm radius, 1550 nm | ≤0.75 dB | ≤0.1 dB |
| Macrobend loss, 1 turn, 10 mm radius, 1625 nm | ≤1.5 dB | ≤0.2 dB |
| Macrobend loss, 1 turn, 7.5 mm radius, 1550 nm | Not specified | ≤0.5 dB |
| Macrobend loss, 1 turn, 7.5 mm radius, 1625 nm | Not specified | ≤1.0 dB |
| PMD | ≤ 0.15 ps/√km | ≤ 0.2 ps/√km |

9.2 Presently, few manufacturers have started manufacturing G.657 A2 fibre with following specification:

Mode file diameter (MFD) at 1310nm for G.657 A2 fibre: 9.1 ± 0.4 µm (Optional)

The purchaser may ask for the G.657 A2 fibre as per their requirement with above specifications.

9.3 It is suggested that the Optical fibre cable supplied in a particular route may be manufactured from a single source of optical fibres.

9.4 Purchaser may ask for Polyarylate Yarn as an alternative material for Aramid yarn, to be used as peripheral strength member for optical fibre cables as per Section XVII (17.2) of Standard No. TEC 89010:2021 (or latest Issue) for GR of Raw material.

## 10.0 Procedures for the issue of Approval certificate for Lower Fibre Count Cables

The manufacturer may seek approval certificate for Lower Fibre Count Cables against this GR without conducting the actual tests on the cables only when he is having valid approval certificate for higher fibre count of cable against this GR.

- The manufacturer seeking approval certificate for the Lower Fibre Count cable shall apply afresh and submit the documents as per the prescribed approval procedure along with List of Raw Materials used, the make and grade of the raw material and the certificate of source approval issued by CACT or any other recognized laboratory along with the details of the raw materials used in the manufacturing of the higher fibre count cable for which he is holding valid approval certificate. Both the raw materials shall be compared and are required to be of same make and grade.

- Samples of at least 5 cable reels (2 Kms each approx.) for each lower fibre count cable.

Any additional information as required may be sought from the manufacturer and the manufactured cable may be inspected at the manufacturer's premises. After all the above requirements are met, the approval certificate may be issued to the lower fibre count of the cable based upon the test results and other details submitted by the manufacturer. The tariff in each case shall be as applicable for category – II.

The following shall be mentioned in the remarks column of the Approval Certificate to be issued for the lower fibre count of the cable:

**"This certificate is issued on the basis of certificate No. _____ dated _____ for _____ fibre count cable".**

The validity of the certificate for lower fibre count cables shall be coterminous to the validity of approval certificate of higher fibre count cable.

The above procedure shall be applicable only for the approval of Aerial Drop Optical Fibre Cable against this GR and subsequent amendments, if any.

# ABBREVIATIONS

| | | |
|---|---|---|
| ASTM | - | American Society for Testing and Materials |
| BIS | - | Bureau of Indian Standards |
| CACT | - | Component Approval Centre For Telecommunications |
| EIA | - | Electronic Industry Association |
| ESCR | - | Environmental Stree Cracking Resistance |
| FRP | - | Fibre Reinforced Plastic |
| FOTP | - | Fibre Optic Test Procedure |
| Gpa | - | Gega Pascal |
| HDPE | - | High Density Polyethylene |
| IEC | - | International Electro –Technical Commission |
| IS | - | Indian Standards |
| ISO | - | International Standard Organizations |
| ITU-T | - | International Telecommunication Union Telecommunication |
| MFD | - | Mode Field Diameter |
| MSDS | - | Materail Safety Data Sheet |
| Nm | - | Nanometer |
| OTDR | - | Optical Time Domain Reflectometer |
| Ps/nm | - | Pico second/ Nano meter |
| Ps | - | Pico second |
| QA | - | Quality Assurance |
| QM | - | Quality Manual |
| RMS | - | Route Mean Square |
| SMOF | - | Single Mode Optical Fibre |
| UV | - | Ultra Violet |
| µm | - | micrometer |

# ANNEXURE – A

The following parameters of the component parts of the cable are to be taken into account while designing and manufacturing the optical fibre cables of the required fibre count. These parameters shall be checked during evaluation of the OF Cables.

**Table A1: Cable design parameters for Aerial Drop Optical Fibre Cable**

| SN | Parameter | Unit | Design Type | |
|---|---|---|---|---|
| 1 | Fiber Count | No. | Upto12Fibre | 24Fibre |
| 2 | Fiber Per Tube | No. | 12 | 24 |
| 3 | Fiber Color | | Blue, Orange, Green, Brown, Slate, White, Red, Black, Yellow, Violet, Pink, Aqua | As per Clause 5.4.2 (Table –I) |
| 4 | Tube Internal Diameter | mm | 1.4 +/- 0.1 | 2.4 +/- 0.1 |
| 5 | Tube Outer Diameter | mm | 2.0 +/- 0.1 | 3.0 +/- 0.1 |
| 6 | Loose Tube Color | | Natural | Natural |
| 7 | Loose Tube Material | | PBT | PBT |
| 8 | Embedded Strength Member Material | | FRP/ARP | FRP/ARP |
| 9 | Diameter of FRP (Embedded Strength Member) | mm | 1.0+0.1 | 1.0+0.1 |
| 10 | Aramid Yarns (Peripheral Strength Member) | Kg/Km | 3.9 $\pm$ 0.4 | 3.9 $\pm$ 0.4 |

| | | | | |
|---|---|---|---|---|
| 11 | Sheath Material | | UV Proof HDPE | UV Proof HDPE |
| 12 | Colour of Sheath Material | | Black | Black |
| 13 | Thickness of Sheath Material ( Minimum) | | 1.8 | 1.8 |
| 14 | Cable Weight | | 38 ± 10% | 50 ± 10% |
| 15 | Cable Diameter | | 6.5 ± 0.5 | 7.5 ± 0.5 |

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