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(सं: जीआर/ओएफसी-१९/०१. फ़रवरी २००९ को अधिक्रमित करता है)

STANDARD FOR GENERIC REQUIREMENTS

TEC 85160:2021

(Supersedes No.: GR/OFC -19/01. FEB 2009)

ऑप्टिकल फाइबर केबल एफ़टीटीएच एप्लिकेशन हेतु

(G.657A फाइबर)

OPTICAL FIBRE CABLE FOR FTTH APPLICATION

(G.657A Fibre)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली-११०००१, भारत

TELECOMMUNICATION ENGINEERING CENTRE

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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 Standard for Generic Requirements of Optical fibre cable pertains to Single Mode Metal free Optical Fibre Cable (Type-I & Type-II) for FTTH applications. Type-I is loose tube design cable with 1 to 12 nos. of fibres whereas Type-II is Flat cable design with 2 nos. of fibres. These cables are envisaged to be installed inside the premises/buildings. The Optical fibre being used as per ITU-T Rec G.657 A is bend insensitive which is suitable for fibre to the home application purpose.

The document has been revised to update all the Fibre parameters as per latest GR of Raw Material for manufacturing Optical fibre cable (Section-I of GR No. TEC/GR/TX/ORM-001/05/DEC-17 with Amendment No. 1 dated 06.07.2020). In the revised document, Fire Tests have been added under Safety requirements to increase human safety level in the event of fire in building escape routes and general installations in the event of fire. Moreover, the design parameters for both the cables (Type-I & Type-II), have also been improved.

CONTENTS

HISTORY SHEET

S. No.	Standard / document *No.*	*Title*	*Remarks*
1.	GR/OFC - 19/01. FEB 2009	Optical fibre cable for FTTH application (G.657A Fibre)	1st Release
2.	Standard No. TEC 85160:2021	Standard for Generic Requirements for Optical fibre cable for FTTH application (G.657A Fibre)	2nd Release • GR has been converted into Standard with new document No. and format is modified accordingly. • All Fibre parameters have been updated as per TEC/GR/TX/ORM-001/05/DEC-17 (Section-I) with Amendment No. 1 dated 06.07.2020. • New clauses (6.2 & 6.3) for Fire Test have been added. • Design parameters for both cables (Type-I & Type-II), have been modified considering the suggestions of manufacturer which were agreed during the meeting.

REFERENCES

SN	*Document No.*	*Title/Document Name*
1.	G/OFT-01/03. APR 2006	Specification for Tools for Installation & Operating the OFC & for Assembly of the Optical Fibre Splice Closures
2.	TEC/GR/TX/ORM-001/05/DEC-17	Specification for Raw Material
3.	ITU-T G.657	ITU-T Recommendation
4.	GR-20 –CORE, issue 4, July 2013	Generic Requirement for optical Fibre cable (Bell core)
5.	IEC 60793-1, IEC 60793-2-50	Test method for Optical Fibres
7.	ISO 9001:2015	International Quality Management System
8.	IEC Publication 304(4), EIA 598C	Color Standards
10.	TIA-EIA-455-33, TIA-EIA-455-41A, TIA-EIA-455-25A, TIA-EIA 455-104, TIA-EIA-455-85, TIA-EIA RS-455-37A	Test Methods
11.	IEC 811-5-1, IEC 60794-1-21-E1, IEC 60794-1-21-E3, IEC 60794-1-21-E4, IEC 60794-1-21-E7, IEC 60794-1-21-E10, IEC 60794-1-21-E11, IEC 60794-1-22-F1, IEC 60794-1-22-F5 IEC 60794-1-21, IEC 60794-1-22	Test Methods
12.	IEC 60332	Fire Test Standard

CHAPTER-1

1.0 Introduction:

This document describes the Standard for generic requirements of Single mode Metal free Optical Fibre Cable (Type-I & Type-II) for FTTH applications. Type-I is loose tube design cable with 1 to 12 nos. of fibres whereas Type-II is Flat cable design with 2 nos. of fibres. These cables are envisaged to be installed inside the premises/buildings and meant to carry high bit rate optical signals to the end user. The Optical fibre (G.657 A) being used is bend insensitive which is suitable for fibre to the home application purpose.

