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**INDIAN RAILWAYS STANDARD SPECIFICATION  
FOR  
24 FIBRE ARMOURED OPTICAL FIBRE CABLE  
(TENTATIVE)**

**SPECIFICATION NO. IRS: TC 55-2006**

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**TELECOM DIRECTORATE  
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Author  Shri Anil Kumar Mishra <b>Director/ Telecom-II/ RDSO</b>		
Approved by  Shri M. Alam <b>Executive Director/ Telecom/ RDSO</b>		
Abstract  <b>This document specifies technical specifications of 24 Fibre Armoured Optical Fibre Cable.</b>		

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**DOCUMENT CONTROL SHEET**

<b>NAME</b>	<b>ORGANIZATION</b>	<b>FUNCTION</b>	<b>LEVEL</b>
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**REVISIONS/ AMENDMENTS :**

<b>Version</b>	<b>Chapter/ Annexure</b>	<b>Amendment/ Revision</b>	<b>Effective Month/Year</b>
IRS: TC 55-1991	-	FIRST ISSUE	1991
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IRS: TC 55-2006		Revision -1	May, 2006

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**INDIAN RAILWAY STANDARD SPECIFICATION**  
**FOR 24 FIBRE ARMoured OPTIC FIBRE CABLE-**

**0. FOREWORD:**

0.1 This specification was adopted in 1991, Ist revision was issued in May 1996, 2<sup>nd</sup> revision in October 1996, 3<sup>rd</sup> revision in 1998 & 4<sup>th</sup> revision in 2000 and specification was issued with serial no. IRS:TC 55-2000. After issue of specification in year 2000, Ist amendment was issued in year 2003, 2<sup>nd</sup> in 2004 & 3<sup>rd</sup> in 2005. This specification is being issued incorporating all the amendments with some additional changes as serial no. IRS:TC 55- 2006 (Rev. 1)

0.2 In preparing this standard, assistance has been derived from the following :

- i) Vol. III - FASCICLE III.2 - International Analogue carrier systems, Transmission Media- characteristics – ITU-T , 2003, Rec.G.652 D (03/03),ITU-T,(Characteristics of Single Mode Optic Fibre Cable).
- ii) Vol III - FASCICLE III.3 - Digital Networks Transmission system and multiplexing equipment Rec.G.956,ITU,1984.
- iii) IEC Publication 60793-1(1998) - Optical Fibres, Part 1:Generic specification.
- iv) IEC Publication 60793-2 (1998), Optical Fibres, Part-2: Production Specifications.
- v) IEC Publication of 60794-1(1998-02) Optical Fibre Cables, Part 1 : Generic specification.
- vi) IEC Publication 189-1 (1986).
- vii) International Electrotechnical Vocabulary on Optical Communication -DOC 1 (IEV 731), C.O.1270-I & II.
- viii) ASTM:D789-92 Standard Test method for Polyamide materials (Nylon & others).
- ix) ASTM:D1248-84(Reapproved 1989) Standard Specification and Test methods for Polyethylene Moulding and Extrusion Materials.
- x) ASTM:D374-88 Standard Test method for Thickness of Solid Electrical insulation.
- xi) ASTM:D3916-84 Standard Test method for Tensile Properties of Pultruded Glass Fibre Reinforced Plastic Rod.
- xii) ASTM:A167-92b Standard specification for Stainless and Heat-Resisting Chromium

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Nickel Steel Plate, Sheet and Strip.

- xiii) ASTM:A751-92 Standard Test Methods, Practices and Terminology for Chemical Analysis of Steel Products.
  - xiv) ASTM:A370-82 Standard method and definition for mechanical Testing of Steel Products.
  - xv) ASTM D:2581-91 Standard specification for Polybutylene (PB) Plastic moulding and extrusion material.
  - xvi) ASTM D:2287-81 Nonrigid Vinylchloride Polymer and Copolymer Moulding and Extrusion Material.
  - xvii) Generic Requirements of Armoured Optic Fibre Cable for direct Burial(underground) No. G/OFC-02/03.September 2003 and Generic Requirements of Raw Material Used in Manufacturing of Optical fibre Cable No. G/ORM-01/03. MAR 2004, issued by TEC.
  - xviii) ASTM: D 638 F.R.P.
  - xix) ASTM: D 217,566,FTM 791B, 93-IP-34 for Jelly.
  - xx) ASTM: D 570,211 for P.B.T.P.
  - xxi) ASTM: D 1505 for Poly Carbonate.
  - xxii) ASTM: D 1633,150 for H.D.P.E.
- 0.3 Wherever in this specification, any other specification is referred to, the latest issue is implied, otherwise the particular issue mentioned is to be meant.

