Transmission
Issue: JULY 2005

MICRO DUCT OPTICAL FIBRE CABLE

GENERIC REQUIREMENTS
NO. GR/OFC - 16/01. JULY 2005

TEC

TELECOMMUNICATION ENGINEERING CENTRE
KHURSHIDLAL BHAWAN, JANPATH
NEW DELHI 110001.

HISTORY SHEET

Name of the Generic Requirements	No. of the Generic Requirements	Remarks
Micro Duct Optical Fibre Cable	**GR/OFC-16/01. JULY 05**	**New GR (First issue)**

CONTENTS

REFERENCES

TEC STANDARDS

1. GR/ORM-01/03. MAR 04	Specification for Raw Material
2. G/OFT-01/02. MAR 99	Specification for Tools For Installation & Operating the OFC & for Assembly of the Optical Fibre Splice Closures

OTHER STANDARDS (ITU-T/EIA/IEC/Bell core/ISO)

1. EIA 359-A IEC Publication 304(4)	Color Standards Color Standards
2. EIA 455-104	Test Methods
3. G. 652 D	ITU-T Recommendation
4. GR-20 –CORE July 98	Generic Requirement for Optical Fibre Cable. (Bell core)
5. ISO 9001:2000	International Quality Management System.
6. IEC 60793 -2-50, IEC 60794-1-2-E1, IEC 60794-1-2-E2, IEC 60794-1-2-E3, IEC 60794-1-2-E10, IEC 60794-1-2-E11, IEC 60794-1-2-F1, IEC 60794-1-2-F5	Test Methods

PART I - TECHNICAL SPECIFICATION

1.0 Introduction :

This document describes the generic requirements of Micro Duct Optical Fibre Cable for installation in ducts. The Micro Optical Fibre Cable shall have low weight, small volume and high flexibility.

2.0 Functional Requirements :

2.1 The design and construction of Micro duct optical fibre cable shall be inherently robust and rigid under all conditions of installation, operation, adjustment, replacement, storage and transport.

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

2.3 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.

2.4 It shall be possible to operate and handle the Micro duct optical fibre cable with tools as per GR No. G/OFT-01/02. MAR 99 and subsequent amendments, if any. If any special tool required for operating and handling the optical fibre cable, the same shall be provided along with the cable.

3.0 Technical Requirements of Optical Fibres :

Single Mode Optical Fibre used in manufacturing optical Fibre Cables shall be as per ITU-T Rec. G 652 D . The specification of optical fibres are mentioned below.

3.1	Type of fibre (Wavelength band optimized nominal 1310 nm)	:	Single mode (Section I of the GR No.GR/ORM-01/03. MAR 04 and subsequent amendments, if any)

3.2 Geometrical Characteristics :

3.2.1	Nominal MFD For matched clad	:	8.8-9.8 µm
3.2.2	Nominal Cladding Dia.	:	125 µm ± 1.0 µm
3.2.3	Cladding Non-circularity	:	$\leq$ 1%
3.2.4	Mode field concentricity error	:	$\leq$ 0.8 µm

3.2.5 Diameter over primary coated with double UV cured acrylate. (Shall be measured on un coloured fibre) : 245 µm ± 10 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.

3.3 Transmission Characteristics:

3.3.1 Attenuation :

a) Fibre attenuation before Cabling
   - i) At 1310 nm : ≤ 0.34 dB/km
   - ii) Between 1285 to 1330 nm : ≤ 0.37 dB/Km
   - iii) At 1550 nm : ≤ 0.21 dB/Km
   - iv) Between 1525 to 1625 nm : ≤ 0.24 dB/Km

b) Fibre attenuation after Cabling
   - i) At 1310 nm : ≤ 0.36 dB/km
   - ii) Between 1285 to 1330 nm : ≤ 0.39 dB/Km
   - iii) At 1550 nm : ≤ 0.23 dB/Km
   - iv) Between 1525-1625nm : ≤ 0.26 dB/Km

c) Water Peak Attenuation
   Between 1360 – 1480nm : ≤ 0.34 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 .
2. Sudden irregularity in attenuation shall be less than 0.1 dB
3. The spectral attenuation shall be measured on un-cabled fibre.
4. The Spectral attenuation in the 1250 nm–1625 nm band at an interval of 10nm shall be measured 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