The Optical fibre cable shall have low weight, small volume and high flexibility. The optical fibre cable shall be suitably protected with LSZH (Low Smoke Zero Halogen) sheath. The optical fibre cable shall be suitably protected from the ingress of moisture by filling jelly, if applicable. The raw material used in the cable shall meet the requirements of the TEC GR for Raw materials GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and subsequent amendments, if any.

The document has been revised to update all the fibre parameters as per latest GR of Raw Material for manufacturing Optical fibre cable (Section-I of GR No. TEC/GR/TX/ORM-001/05/DEC-17 with Amendment No. 1 dated 06.07.2020). In the revised document, Fire Tests have been added under Safety requirements to increase human safety level in the event of fire in building escape routes and general installations in the event of fire. Moreover, the design parameters for both the cables (Type-I & Type-II), have been improved.

2.0 Functional Requirements:

2.1 The design and construction of Optical fibre cable shall be inherently robust and rigid under all conditions of operation, installation, adjustment,

replacement, storage and transport for fibre to the home applications. It shall be able to withstand the ducting / application inside buildings and premises.

2.2 The Optical fibre cable shall be able to work in a saline atmosphere in coastal areas and should be protected against corrosion.

2.3 Life of the Optical fibre cable shall be minimum 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.

2.4 It shall be possible to operate and handle the Optical fibre cable with tools as per GR No. G/OFT-01/03 APR 2006 (or latest release) and subsequent amendments, if any. Any special tool required for operating and handling the Single Mode metal free optical fibre cable shall be provided along with the cable.

2.5 The Optical fibre Cable supplied shall be suitable and compatible to match with the dimensions, fixing, terminating and splicing arrangement of the all applicable optical accessories i.e. FDMS, Splice closure, Termination box, splitters etc. as per latest release of TEC GRs and subsequent amendments, if any.

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

2.7 The Flexible optical fibre cable shall be flame retardant and shall meet the requirements of IEC 60332.

3.0 Technical Requirements

The Single Mode Optical Fibre used in manufacturing Optical Fibre Cables shall be as per ITU-T Rec. G.657.A1 or G.657.A2. The detailed specifications of optical fibres are mentioned below:

3.1 Type of fibre (Wavelength band optimized nominal 1310 nm):

Single mode (As per Section I of the GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and subsequent amendments, if any)

3.2 Geometrical Characteristics of fibre: As per Section I of the GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and subsequent amendments, if any.
All the parametric values shall be as per latest Standard for GR of Raw Material for manufacturing Optical fibre cable

3.2.1	Nominal MFD at 1310nm	:	[8.8 - 9.2] ± 0.4 μm (A1 fibre) [8.6 -9.2] ± 0.4 μm (A2 fibre)
3.2.2	Nominal Cladding Diameter	:	125 μm ± 0.7 μm
3.2.3	Cladding non circularity	:	≤ 0.8%
3.2.4	Core Clad Concentricity Error	:	≤ 0.5 μm
3.2.5	Diameter over primary coated with double UV cured acrylate. (This shall be measured on un coloured fibre)	:	
	a) 250 μm fibre	:	242 ± 5 μm
	b) 200 μm fibre	:	180 – 210 μm

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.

3.2.6 Colored fibre coating diameter

a) 250 μm fibre : 252 ± 10μm

b) 200 μm fibre : 180 – 220 μm

3.2.7 Coating / Cladding Concentricity

a) 250 μm fibre : ≤ 12 μm

b) 200 μm fibre : ≤ 10 μm

3.3 Transmission Characteristics: As per Section I of the GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and subsequent amendments, if any.