## 1. SCOPE:-

- 1.1 This specification covers the requirements of optical, mechanical characteristics and testing & inspection for monomode underground armoured optical fibre cable for use on Indian Railway Telecommunication Network between 1300 nm to 1550 nm band.

## 2. GENERAL REQUIREMENTS:-

- 2.1 The cable shall consist of 24 monomode fibres.
- 2.2 The cable shall be suitable for direct underground burial and mechanized laying in the duct.

## 3. TERMINOLOGY:

The terminology used in this specification is as indicated in International

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Electrotechnical Vocabulary on Optical communication [DOC 1(IEV 731) C.O. 1270 – I and II].

#### 4. SERVICE CONDITIONS:-

4.1 The optic fibre cable shall be able to withstand the following environmental conditions.

- (a) Ambient temperature over which specification are guaranteed (50% RH max)  $0^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$
- (b) Storage temperature  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

#### 5. TECHNICAL REQUIREMENTS :-

5.1 CHARACTERISTICS OF FIBRE :-

5.1.1 Monomode fibre shall be as per ITU-T Rec.G.652 D(03/03 or latest) unless otherwise specified and also conform to the generic requirement for DWDM equipment suitable to TEC GR NO. G/ WDM 01/01 Nov. 99.

5.1.2 Cut-off wave length : Cut off wavelength for 2 meter fibre section shall be 1320 nm max.

5.1.3 Attenuation :

- (a) Fibre Attenuation before cabling
- i) At 1310 nm :  $\leq 0.36$  dB/km
  - ii) Between 1285 to 1330 nm :  $\leq 0.36 + 0.02$  dB/km
  - iii) At 1550 nm :  $\leq 0.23$  dB/km
  - iv) At  $1383 \pm 3$ nm Hydrogen ageing attenuation :  $\leq$  attenuation at 1310 nm
- (b) Fibre Attenuation after cabling
- i) At 1310 nm :  $\leq 0.38$  dB/km
  - ii) Between 1285 to 1330 nm :  $\leq 0.38 + 0.02$  dB/km
  - iii) At 1550 nm :  $\leq 0.25$  dB/km
  - iv) At  $1383 \pm 3$ nm Hydrogen ageing attenuation :  $\leq$  attenuation at 1310 nm

Note - Sudden irregularity in attenuation shall be less than 0.1 dB.

5.1.4 i) Nominal diameter :  $8.8 \mu\text{m} - 9.8 \mu\text{m}$  for matched clad fibre. (Pettermann method).



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ii) Nominal Cladding diameter :  $125 \mu\text{m} \pm 1.0 \mu\text{m}$

iii) Cladding Non-circularity :  $\leq 1\%$

iv) Mode field concentricity error :  $\leq 0.8 \mu\text{m}$

5.1.5 Primary coating : Material UV curable acrylate, Diameter  $245 \pm 10 \mu\text{m}$ . It should not have any reaction with cladding or cable material. (This diameter is of natural coloured/ uncoloured fibre).

5.1.6 Chromatic dispersion : Max.  $5.3 \text{ ps/nm.km}$  from 1270 to 1340 nm with value not exceeding  $3.5 \text{ ps/nm.Km}$  in 1285 to 1330 nm. It shall be Max.  $18 \text{ ps/nm. km}$  at 1550 nm.  
The zero dispersion slope shall be  $\leq 0.092 \text{ ps/nm}^2 \cdot \text{Km}$ .  
Zero dispersion Wavelength range shall be 1300 - 1324 nm.

5.1.7 Proof test for Minimum strain level: 1%

Note : In case of non-availability of test facilities, fibre manufacturer's certificate shall be submitted for the particular lot/batch.