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) Fibre : $\leq$ 0.2 ps/$\sqrt{}$ km
   ii) Cabled Fibre : $\leq$ 0.3 ps/$\sqrt{}$ 'km

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

c) Zero Dispersion Slope : $\leq$ 0.092 ps/(nm ^{2} Km)

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

3.3.3 Cut off wavelength for fibres used in cables : 1320 nm Max.

Note - The above cut off wavelength is w.r.t. 2M sample length of fibre.

3.4 Mechanical Characteristics:

3.4.1 Proof test for minimum strain level : 1%

3.4.2 Stripability force to remove primary coating of the fibre. : $1.3 \leq F \leq 8.9$ N

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 1.3 N.

3.4.3 Dynamic Tensile Strength

a) Un-aged : $\geq$ 550 KPSI (3.80 Gpa)
b) Aged : $\geq$ 440 KPSI (3.00 Gpa)

3.4.4 Dynamic Fatigue : $\geq$ 20
(Test method IEC- 60793 - 1)

3.4.5 Static Fatigue : $\geq$ 20
(Test method IEC- 60793 - 1)

3.4.6 Change in attenuation measured at 1550 nm when fibre is coiled with 100 turns on 30 $\pm$1.0 mm radius mandrel : $\leq$ 0.10 dB.

3.4.7 Fibre Curl : $\geq$ 4 meters radius of curvature
(Test method as per IEC 60793-1)

3.4.8 Fibre micro bend : $\leq$ 0.5dB at 1550 nm
(1 turn-around 32 $\pm$0.5 mm diameter mandrel)

3.5 MATERIAL PROPERTIES:

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 :

3.6.1 Operating Temperature

(Test Method IEC – 60793 – 1)

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)

Induced Attenuation at 1550 nm at -10°C to +85°C and 95% relative humidity. : $\leq$ 0.05 dB/km

3.6.3 Water Immersion 23°C

(Test method IEC- 60793 – 1)

Induced Attenuation at 1550 nm due to Water Immersion at 23 $\pm$ 2°C : $\leq$ 0.05 dB/km

3.6.4 Accelerated Aging (Temperature) 85°C
(Test method IEC- 60793 – 1)

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)

Coated Fiber shall show no discernible change in color, when aged for relative humidity : 30 days at 85°C with 95% Humidity and then 20 days in 85°C dry heat.

3.7 Colour Qualification and primary coating Test

3.7.1 MEK RUB Test (Methyle Ethyl Ketone Test)

To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No colour traces to be observed on the tissue paper.

3.7.2 Fourier Transform Infrared Spectroscopy (FTIR)Test

To be tested to check the curing level of primary coating on the glass. The curing level shall be better than 90%.

3.8 Micro Optical Fibre Cable Construction Specifications for 6F, 12F and 24F:

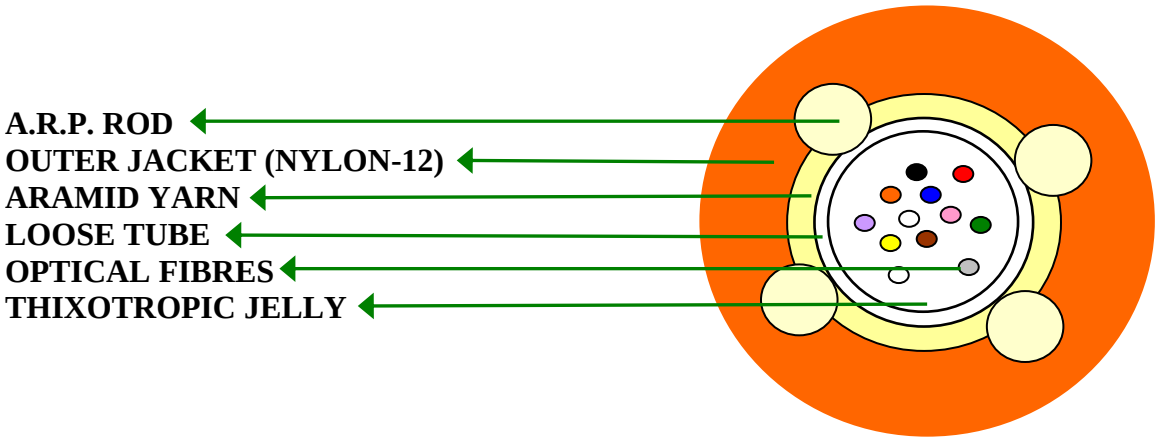
The cable shall be designed to the parameters mentioned in annexure – I. The manufacturer shall submit designed calculation and the same shall be studied and checked.