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

3.3.1 Attenuation

a) Fibre attenuation before Cabling

SN	Parameter	A1 Fibre	A2 Fibre
I	At 1270 nm	≤ 0.40 dB/Km	≤ 0.40 dB/Km
ii	At 1310 nm	≤ 0.34 dB/Km	≤ 0.35 dB/Km
iii	Between 1285 to 1360 nm	≤ 0.37 dB/Km	≤ 0.38 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

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 1380-1390 nm shall be checked at every 2 nm after Hydrogen aging as per IEC 60793-2-50. Hydrogen aging test is to be carried out by CACT, Bangalore or any other govt. 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 shall be measured at an interval of 10 nm and the test results shall be submitted

3.3.2 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 at an interval of 10 nm, shall be measured and the test results shall be submitted.

b) Polarization mode dispersion

i)	Un-cabled Fibre	:	≤ 0.15 ps/√Km (A1 fibre) ≤ 0.2 ps/√Km (A2 fibre)
ii)	Cabled Fibre	:	≤ 0.3 ps/√ Km
iii)	Link design value for un-cabled fibre	:	≤ 0.06 ps/√ Km

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

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

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

3.3.3 Cable Cut off wavelength : 1260 nm Max.

Note - The above cut off wavelength is w.r.t. 22 m sample length of fibre.

3.4 Mechanical Characteristics:

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

3.4.1 Proof test for minimum strain level : 1 %

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

a) 250 μm fibre

i)	Peak strip force	:	1≤ N ≤ 8.9N
ii)	Average strip force	:	1≤ N ≤ 5N

b) 200 μm fibre

i) Peak strip force : 0.4 ≤ N ≤ 8.9N

ii) Average strip force : 0.4 ≤ N ≤ 5N

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

3.4.3 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)

3.4.4 Dynamic Fatigue (Test method IEC- 60793 - I - 33)

a) Un-aged : ≥ 20

b) Aged (Damp heat aged) : ≥ 20

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

3.4.6 Fibre Macro bend (Test method FOTP–62/ IEC- 60793-1–47)

SN	Parameter	A1 Fibre	A2 Fibre
a)	Change in attenuation when fiber is coiled with 10 turns on 15 mm radius mandrel	≤ 0.25 dB at 1550 nm ≤ 1.0 dB at 1625 nm	≤ 0.03 dB at 1550 nm ≤ 0.1 dB at 1625 nm
b)	Change in attenuation when fiber is coiled with 1 turn around 10mm radius mandrel	≤ 0.75 dB at 1550 nm ≤ 1.5 dB at 1625 nm	≤ 0.1 dB at 1550 nm ≤ 0.2 dB at 1625 nm
c)	Change in attenuation when fiber is coiled with 1 turn on 7.5mm radius mandrel	NA	≤ 0.5 dB at 1550 nm ≤ 1.0 dB at 1625 nm

3.5 Material Properties :

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

3.5.1 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 the requirement of fibre coating stripping force as per clause No.3.4.2

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.

3.6 Environmental Characteristic of Fibre (Type test):

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

3.6.1 Operating Temperature

(Test Method IEC - 60793-1-52)

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

Induced Attenuation at 1550 nm at -60°C to +85°C : $\leq$ 0.05 dB/Km

3.6.2 Temperature – Humidity Cycling
(Test method IEC - 60793-1-51)
Induced Attenuation at 1550 nm at -10°C to +85°C and 95% relative humidity. : ≤ 0.05 dB/Km

3.6.3 Water Immersion 23°C
(Test method IEC - 60793-1-53)
Induced Attenuation at 1550 nm due to Water Immersion at 23 ± 2°C : ≤ 0.05 dB/Km

3.6.4 Accelerated Aging (Temperature) 85°C
(Test method IEC - 60793-1-51)
Induced Attenuation at 1550 nm due to temperature Aging at 85 ± 2°C : ≤ 0.05dB/Km

3.6.5 Retention of Coating Color
(Test method IEC - 60793-1-51)
Coated Fiber shall show no discernible change in color, when aged for relative humidity. : 30 days at 85°C and 95% Humidity and then 20 days in dry heat at 85°C

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

3.7 Colour Qualification and Primary Coating Test:

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

3.7.1 Colour Qualification Test:

a) MEK RUB Test (Methyle Ethon Ketone Test)

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 fibre for 30 days. After the test Colour qualification, attenuation measurement & stripability test are to be taken.