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

5.1.9 a) Polarisation Mode dispersion at 1310 & 1550 nm

i) Fibre :  $\leq 0.2 \text{ Ps}/\sqrt{\text{km}}$

Note : Fibre manufacturer's certificate shall be submitted for the particular lot/batch.

ii) Cabled Fibre :  $\leq 0.3 \text{ Ps}/\sqrt{\text{km}}$

b) Strippability force to remove primary coating of the fibre :  $1.3 \leq F \leq 8.9 \text{ N}$

Note : The force required to remove  $30 \text{ mm} \pm 3 \text{ mm}$  of fibre coating shall not exceed 8.9 N and shall not be less than 1.3 N. In case of non-availability of test facilities, fibre manufacturer's certificate shall be submitted for the particular lot/ batch.

c) Fibre curl :  $\geq 4 \text{ meter}$  radius of curvature

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Note : Fibre manufacturer's certificate shall be submitted for the particular lot/batch.

d) Fibre microbend at 1550 nm :  $\leq 0.5$  dB  
(1 turn around  $32 \pm 0.5$  mm diameter mandrel)

e) Fibre materials :

(i) The substance of which the fibres are made : To be indicated by the manufacturer

(ii) Protective material requirement

➤ 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.

➤ The best way of removing protective coating material : To be indicated by the manufacturer

(iii) Group Refractive index of fibre : --- do ---

Note : Documents/ certificates of fibre manufacturer are to be submitted by cable manufacturer of particular fibre used in the cable.

Cl. 5.1.10 Dynamic Tensile Strength of fibre  
a) Un-aged  $\geq 550$  KPSI (3.80 Gpa)  
b) Aged  $\geq 440$  KPSI (3.00 Gpa)

Note : In case of non availability of test facilities, fibre supplier's certificate shall be acceptable.

Cl. 5.1.11 Dynamic Fatigue of fibre :  $\geq 20$   
Test Method IEC 60793 –I- 33

Note : In case of non availability of test facilities, fibre supplier's certificate shall be acceptable.

Cl. 5.1.12 Static Fatigue of fibre :  $\geq 20$   
Test Method IEC 60793 –I- B7C

Note : In case of non availability of test facilities, fibre supplier's certificate shall be acceptable.

Cl. 5.1.13 The raw material used shall be approved by CACT as per TEC GR No. GR/ ORM 01/03. March 2004 or latest.

- Cl. 5.1.14 The HDPE black in colour used for sheath shall be UV stabilized.  
Note : A test certificate from raw material manufacturer or a recognized laboratory or institute may be submitted for the UV stability of the HDPE sheath material.
- Cl. 5.1.15 The material used in optical fibre cable must not evolve hydrogen that will effect the fibre glass.  
Note : A test certificate from raw material manufacturer or a recognized laboratory or institute may be submitted.
- Cl. 5.1.16 Safety : The material used in the manufacturing of the armoured optical fibre cables 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 the cable to substantiate the statement.

## 5.2 CABLE CONSTRUCTION:

### 5.2.1 GENERAL:

- (a) LOOSE TUBE CABLE : (Ref : Fig. 1 & 2) Primary coated fibres shall be covered by a secondary coating loose tube made of Polybutylene terephthalate or Polypropylene material of Outer diameter 2.4 mm  $\pm$  0.1 mm.  
Construction details of 24 fibre shall be as under:-

	No. of loose tubes	No of fibres in each tube	Total
24 Fibre	6	4	24

The space between the primary coated fibres and the secondary coating tube shall be filled with a suitable water blocking thixotropic jelly compound which shall be compatible with primary and secondary coating materials. The secondary coating loose tubes shall be stranded around strength member in an appropriate manner to form the cable core. A pictorial format depicting the design shall be specified.

- 5.2.2 The cable core shall be wrapped with suitable material which does not adhere to secondary fibre coating. The cable core shall not have any metallic component and shall have splice free optical fibre.
- 5.2.3 (i) The strength members in the cable shall be for strength and flexibility of the cable. These shall also keep the fibres strain within permissible values.
- (ii) The construction of the strength member shall be such as to meet mechanical strength criteria given in para 5.3.1 of this specification.
- (iii) Manufacturer shall submit the design calculation of FRP young modulus, excess

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fibre, cable factor, ratio of fibre length to cable length etc to achieve the above values.

- (iv) The armoured optic fibre cable shall have solid non- metallic FRP central strength member.
- (v) To provide additional strength aramid/ glass yarn can be used in addition to central member in the periphery if required.

5.2.4 CABLE CORE COVERING – MOISTURE BARRIER: The cable core shall be covered with a continuous layer of a non-hygroscopic dielectric material applied longitudinally or helically with an overlap. The cable core shall be filled with suitable water blocking jelly compound compatible to fibre. Further, to achieve additional tensile strength aramid yarn can be provided between the core covering and inner PE sheath.