3.8.1 Secondary Protection :
The primary coated fibres may be protected by loose packaging within a tube, which shall be filled with thixotropic jelly .

3.8.2 Number of fibres : 6,12 and 24
(Type approval for a cable shall be issued depending upon the no. of fibres in the cable)

3.8.3 Strength Member : The strength member in the cable shall provide the strength and flexibility to the cable and shall have anti buckling properties. The four nos. Solid Aramid reinforced plastic rod (ARP rod) of 0.5 mm shall be used over the loose tube diagonally to each other. The specification of ARP rod shall be as per Annexure –III.

MICRO CABLE FROM 6 TO 24 FIBRES:



3.8.4 Filling compound : The filling compound used in the loose tube shall be compatible to fibre, secondary protection of fibre etc. The drip point shall not be lower than +70 degree C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. The filling jelly compound shall be as per the GR no. GR/ORM–01/03. MAR 04 and subsequent amendments, if any.

3.8.5 Reinforcement : The Micro optical fibre cable shall be reinforced with Aramid Yarn in the periphery over loose tube. The Aramid Yarn shall be uniformly and equally distributed on the entire periphery (circumference) of the loose tube. The quantity of the Aramid Yarn used per kilometer length of the cable with its D-Tex value shall be as per the requirement mentioned.

3.8.6 Outer Jacket : A circular jacket of minimum 0.50 mm thick of nylon-12 material orange in colour, free from pin holes, scratches and other defects etc shall be provided over and above the Aramid reinforcement. The nylon jacket shall have smooth finish.

3.8.7 Cable diameter :

The manufacturer shall define the cable diameter. The finished cable diameter shall be as per Annexure-I.

3.8.8 Cable weight :

The manufacturer shall define the cable weight. The nominal cable weight shall be as per Annexure-I.

3.9 Micro Optical Fibre Cable Construction Specifications for 48F and 72F :

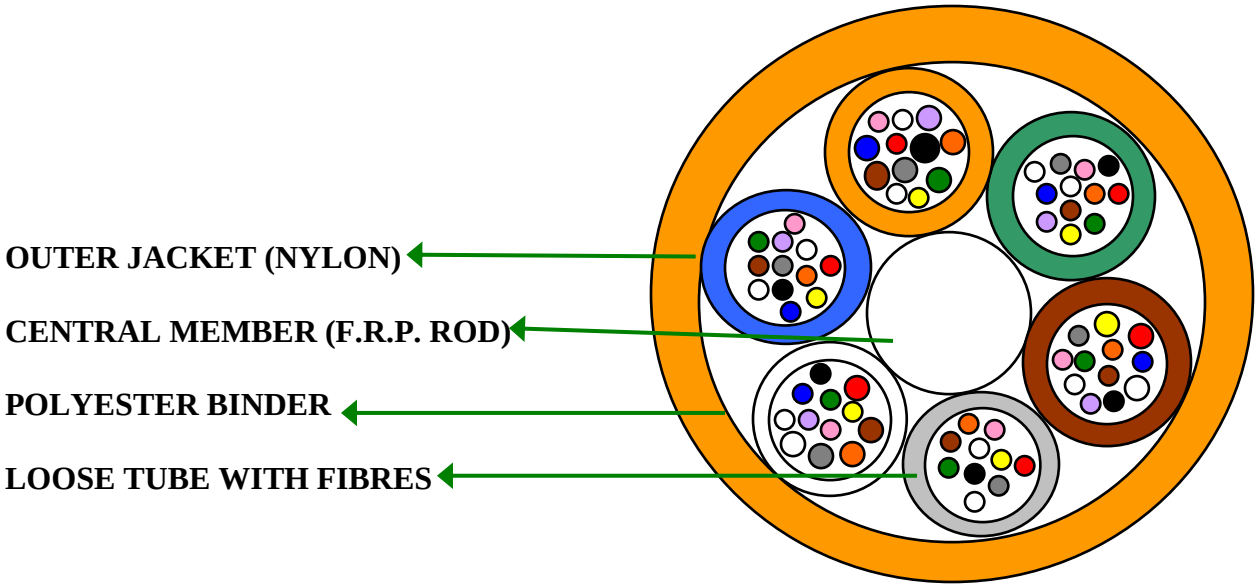
3.9.1 Secondary Protection :