3.7.2 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.

3.8 Optical Fibre Cable Construction Specifications (Type-I):

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.

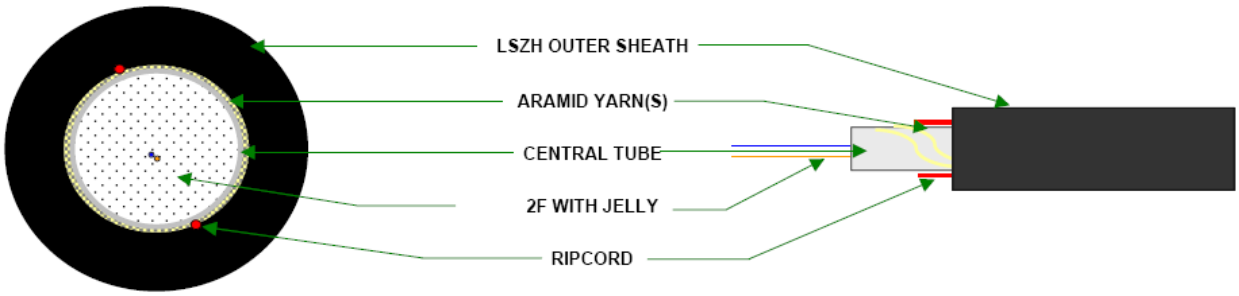

Fig. 1: Typical Structural Drawing for 2 Fibre Optical Fibre Cable (Type-I)

3.8.1 Secondary Protection:

The primary coated fibres (G.657.A1 or G.657 A2) shall be protected by loose packaging within a tube, which shall be filled with thixotropic jelly. The tubing material shall be as per the GR no. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and subsequent amendments, if any. Various design parameters of the cable shall be as per Annexure - A.

3.8.2 Number of fibres: 1 -12

3.8.3 Strength Member :

Aramid yarns are used to achieve the required tensile strength of the optical fibre cables over the cable core to provide peripheral reinforcement. These flexible strength members shall be of water blocking type. Aramid yarns used shall be equally distributed over the periphery of the cable core. The quantity of the Aramid yarns used per Km length of the cable along with its dimensions shall be indicated by the manufacturer. The Aramid Yarn shall be as per Section XVII (17.1) of the GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and the subsequent amendments, if any.

3.8.4 Filling compound: The filling compound used in the loose tube shall be compatible to fibre, secondary protection of fibre, and other component parts of the cables. The drip point shall not be lower than +70 degree C. The fibre movement shall not be constrained by stickiness and shall be removable easily for splicing. The test method to measure drop point shall be as per ASTM D 556. The filling jelly compound shall be as per GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and the subsequent amendments, if any.

3.8.5 Cable jacket: The core shall be jacketed with fire resistant Low Smoke Zero Halogen (LSZH) sheath yellow in colour and colour shall conform to Munsell Colour Standards. Thickness of the sheath shall be uniform & shall not be less than 0.3 mm at any point. The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measure thickness shall be as per IEC 189 para 2.2.1 and para 2.2.2.

3.8.6 Cable diameter: The finished cable diameter shall be as per Table A1 (S.N. 9) of Annexure – A.

3.8.7 Cable Weight: The nominal cable weight shall be as per Table A1 (S.N. 10) of Annexure – A.

3.9 Optical Fibre Cable Construction Specifications (Type-II):

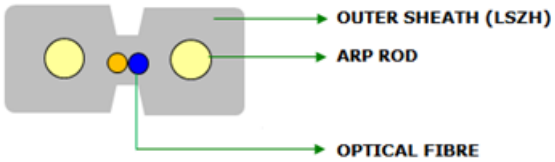

Fig. 2: Typical Structural Drawing for 2 Fibre Optical Fibre Cable (Type-II)

3.9.1 Cable Description :

The Single mode colour coded fibres, Aramid reinforced plastic rods are embedded in the sheath of LSZH which protects the fibre from damage. The notch is provided at mid point in sheath to separate the fibres easily.