5.2.5 INNER PE SHEATH: Over the core covering a PE sheath of HDPE, free from pinholes, joints, mended places or other defects, and which is made of sheath of a tough, weather resistant and high molecular weight polyethylene compound shall be provided. The thickness of the sheath shall be 1.5 mm (minimum) through out from top end to bottom end.

5.2.6 ARMOURING OF CABLE: Over the inner PE sheath and below outer sheath, armouring to the following construction shall be provided to make the cable rodent and termite proof.

5.2.6.1 The thickness of stainless steel Alloy shall not be less than 0.125mm. The steel tape shall be both sides coated with a transparent copolymer of thickness 0.05 mm(min.) so as to bond the armouring to the outer jacket and make a unitary construction.

5.2.6.2 Stainless steel armouring corrugated transversely for lateral strength and bending flexibility to be applied longitudinally with an overlap of 10% (minimum) over the inner PE sheath. The corrugation over the entire length of the tape used in the cable shall be uniform. Polyamide based hot melt adhesive should be provided in between overlap portion of cable armouring for bonding to avoid ingressing of moisture. The detail of specification of compound used should be submitted by the manufacturer.

The height of corrugation shall be 0.6mm (min.) & the pitch of corrugated tape shall be 2.5 mm (max.). Height and pitch of corrugation shall be measured between crest and trough base line.

5.2.6.3 (a) The corrugated armouring of stainless steel shall offer excellent corrosive resistance and shall be of AISI Alloy 304 or 305.

(b) The chemical composition and mechanical properties of steel shall be as specified

in table 1 and table 2 of ASTM:A 240/ A240 M-99 for AISI 304 or 305 respectively.

5.2.6.4 (i) OUTER SHEATH : Over corrugated steel armouring outer jacket of HDPE of thickness 2.0 mm (minimum), shall be provided through out the length from top end to bottom end.

(ii) RIP CORD : Three suitable rip cord(s) shall be provided which shall be used to open the sheath(s) and the armour of the cable.

a. One suitable ripcord below the inner sheath.

b. Two suitable ripcords below the armour.

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

5.2.6.5 The outer jacket of HDPE shall be such as to preserve the sheath from attack by termites. Manufacturer will submit the details of doping material used.

5.2.6.6 SPARK TEST (IEC 794-1-F3): The over all outer jacket shall withstand spark test voltage of 10 KV AC rms or 12 KV DC at the time of extrusion. There shall be no spark over.

5.2.7 MARKING ON CABLE: On the outer jacket there shall be indelible length marking at an interval not exceeding 1 meter. The outer jacket shall be in black colour and marking shall be in white colour. Sequential length and identification marking will be one by hot melt printing process by pressing white tape causing indentation on the outer jacket. The accuracy of the sequential markings shall be within  $\pm 0.5\%$  of the actual measured length.

The sequential length markings shall not rub off during normal installation. The marking on the cable shall be as given below. "Manufacturer/ Company's trade mark, I.R.marking, telephone mark, laser symbol, type of cable, no. of fibres, type of fibres, month, year of manufacture and drum no."

5.2.8 OVERALL DIAMETER: The overall diameter of the cable shall be  $16\text{mm} \pm 1 \text{ mm}$  and uniform through out the length from top end to bottom end.

5.2.9 THE FIBRE & UNIT IDENTIFICATION:

5.2.9.1 Fibres shall be coloured with readily distinguishable durable colours. The colour of four fibres in a tube shall be Blue, Orange, Green and Natural.

5.2.9.2 Loose tubes shall be placed in circular format as given below.

<u>Loose Tube No.</u>	<u>Loose Tube colour</u>
1.	Blue
2.	Orange
3.	Green

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- |    |       |
|----|-------|
| 4. | Brown |
| 5. | Slate |
| 6. | white |

### 5.3 MECHANICAL PERFORMANCE OF CABLE:

The following requirement shall be met.