The primary coated fibres may be protected by loose packaging within a tube, which shall be filled with thixotropic jelly .

3.9.2 Number of fibres : 48 or 72

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

MICRO CABLE FROM 48 TO 72 FIBRES



3.9.3 Strength Member : Solid non-metallic strength member (FRP) shall be provided in the center of the cable core. The strength member (as per Annexure-II) in the cable shall be for strength and flexibility to the cable and shall have anti buckling properties.

3.9.4 Filling compound : The filling compound used in the loose tube shall be compatible to fibre, secondary protection of fibre etc. The drip point shall not be lower than +70 degree C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. The filling jelly compound shall be as per the GR no. GR/ORM–01/03.MAR04 and subsequent amendments, if any.

3.9.5 Cable Core Assembly: The primary fibres in loose tubes, stranded together around a central strength member (using helical or reverse lay techniques), shall form the cable core. The polyester/Nylon binder thread shall be used to hold the cable core assembly.

3.9.6 Outer Jacket : A jacket of minimum 0.5 mm thick of nylon -12 material, orange in colour, free from pin holes, scratches and other defects etc., shall be provided over the cable core assembly.

3.9.7 Cable Diameter :

The manufacturer shall define the cable diameter. The finished cable diameter shall be as per Annexure-II.

3.9.8 Cable Weight :

The manufacturer shall define the cable weight. The nominal cable weight shall be as per Annexure-II.

3.10 Mechanical Characteristics and Tests on Micro Optical Fibre Cable :

3.10.1 Tensile Strength Test:

Objective : To test the tensile strength of Micro optical fibre cables in order to examine the behavior of the attenuation as a function of the load on a cable which may occur during installation.

Test Method : IEC 60794-1-2-E1.

Test Specs. : The cable shall have sufficient strength to withstand a load of value T(N) = 9.81 x 1.3 W (where W-mass of 1 Km of cable in Kg) or 300 Newtons which is higher. The load shall be sustained for 10 minutes and the strain on the fibre shall be monitored and the same shall not exceed above 0.25%.

Requirements: The load shall not produce a strain exceeding 0.25% in the fiber and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fiber after the test shall be $\leq$ 0.05dB, both for 1310nm & 1550 nm wavelength

3.10.2 Abrasion Test :

Objective : To test the abrasion resistance of the jacket and marking printed on the surface of the Micro cable.

Test Method : IEC-60794-1-2- E2 or by any other international test method

Test Specs : The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1mm with 500 grams weight (Total weight more than equal 650 gms.)
No. of cycles : 50
Duration : One minute (Nominal)

Requirement : There shall be no perforation and loss of legibility of the marking on the jacket.

3.10.3 Crush Test (Compressive test):

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

Test Method : IEC-60794-1-2-E3

Test Specs : The fibers and component part of the cable shall not suffer permanent damage when subjected to a compressive load of 1000 N applied, between the plates of dimension 100 X 100 mm. The load shall be applied for 60 seconds. The attenuation shall be noted before/after the completion of the test.

Requirement :The change in attenuation of the fibre after the test shall be $\leq$ 0.05dB, both for 1310nm and 1550nm wavelength.

3.10.4 Repeated Bending Test :

Objective : The purpose of the test is to determine the ability of Micro optical fiber cable to withstand repeated bending.