3.9.2 Number of fibres : 1 or 2

3.9.3 Strength Member

The strength member in the cable shall provide the strength and flexibility to the cable and shall have anti buckling properties. The two nos. of Solid Aramid reinforced plastic rod (ARP rod) shall be used for the strength. The specification of ARP rod shall be as per Section- GR No. TEC/GR/TX/ORM-001/05/DEC-17 (or latest release) and the subsequent amendments, if any.

3.9.4 Outer Sheath

A sheath of LSZH (low smoke zero halogen) yellow or white in colour shall be provided. The colour shall conform to Munsell Colour Standards.The sheath shall be smooth, free from pin holes, joints, mended pieces, scratches and other defects.

3.9.5 Cable Parameters: The finished cable design parameters shall be as per Table B1 of Annexure – B.

3.9.6 Cable Weight**:** The nominal cable weight shall be as per Table B1 (S.N. 6) of Annexure - B

4.0 Mechanical Characteristics and Tests on Optical Fibre Cable:

All observations shall be taken at 1310 nm and 1550 nm wavelengths. The attenuation of any fibre, after any of the tests, shall not increase more than 0.1 dB for both 1310 nm and 1550 nm wavelengths.

4.1 Tensile strength Test:

Objective: This measuring method applies to optical fibre cables which are tested at a particular tensile strength in order to examine the behaviour of the attenuation as a function of the load on a cable which may occur during installation.

Method: IEC 60794-1-21-E1

Test Specs.: The cable shall have sufficient strength to withstand a load of value T (N) = 9.81 x 1.3 W Newton or 150 N whichever is higher (where W-mass of 1 Km of cable in Kg). The load shall be sustained for 10 minutes and the strain of the fibre monitored.

Requirement: The load shall not produce a strain exceeding 0.25 % (for type I cable) & 0.6% (for type II cable) fibre strain in the fibre and shall not cause any permanent physical and optical damage to any component part of the cable. The attenuation shall be noted before strain and after the release of strain.

Note: The value of necessary correction factor (K factor) of used fibre (under measurement) taken into account by the cable manufacturer during fibre strain measurement shall be indicated by the manufacturer for correction to be made in the results such obtained, if applicable.

4.2 Crush Test (Compressive Test):

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing.

Method: IEC 60794-1-21-E3

Test Specs.: The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 1000 Newton applied between the plates of dimension 100 mm x 100 mm. The load shall be applied for 10 minutes. The attenuation shall be noted before and after the completion of the test.

Requirement: The cable must be able to withstand the crush test without degradation beyond permissible limits.

4.3 Impact Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand impact.

Method: IEC 60794-1-21-E4

Test Specs.: The cable shall have sufficient strength to withstand an impact caused by a mass weight of 5 Newton, when falls freely from a height of 70 mm. The radius R of the surface causing impact shall be 100 mm. Ten such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.

Requirement: The cable must be able to withstand the impact without degradation beyond permissible limits.

4.4 Repeated Bending:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.

Method: IEC 60794-1-21-E6

Test Specs.: The cable sample shall be of sufficient length (5 m minimum) to permit radiant power measurements as required by this test. Longer lengths may be used, if required. The cable shall withstand 30 mechanical flexing cycles.

Parameters:

Weight	:	2.5 Kg
Minimum distance from Pulley centre to holding Device.	:	216 mm
Minimum distance from Wt. to Pulley centre	:	457 mm
Pulley Diameter (D – cable diameter)	:	20 D
Angle of Turn	:	90°
No. of cycles	:	30
Time Required for 30 cycles	:	1 min

Requirement: During the test no fibre shall break. The attenuation shall be noted before and after the completion of the test.

4.5 Torsion Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.

Method: IEC 60794-1-21-E7

Test Specs.: The length of the specimen under test shall not be greater than 0.3 meters and the load shall be 25 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp sufficiently tight to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp, which shall be rotated in a clock wise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand ten such complete cycles.

Requirement: The cable shall be examined physically for any cracks, tearing on the outer sheath and for the damage to other component ports of the cable. The twist mark shall not be taken as damage.

4.6 Kink Test:

Object: The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.