- 5.3.1 TENSILE STRENGTH TEST (IEC 794-1-E1): The cable shall have sufficient strength to withstand a load of  $9.8 * W * 2.5$  Newtons or 2670 N, whichever is higher. (where W is the weight of 1 KM of cable in Kg). The distance between pulleys shall be minimum 15 meter , minimum number of pulleys shall be 5 and sample of cable under test shall be minimum 150 meter. This load shall be sustained for 10 minutes. It shall not produce elongation of cable fibre exceeding 0.25% and shall not cause permanent damage to constituent parts of the cable.
- 5.3.2 COMPRESSIVE STRESS TEST (IEC 794-1-E3) : The fibre and component parts of cable shall not suffer permanent damage when subjected to a compressive load of 4000 Newton applied between two plates of dimensions 100mm \* 100mm. The load shall be applied for 600 seconds.
- 5.3.3 CABLE BEND TEST (IEC 794-1-E11) : The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped four complete turns of ten complete cycle, around a mandrel of 20 D in diameter, where D is the overall diameter of cable .
- 5.3.4 IMPACT TEST (IEC 794-1-E4):The fibre and the component parts of the cable shall not show any cracks or break when the cable is exposed to 10 impacts each of 50 Newton from a height of 0.5 meter with impacting surface radius of 300 mm.
- 5.3.5 TORSION TEST (IEC 794-1-E7): The fibre and the component parts of the cable shall not suffer any damage when a 2 meter length of cable is subjected to torsion of  $\pm 180^{\circ}$  with 400 Newtons load for 10 times. The twist mark shall not be taken as damage.
- 5.3.6 KINK TEST (IEC 794-1-E10) :The bending radius shall be 20 D where D is the overall diameter of the cable. When a sample length of ten times the minimum bending radius of the cable is subjected to kinking, it shall not result in breakage of any fibre and kink should disappear after normalising the cable.
- 5.3.7 REPEATED BENDING TEST (IEC 794-1-E6) : When a sample length of minimum 5 meter is subjected to repeated bending test under load of 5kg for 50 cycles. It shall not result in breakage of any fibre.
- 5.3.8 CHANGE IN ATTENUATION AFTER MECHANICAL TESTS : Initial reading of fibre attenuation shall be measured at 1310 and 1550 nm and after conducting mechanical tests (cl. 5.3.1 to 5.3.7) final reading of fibre attenuation shall be measured. Change in attenuation shall not be more than 0.05 dB/Km

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- 5.4 TEMPERATURE CYCLING TEST (IEC 794-1-F1): (Ref: Fig 3) Temperature cycling test shall be carried out on one drum length of the cable to ensure stability of attenuation parameter of the cable when subjected to temperature changes which may occur during storage, transportation and usage. The permissible temperature change for storage and operation shall be from  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

The rate of change of temperature during the test shall be  $1^{\circ}\text{C}$  per minute (approx). After attaining temperature stability in the chamber the cable shall be subjected to temperature cycling for 12 hours at each temperature as indicated below.

TA2 temp :  $-20^{\circ}\text{C}$   
TA1 temp :  $-10^{\circ}\text{C}$   
TB1 temp :  $+60^{\circ}\text{C}$   
TB2 temp :  $+70^{\circ}\text{C}$

The attenuation shall be measured at the end of each temp. range both at 1310 nm & 1550 nm. The change in attenuation for entire range of temperature shall not be more than 0.05 dB/Km. Two such cycles tests shall be performed. Time/temperature print out shall be maintained.

- 5.5 WATER PENETRATION TEST : (IEC 794-1-F5) A circumferential portion of the sheath and wrapping 25mm wide shall be removed from one end of a sample length of 3 meter of the cable and a watertight sleeve shall be applied over the exposed core so as to bridge the gap in the sheath. The cable shall be supported horizontally and a 2 meter head of water, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied to the core at ambient temperature for a period of 24 hours for Acceptance Test and 7 days for Type Test. No dye shall be detected when the end of the 3 M cable is examined after removing it from water column with ultra violet light. It should be conducted on top and bottom end.
- 5.6 DRIP TEST : The test specimen of 30 cm length shall be cut from a completed cable. One end of the cable shall be stripped of 5 cm approx. and the fibre with jelly shall be flared out at 45 degree angle. The other end shall be sealed by the end cap. The sample shall then be suspended in an air oven with a glass disc placed directly below the flared end of the cable. The oven temperature shall be set at  $70^{\circ}\text{C} \pm 1^{\circ}\text{C}$  for a period of 24 hours. At the end of the test the glass disc shall be examined for the presence of filling compound which might have dripped. There shall be no dripping of jelly compound or oil impression on the glass disc.
- 5.7 LIFE OF CABLE: The minimum expected life of the cable shall not be less than 25 years, supportive documents should be submitted by the manufacturer.
- 5.8 CABLE ENDS: Both ends of the cable shall be provided with a thermo shrink cap and pulling eye/ pulling grip with anti twist device.
- 5.9 LENGTH OF CABLE DRUM: The standard factory length of optical fibre cable

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shall be 3.0 Km  $\pm$  10% However the purchaser may specify special lengths as per requirement. The fibre in cable lengths on a reel shall not have any joints.