Test Method : EIA-455-104

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

Parameters :

a) Weight : 2 Kg
b) Minimum distance from Pulley centre to holding device : 216 mm
c) Minimum distance from Wt. to Pulley centre : 457 mm
d) Pulley Diameter (D - cable diameter) : 20 D
e) Angle of Turning : 90°
f) No. of cycles : 30
g) Time Required for 30 cycles : 2 minutes

Requirement : During the test no fiber shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be less ≤ 0.05 dB, both for 1310 and 1550nm wavelength.

3.10.5 Kink Test :

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

Method : IEC 60794-1-2-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 so that no kink shall form. After the cable comes in normal condition, the attenuation reading is taken.

Requirement : The kink should disappear after the cable comes in normal condition. The change in attenuation of the fibre after test shall be ≤ 0.05 dB, both for 1310 nm & 1550 nm wavelength.

3.10.6 Cable Bend Test :

Objective : The purpose of this test is to determine the ability of Micro 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 60794-1-2-E11 (Procedure-I).

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 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.

Requirement : The change in attenuation of the fibre after the test shall be ≤0.05 dB, both for 1310 nm and 1550 nm wavelength. The jacket shall not show any cracks visible to the naked eye, when examined whilst still wrapped on the mandrel.

3.10.7 Temperature Cycling Test :

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

Method : IEC 60794-1-2-F1. (To be tested on standard cable length of drum i.e. 2 Km)

Test Specs. : The permissible temperature range for storage and operation will be from -20°C to +70°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 given below :

TA2 temp. : - 20°C.
TA1 temp. : - 10°C.
TB1 temp. : + 60°C.
TB2 temp. : + 70°C.

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

Requirement: The change in attenuation of the fibre under test shall be $\leq$ 0.05 dB, both for 1310 nm and 1550 nm wave length for the entire range of temperature.

3.10.8 Cable aging Test :

Objective : To check the cable material change dimensionally as the cable ages.

Method : At the completion of temperature cycle test, the test cable shall be exposed to 85 $\pm$ 2 degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wave length to be made after stabilization of the test cable at ambient temperature for 24 hours.

Requirement : The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB, both for 1310 nm and 1550 nm wavelength.

Note : The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

3.10.9 Water Penetration Test :

Objective : The aim of this test is to ensure that installed optical fibre cable will not allow water passage in the cable.

Method : IEC 60794-1-2-F5 (Fig. B) 1992.

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

Requirement : No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.

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

Objective : Check of easiness in formation of figure of 8 of the cable during installation in the field.

Test Method : 1000 meter of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8 (eight) shape. The diameter of each loop of the figure of 8 shall be maximum 2 meters.

Requirement : It shall be possible to make figure of 8 of minimum 1000 meters of the cable uncoiled from the cable reel, without any difficulty. No visible damage shall occur.

3.10.11 Check of quality of the loose tube (containing optical fibre) (Type Test) :

a. Embrittlement Test method :

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

Sample : The minimum length of the test sample depends on the outside diameter of the loose tube and should be 85 mm for tubes upto 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 dia of loose tube.
d = Inside dia of loose tube.

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 exerts a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute towards the fixed jaw. Under load, the tube will bend so that it 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 ink should appear on the tube up to the safe bend dia of tube (15 D), where D is the outside diameter of the loose tube. There should also not be any physical damage or mark on the tube surface.

b. Kink Resistance Test method

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 occur 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 out side dia 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.

3.10.12 Drainage Test for loose Tube :

Sample Size : 30 cm tube length.

Test procedure :

i. Cut the tube length to 40 cm.
ii. Fill the tube with the tube filling gel ensuring that there are no air bubbles and the tube is completely full.
iii. Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from either end so that the finished length of the sample is 30 cm.
iv. Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs
v. 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.
vi. 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.

3.10.13 Check of easy removal of Jacket :

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

Procedure : To check easy removal, the jacket shall be cut in circular way and the about 300 mm length of the jacket should be removed in one operation. It should be observed during jacket removal process that no undue extra force is applied and no component part of the cable is damaged. One should be able to remove the jacket easily.