Method: IEC 60794-1-21-E10

Test Specs.: The sample length shall be 10 times the minimum bending radius of the cable. The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius and no kink shall form. The cable is then brought in original position and attenuation reading is taken.

Requirement: The kink should disappear after bringing the cable in original condition.

4.7 Cable Bend Test:

Objective: The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.

Method: IEC 60794-1-21-E11

Test Specs.: The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 40 mm diameter. The attenuation shall be noted before and after the completion of the test.

Requirement: Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

4.8 Temperature Cycling (Type Test):

Objective: To determine the stability behaviour of the attenuation of a cable subjected to temperature changes which may occur during storage, transportation and usage.

Method: Method: IEC 60794-1-22-F1
(To be tested on standard cable length of drum)

Test Specs.: The permissible temperature range for storage and operation will be from 0° C to +65° C. The rate of change of temperature during the test shall be 1° per minute approx. The cable shall be subjected to temperature cycling for 12 hrs. at each temperature as follows:

TA_2 temperature	:	- 20° C
TA_1 temperature	:	- 10° C
TB_1 temperature	:	+ 50° C
TB_2 temperature	:	+ 60° C

The test shall be conducted for 2 cycles at the above temperatures.

Requirement: The cable must be able to withstand the temperature cycling without degradation beyond permissible limits.

4.9 Water Penetration Test (Type Test for Type-I cable):

Objective: To check the installed cable shall not allow the water passage along its length.

Method: IEC 60794-1-22-F5

Test Specs.: A circumferential exposed portion of the tube containing the fibres (after removing the LSZH sheath) shall face the water head. The water tight sleeve shall be applied over the tube. The cable shall be supported horizontally and two meter water head, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage shall be applied on the tube for a period of 7 days at ambient temperature.

Requirement: No dye shall be detected when the end of the 3 m length is examined with ultraviolet light detector. The cable sample under test shall be ripped open after the test and then it shall be examined for seepage of water into the cable and the distance to be noted. It shall not be more than 20 cm.

4.10 Fibre curl (Type Test):

Objective: To determine the fibre curl of the fibres.

Method: IEC 60793 –1-34, FOTP III

Test Specs.: Measurement of the deviation on the 10 mm free fibre using Dual Beam differential laser triangulation is conducted. Two laser spots, accurately separated on the fibre sample by 10 mm, are recorded on a linear CCD array during motorized rotation of the fibre. The fibre is held in a special mandrel with fast loading and simple fibre location.

Requirement: It shall be $\geq$ 4 meter radius of curvature.

4.11 Check of the quality of the loose tube (containing optical fibre) (Type Test for Type-I cable):

Methods:

A) Embrittlement Test of Loose Tube

This test method is based on bending by compression and reflects embrittlement much better than the other used tensile test. This test is independent of wall thickness of the loose tube.

Sample: The minimum length of the test sample depends of the outside diameter of the loose tube and should 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:

$$Lo > 100 \times \sqrt{\frac{(D^2 + d^2)}{4}}$$

Where Lo = Length of tube under test.

D = Outside diameter of loose tube.

d = Inside diameter of loose tube.

For example:-

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

Lo > $100 \times \sqrt{(5^2 + 3^2)} / 4 = 100 \times 5.83/4 = 145.8$

Procedure: Both the ends of a buffer tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load the tube will bend, so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.

Requirement: The tube should not get embrittled. No kink should appear on the tube up to the safe bend diameter of tube (20 D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.

B) Kink Resistance Test on the Loose Tube

Objective: To safeguard the delicate optical fibres, the quality of the loose tube material should be such that no kink or damage to the tube occurs while it is being handled during installation and in splicing operations.

Procedure: To check the kink resistance of the loose tube, a longer length of the loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 15 D (where D is the outside diameter of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.

Requirement: No damage or kink should appear on the surface of the tube.

4.12 Drainage Test for loose Tube (Type Test for Type-I cable):

Sample Size: 30 cm tube length.