5.10 **SHORT LENGTH:** Short lengths, single length not less than 1.5 Km, will not exceed 5% of the total ordered quantity.

5.11 Tolerance on ordered quantity -  $\pm$  1.5 %

5.12 **CABLE ABRASION TEST :**

Objective : To test the abrasion resistance of the sheath and the marking printed on the surface of the cable

Method : IEC-794-1-E2 or any other international test method

Test Specs.: The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1 mm with 500 grams weight (Total weight more than or equal to 650 gms.)

No. of cycles : 50

Duration : One minute (Nominal)

Requirement : There shall be no perforation & loss of legibility of the marking on the sheath.

5.13 **CHECK OF EASY REMOVAL OF SHEATH :**

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

Procedure : To check easy removal, the sheath shall be cut in circular way and 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 and no component part of the cable is damaged. One should be able to remove the inner sheath easily.

**Note :** Easy removal of both the outer jacket and the inner sheath shall be checked separately.

5.14 **CHECK OF EFFECT OF AGGRESSIVE MEDIA ON THE CABLE SURFACE (ACIDIC AND ALKALINE BEHAVIOUR)**

Procedure : To check the effect of aggressive media, solution of PH4 and PH10 are 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 sheath and other markings of the cables. (Test method no. ISO 175).

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



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## 5.15 TO CHECK THE QUALITY OF THE LOOSE TUBE :

### (a) EMBRITTLE TEST OF LOOSE TUBE :

This test method is based on bending by compression.

**Sample :** The minimum length of the test sample depend 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 :

$$L_o > 100 * \sqrt{(D^2 + d^2)}/4$$

$L_o$  = Length of tube under test

$D$  = Outer dia. of loose tube

$d$  = Inner 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 exert 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 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 upto the safe bend dia. of the 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 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 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 minimum bend radius of loose tube i.e. 20 D (where D is the outside 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 tube

## 5.16 DRAINAGE TEST FOR LOOSE TUBE :

Sample Size : 30 cm tube length.

Test procedure :

1. Cut the tube length to 40 cm.
2. Fill the tube with the tube filling gel ensuring there are no air bubbles and the tube is completely full.

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3. 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.
4. Leave the filled tube in a horizontal position at an ambient temperature for 24 hours.
5. 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<sup>0</sup>C for a period of 24 hours.
6. 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 : There shall be no gel or oil in the beaker.

## 6. PACKING:

- 6.1 The cable shall be wound on strong wooden drums of suitable size conforming to DOT/TEC,s Generic Requirements No. G/CBD-01/02.Nov 94.
- 6.2 Before dispatch, drums shall be effectively lagged with suitable closely fitting battons and every batton shall be secured so as to prevent the batton from getting displaced or damaged during transit and storage. The lagging shall further be strengthened by steel straps bound circumferentially over the drum.
- 6.3 Nails used in the drums shall be properly clinched. Both ends of the cable shall be kept inside the drums & shall be located so as to be easily accessible for the test. The battons on the drum to gain access to the cable end shall be painted red.
- 6.4 The cable ends shall be sealed immediately after the tests to prevent entry of moisture and shall be so fastened and secured to the drum that during transit, transhipment and rolling, neither the cable end sealing gets damaged nor does the cable get loosened or displaced.
- 6.5 Each drum shall be stenciled in good oil paint giving the following particulars:
  - a) Drum number;
  - b) Name of the manufacturer; Month, Year;
  - c) Address of the consignee;
  - d) Description of contents including size, and type of fibre in cable;
  - e) Cable length;
  - f) Gross weight and Batch number;
  - g) Arrow to indicate the direction in which the drum can be safely rolled;
- 6.6 Packing list supplied with each drum shall have the following information:
  - 1) Drum Number
  - 2) Cable length
  - 3) Number of fibres
  - 4) Type of cable
  - 5) Attenuation/Km. of each fibre
  - 6) USER'S/consignee name
  - 7) Manufacture's Name, Month, Year & Batch No.
  - 8) Group refractive index.
  - 9) Cable factor i.e ratio of fibre length to cable length.
  - 10) Precautions for handling OFC during transportation and laying sheet to be provided

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one copy in each lot during dispatch.