3.10.14 Check of Effect of aggressive media on the cable surface (Acidic and alkaline behavior) (Type Test) :

Procedure : To check the effect of aggressive media, solution of PH4 and PH10 shall be made. The two test samples of the finished cable, each of 600 mm in length, are taken and the ends of the samples are sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc on the jacket and other markings of the cables. (Test method no. ISO175).

Requirement : The sample should not show any effect of these solution on the jacket and other marking of the cable.

PART II - GENERAL REQUIREMENTS

4.0 Engineering Requirements :

4.1 Cable Marking :

4.1.1 Marking on Micro optical fibre cable shall be of durable quality. It shall be marked at one meter intervals in black colour inkjet printing over the orange colour jacket. 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.

4.1.2 The type of legend marking on O.F. cable shall be as follows :

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

4.2 The nominal drum length:

4.2.1 Length of Micro optical fibre cable in each drum shall be 2 Km ± 10%.

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

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

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

a) Drum No.
b) Type of cables
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) Name of the route
l) Diameter of cable

4.3 Colour coding in O.F. Cables & Unit Identification :

4.3.1 The colorant applied to individual fibres shall be readily identifiable throughout the lifetime of the cable and shall match and confirm to the MUNSELL Color Standards (For EIA Standard EIA-359-A) and also IEC Publication 304 (4).

4.3.2 Colour code to be adapted for individual fibres :

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

4.3.3 Unit / Bundle Identification:

Each unit/bundle has to be identified by colour of the binder with colours indicated as follows :

Blue, Orange, Green, Brown, Slate/Grey, White, Red, Black, Yellow, Violet, Rose / Pink, Natural/Aqua.

4.3.4 Colour Coding Scheme :

When the loose tubes are placed in circular format, the marking to indicate the loose tube no. "1" shall be in blue colour followed by loose tube no.2 of orange and so on for other tubes as per the colour scheme given below and complete the circular format by placing the dummy /fillers at the end.

Depending upon the number of fibres in a loose tube (which depends on the cable capacity), the fibres are serially chosen from the column no. II of the table. One of the fibres in a tube shall be of natural color, while the rest of fibres are colored.

Colour Coding scheme of the Optical Fibres & Loose tube

No. of Fibers/Buffer tube I	Fiber identification II	Loose tube identification III
1	Blue	Blue
2	Orange	Orange
3	Green	Green
4	Brown	Brown
5	Slate	Slate
6	White	White
7	Red	Red
8	Black	Black
9	Yellow	Yellow
10	Violet	Violet
11	Rose/Pink	Rose/Pink
12	Aqua/Natural	Aqua

5.0 Quality Requirements :

5.1 The cable shall be manufactured in accordance with the international quality standards ISO 9001-2000 for which the manufacturer should be duly accredited. The Quality Manual shall be submitted by the manufacturer.

5.2 Raw Material:

5.2.1 The cable shall use the raw materials approved against the No. GR/ORM-01/03 MAR. 04 and the subsequent amendment issued, if any.

5.2.3 The material used, other than above materials, 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.

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

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

5.2.5 The material used in Micro 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.

5.3 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 as per clause no. 6.3.4 of GR-20-CORE issue 2, July 1998.

6.0 Documentation:

6.1 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.

6.2 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.

7.0 Safety Requirement:

7.1 The material used in the manufacturing of the Micro optical fibre cables shall be non toxic and dermatological 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 Micro optical fibre cable to substantiate the statement

_____

ANNEXURE – I

CABLE DESIGN PARAMETER FOR 6 TO 24 FIBRES

The following parameters of the component parts of the Micro Optical fibre cable (6 to 24 fibres) are to be taken in to account while designing and manufacturing the cable of the required fiber count. These parameters shall be checked during evaluation of the Micro Optical fibre cables:

S. No.	Parameter	Unit	No. of Fibres Cables		
			6F Micro O.F. Cable	12F Micro O.F. Cable	24F Micro O.F. Cable
1	Tube OD	mm	1.7 ± 0.2	1.7 ± 0.2	3.5 ± 0.2
2	Colour of fibre		As per clause no.4.3.2	As per clause no. 4.3.2	As per clause no. 4.3.2
3	Colour of binder		--	--	BL,OR
4	Aramid yarn	Kg/Km	0.50	0.50	0.67
5	Diameter of Solid Aramid Reinforced Plastic Rod (4 Nos.)	mm	0.50 ± 0.05	0.50 ± 0.05	0.50 ± 0.05
6	Outer Jacket Thickness	mm	≥ 0.5	≥ 0.5	≥0.5
7	Cable diameter	mm	3.8 ± 0.3	3.8 ± 0.3	5.6 ± 0.3
8	Nominal Cable weight	Kg/km	11 ± 2	11 ± 2	24 ± 3
9	Cable to be tested at defined load for fibre strain value of.	%	0.25	0.25	0.25

ANNEXURE – II

CABLE DESIGN PARAMETER FOR 48 to 72 FIBRES

The following parameters of the component parts of the Micro Optical fibre cable (48 to 72 fibres) are to be taken in to account while designing and manufacturing the cable of the required fiber count. These parameters shall be checked during evaluation of the Micro Optical fibre cables:

S. No.	Parameter	Unit	No. of Fibres Cables	
			48F Micro O.F. Cable	72F Micro O.F. Cable
1	Tube OD	mm	1.9 ± 0.1	1.9 ± 0.1
2	Nos. of Fibres in Loose tube	Nos.	8	12
3	Colour of fibre		As per clause no.4.3.4	As per clause no. 4.3.4
4	Colour of loose tube		BL,OR,GR,BR,SL,WH	BL,OR,GR,BR,SL,WH
5	Diameter of Solid EAA Coated FRP Rod	mm	2.0 ± 0.05	2.0 ± 0.05
6	Outer Jacket Thickness	mm	≥ 0.5	≥ 0.5
7	Cable Diameter	mm	6.9 ± 0.3	6.9 ± 0.3
8	Nominal Cable weight	Kg/km	40 ± 4	40 ± 4
9	Cable to be tested at defined load for fibre strain value	%	0.25	0.25

ANNEXURE-III

SPECIFICATION OF ARAMID REINFORCED PLASTIC ROD (A.R.P. ROD)

APPLICATION:

The (ARP) rod is used as strength member for Micro optical fibre cable. The Aramid Reinforced Plastic rod shall be smooth and even surface, free from defects and manufactured from Aramid yarn & resin by continuous moulding / pultrusion method. The material shall not offer any health hazards. The ARP rod shall be coated with Ethelene acrylic acid. The thickness of coating shall be $\geq$ 20 µm.

CHARACTERISTICS:

S.NO.	PARAMETER	UNIT	REQUIREMENT	TEST METHOD
1.	Physical Dimensions of Coated Rod	mm	0.5 $\pm$ 0.05	Micrometer
2.	Tensile Strength at break	Kg/mm²	$\geq$ 150	ASTM D 3916
3.	Tensile Modulus	Kg/mm²	$\geq$ 6500	ASTM D 638
4.	Elongation at break	%	$\leq$ 3.3	ASTM D 3916
5.	Minimum Bend Diameter ($\leq$16D) At 25 º C (D is the diameter of the rod)	mm	No Decomposition or Delamination	
6.	Heat Stress @ 80 º C. 24 hrs, 50x D (D is the diameter of the rod)		No Decomposition or Delamination	

LIST OF ABBREVIATIONS

ASTM	- American Society for Testing and Materials
ARP	- Aramid Reinforced Plastic
BIS	- Bureau of Indian Standards
dB	- Decible
EIA	- Electronic Industry Association
F	- Force
FRP	- Fibre Reinforced Plastic
Gpa	- Gega Pascal
HDPE	- High Density Polyethylene
IEC	- International Electro -Technical Commission
IS	- Indian Standards
ISO	- International Standard Organisations
ITU-T	- International Telecommunication Union – Transmission
KM	- Kilo meter
KPSI	- Kilogram per sq. inch
MFD	- Mode Field Diameter
Nm	- nanometer
N	- Newton
OF	- Optical Fibre
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
°C	- Degree Celsius