Test procedure:

a) Cut the tube length to 40 cm.
b) Fill the tube with the tube filling gel ensuring there are no air bubbles and the tube is completely full.
c) Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from each end so that the finished length of the sample is 30 cm.
d) Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs (This is necessary because the gel has been sheared and the viscosity has been reduced during the filling process).
e) The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70° C for a period of 24 Hrs.
f) At the end of the 24 Hrs period the beaker is checked and weighed to see if there is any gel in the beaker.

Requirement:

i. If there is no gel or oil in the beaker the tube has PASSED the drainage test.
ii. If there is gel or oil in the beaker the tube has FAILED the drainage test.

4.13 Check of easy removal of sheath:

Objective: Check of the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.

Procedure: To check easy removal, the sheath shall be cut in circular way and the about 300 mm length of the sheath should be removed in one operation.

It should be observed during sheath removal process that no undue extra force is applied.

Requirement: No component part of the cable shall be damaged. One should be able to remove the sheath easily.

4.14 Cable Bend Test at High & Low Temperatures:

Objective: To determine the ability of an optical fibre cable to withstand bending at low and high temperatures, which might be encountered during cable placement.

Method: EIA RS-455-37

Test Specs. :

Test Temperature	:	- 20° C to + 60° C.
Mandrel Diameter	:	40 mm
No. of turns	:	4
Conditioning time duration	:	24 hours at each temp.
Acceptance	:	Visual test for the damage of the sheath

Requirement: Sheath shall not show any cracks and damages visible to the naked eye when examined whilst still wrapped on the mandrel.

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. The accuracy of the sequential marking must be within -0.25% to +0.5% of the actual measured length. The sequential length markings must not rub off during normal installation and in life time of optical fibre cable. The total length of the cable supplied shall not be in negative tolerance.

5.1.2 The marking shall be in black colour over the sheath and shall be done by ink jet printing method. It must clearly contrast with the surface. The colour used must withstand the environmental influences experienced in the field.

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: FTTH cable
d) Type of Fibre: G.657A fibre
e) Number of Fibres : (n) Fibre(s), where n = 1 to 12
f) Year of manufacture
g) Sequential length marking
h) User's identification
i) Cable ID

5.2 Cable Ends:

5.2.1 Both ends of the cable in the reel shall be sealed and readily accessible. Minimum 5 meter of the cable of the beginning of the reel shall 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 manufacturer shall submit the methodology used for the same.

5.2.2 The arrangement of the pulling eye and its coupling system, shall withstand the prescribed tensile load applicable to the cable.

5.3 Nominal Length of the Cable:

5.3.1 Length of OF Cable in each drum shall be 500 m, 1 Km, 2 Km or as per the order. $\pm$ 5% variation in length of optical fibre cable may be acceptable.

5.3.2 No fibres in a cable length shall 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 cable
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 nm & 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 OF Cables:

5.4.1 The colorant applied to individual fibres shall be readily identifiable throughout the lifetime of the cable and shall match and conform to the Munsell Colour Standards (For EIA standard EIA 598C) and also IEC Publication 304 (4).

5.4.2 Colour coding scheme to be adopted for individual fibres, shall be as below:

1. Blue	5. Slate/Grey	9. Yellow
2. Orange	6. White (Milky White)	10. Violet
3. Green	7. Red	11. Rose
4. Brown	8. Black	12. Aqua

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 metal-free optical fibre cable shall contain the raw materials approved in accordance with the GR No. TEC/GR/TX/ORM-001/05 Dec-17 (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 approval testing.

6.2.3 The use of raw materials from multiple sources is permitted. 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 Quality Assurance wing of purchaser. In case of change of source/grade of SM Optical Fibre, the call for fresh evaluation/testing shall be decided by Quality Assurance wing of purchaser.

6.2.5 The material used in metal-free optical fibre cable must not release hydrogen to affect the characteristics of optical fibres.

Note: A test certificate from a recognised 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 (Optical fibre and other components shall meet the requirements of the compatibility with materials for Type-II cable) that are in direct contact with identified components within the cable structure (This shall be tested as per clause no. 6.3.4 of Telcordia document GR-20-CORE issue 4, July 2013).