## 7. TEST PARAMETERS AND TEST ON RAW MATERIALS & FINISHED CABLE:-

### 7.1 Test on Stainless steel tape:

- a) Thickness (Cl.5.2.6.1)
- b) Chemical composition of the stainless steel alloy (values as given Table 1 of ASTM A 240/ A 240 M-99)
- c) Tensile strength & Elongation at break (values as given in Table 2 of ASTM A 240/ A 240 M-99)
- d) Thickness of copolymer on either side of steel tape (Cl.5.2.6.1)
- e) Resistivity of SS tape at 20°C :  $72 \pm 8 \times 10^{-6}$  ohm.cm  
should be given by manufacturer
- f) Force of adhesion of SS tape to HDPE as per ASTM 4565 :  $\geq 14$  Newton

### 7.2 Test for PE granules (to be used for inner sheath & outer jacket):

- a) Density (0.94 to 0.958 gm/cc), Test method BS 2782 part 6 (method 620 620 D)
- b) Melt flow index ( $\leq 0.8$  gm/10 minutes at 190<sup>0</sup> C, load 2.16 Kg. Test Method BS 2782. (Method 720A)
- c) Oxidation Induction Time ( $\geq 20$  minutes), Test Method ASTM D 3895
- d) Carbon black content ( $2.5 \pm 0.5$  %), Test Method ASTM D 1603, IS 2530 (P:10)
- e) Carbon black dispersion (uniform dispersion), Test Method IS 7328-1992 (Annx.B)
- f) Environmental stress cracking Resistance (ESCR), (10% igepal solution, 50<sup>0</sup> C for 48 hours) No crack shall be observed. Test Method ASTM D 1693
- g) Tensile strength ( $\geq 2$  Kg/mm<sup>2</sup>), Test Method ASTM D 638
- h) Elongation at break ( $\geq 600$  %), Test Method ASTM D 638
- i) Dissipation factor(tand), (0.007 max.)
- j) Volume resistivity ( $\geq 10E+10$  Ohm-Cm.), Test Method ASTM D 257
- k) Dielectric constant. 2.75 Max. Test Method ASTM D150
- l) Brittle Temperature (-55<sup>0</sup>C Max.), Test Method ASTM D746
- m) Moisture control (to be tested on granule)  $\leq 0.022\%$  ASTM – D 817

### 7.3 Test for secondary coating material (for loose tube construction only)

#### 7.3.1 Test for Polypropylene :

- a) Density 0.9-0.906 gm/cc, Test method ASTM D 1505
- b) Melt flow Index (MFI) at 190<sup>0</sup>C with load of 2.16 Kg- ( $\leq 5$  gm/10 minutes.), test method ASTM D 1238
- c) Tensile strength at break, ( $\geq 2.5$  kg./Sq.mm), Test method ASTM D 638
- d) Elongation at break, ( $\geq 500\%$ ), test method ASTM D 638
- e) Oxidation Induction time, ( $> 30$  minutes), Test Method IEC 538
- f) ESCR(10% Igepal Solution) At 50<sup>0</sup>C for 48 hours, No cracks shall be noticed.

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- 7.3.2 Test for Polybutylene Tetraphthalate (PBTP) :
- Density (1.30-1.33 gm/cc) ASTM-A-1505
  - Melt flow Index (MFI) at 250<sup>0</sup>C with load of 2.16 Kg- ( $\geq 9$  gm/10 minutes) ASTM-1238
  - Tensile strength at Yield, ( $\geq 5.0$  kg./Sq.mm) ASTM-D-638
  - Elongation at break, ( $\geq 50\%$ ) ASTM-D-638
  - Melting point,(220-227<sup>0</sup>C), Test method ASTM D 2117
  - Water absorption for 24 Hrs.( $\leq 0.5\%$ ), Test method ASTM D-1238 or ASTM D-570.
  - Hardness ( $\geq 70$  shore D ) as per ISO 868 (amend. 3)
  - Tensile modulus (2000 – 3000 Mpa ) as per ISO 527 /ASTM D 638
  - Flexural modulus (1900 – 2800 Mpa) as per ISO178/ASTM D 790