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

7.0 Safety Requirement :

7.1 The material used in the manufacturing of the metal free optical fibre cables shall be non-toxic and dermatologic ally 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.

7.2 Flame spread – Single cable (Duplex):

Objective: To test the resistance to vertical flame propagation for a single vertical optical fibre cable, under fire conditions.

Method: IEC/EN 60332-1-2.

Requirement: charring should not extend greater than 540 mm from the lower edge of the top support.

7.3 Flame spread – Bunched cable:

Objective: To test the resistance to vertical flame spread of vertically mounted bunched optical fibre cable, under defined conditions.

Method: IEC/EN 60332-3-24, Cat C

Requirement: The cable shall pass the test if the distance between the lower edge of the top support and the onset of charring is greater than 50mm and charring shall not extend downwards to a point greater than 540mm from the lower edge of the top support.

Note: Latest issue of all the Standards mentioned in this chapter, 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 cable installation, operation, maintenance and fibre splicing shall also be covered in the handbook. A hard as well as soft copy of the manuals shall be provided.

9.0 Accessories :

All accessories (passive) shall be supplied along with cable by manufacturer conforming to the installation requirements of the cable.

10.0 Information for the Procurer of product:

10.1 The procurer may ask for Type-I or Type-II cable for FTTH Drop applications as per their requirements. Type-I is loose tube design cable with 1 to 12 nos. of fibres whereas Type-II is Flat cable design with 2 nos. of fibres. These cables are envisaged to be installed inside the premises/buildings and meant to carry high bit rate optical signals to the end user. The optical fibre being used is bending loss insensitive which is suitable for fibre to the home application purpose.

10.2 The procurer may ask for Cable with G.657 A1 fibre or G.657.A2 fibre as per their requirements

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

11.0 Procedures for the issue of Approval certificate for Lower Fibre Count Cables (Applicable for Type-1 only)

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 FTTH Optical Fibre Cable against this Standard for GR (or latest release) 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
FOTP	-	Fibre Optic Test Procedure
FRP	-	Fibre Reinforced Plastic
GPa	-	Giga 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
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
UL	-	Underwriters Laboratory

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 in accordance with the submitted design calculations, during evaluation of the OF cables:

Table A1: Cable design parameters for FTTH Cable (Type-I)

SN	Parameter	Unit	1 - 12 Fibre OF cable	Remarks
1	Tube ID(min)	mm	2.0	± 0.1 mm
2	Tube OD	mm	2.8	± 0.1 mm
3	No of fibre/tube	No	1 - 12	
4	Colour of fibre		BL, OR, GR, BR, SL, WH, RE, BK, YE, VI, RO, AQ	
5	No of loose tubes	No	1	Central Tube
6	Colour of Tube		-	Any colour
7	Strength Members (Aramid Yarns)	Kg/Km	0.8	Peripheral
8	Minimum thickness of Outer Sheath (LSZH)	mm	0.3	
9	Cable diameter	mm	4.0	± 0.2 mm
10	Nominal cable weight	Kg/Km	16	± 2.0 Kg/Km
11	Excess fibre length	%	0.65	

12	Cable to be designed to sustain fibre strain value of	%	0.1	
13	Cable to be tested at defined load for fibre strain value of.	%	0.25	

ANNEXURE –B

The following parameters of the component parts of the cable are to be taken into account while designing and manufacturing the Optical fibre cables. These parameters shall be checked in accordance with the submitted design calculations, during evaluation of the OF cables:

Table B1: Cable design parameters for FTTH Cable (Type-II)

SN	Parameter	Unit	1 – 2 Fibre OF cable
1.	Fibre Colour		Blue & Orange
2.	Strength Member (2 Nos.)		Aramid Reinforced Plastic Rod
3.	Outer Sheath Material		Low Smoke Zero Halogen
4.	Colour of Sheath		White or Yellow
5.	Cable Dimensions Width Height	 mm mm	 3.0 ± 0.2 2.0 ± 0.2
6.	Cable Weight	Kg/Km	8.0
7.	ARP size	mm	0.5 ± 0.05