- 7.4 Test on Central Strength Member (FRP) :
- Tensile strength at break,( $\geq 140$  kg./Sq.mm),  
Test Method ASTM D 3916 / D 638
  - Elongation at break,( $\leq 4\%$ ) Test Method ASTM D 638
  - Water absorption for 24 Hrs.  $\leq 0.1\%$  Test method ASTM D 570.
  - Young Modulus  $\geq 5000$  Kg/sq.mm Test method ASTM D 638
  - FRP diameter : 2.5 mm  $\pm$  0.05 mm.
  - Min. Bend Radius at 25<sup>0</sup> C ( $\leq 25D$ ) : No decomposition or delamination

Note : A 300 mm long rod sample is bent towards making a half circle (hold the rod at two ends with hand and bend it). The radius at which the loose glass fibre becomes visible , is the mini. bent radius of the rod. It is calculated by dividing the distance between the two bent ends by the diameter of the rod.

- Flexural strength ( $\geq 70$  kg/mm<sup>2</sup> ) as per ASTM D 790
  - Flexural modulus ( $\geq 5000$  kg/mm<sup>2</sup> ) as per ASTM D 790 (amend. 3)
  - Coefficient of thermal expansion  $\leq (6.6 \text{ E}-06)\text{cm}^0\text{c}$  As per ASTM D 696 (amen.1)
- 7.5 Test on filling/compound (Secondary filling): The jelly shall be highly purified, thixotropic, air bubble free, anti-toxic & odourless).
- i) Cone penetration at +25<sup>0</sup>C ,  $\geq 350$ , 1/10 mm  
as per ASTM 217/ASTM D-937
  - ii) Cone penetration at -30<sup>0</sup>C ,  $\geq 230$ , 1/10 mm
  - Oil separation  $\leq 0.8\%$  (24 hrs,150<sup>0</sup>C)FTM (321)
  - Flash point  $\geq 200^0\text{C}$  ASTM-D- 92 (DIN ISO 2592)
  - Drop point  $\geq 150^0\text{C}$  ASTM-D 566
  - O.I.T. at 190<sup>0</sup> C  $\geq 30$  minute as per ASTM D 3895/ D 4765
  - Density : 0.8 - 0.9 g/cm<sup>3</sup> DIN 51757/ ASTM D 1217/ ASTM D 1475

- 7.6 Test on flooding compound (Core filling): The Jelly shall be highly purified, soft, hydrophobic gel, non-toxic, odourless, thixotropic and fibre compatible.
- i) Cone penetration at +25<sup>0</sup>C :  $\geq 280$  1/10 mm  
ASTM-D-217/ ASTM-D-937
  - ii) Cone penetration at -30<sup>0</sup>C :  $\geq 180$ , 1/10 mm

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- b) Oil separation  $\leq 0.8\%$  (24 hrs, 150°C) FTM 791 C
- c) Flash point  $\geq 200^{\circ}\text{C}$  ASTM-D- 92 (DIN ISO 2592).
- d) Drop point  $\geq 170^{\circ}\text{C}$  ASTM D 566
- e) Density : 0.8 - 0.9 g/cm<sup>3</sup> DIN 51757/ ASTM D 217/ ASTM D 1475

7.7 Lightning test (Fibre damage test) as per EIA/TIA – 455 – 181  
 To determine the lightening damage susceptibility of armoured optical fibre cable to direct arc and to magnetic field. The cable shall pass the current level  $\geq 105$  K Amp.  
 No Damage to optical fibre in the cable and optical continuity should be present after the test in 2 meter sample.

7.8 Termite test for the cable : 30 days termite resistance test shall be carried out.

7.9 Testing of aramid/ glass yarn : (if used)

7.9.1 Testing of Aramid Yarn

- (a) Total no. of yarns in dTex unit on tensile test (dTex = weight in grams per 10 Kms)
- (b) Tensile modulus (5160 to 9970)N/tex as per ASTM 885-98

7.9.2 Testing of Glass Yarn

- (a) Total no. of yarns in dtex :  $1700 \pm 10\%$  for type 'A' &  $800 \pm 10\%$  for type 'B', ASTM D 578
- (b) Tensile Strength in Newton :  $\geq 1100$  for type 'A' &  $\geq 440$  for type 'B', ASTM D 885
- (c) Thickness in mm :  $0.45 \pm 0.25$  for type 'A' &  $0.20 \pm 0.10$  for type 'B', ASTM D 885
- (d) Elongation at break :  $\leq 5$  for both type A & B, ASTM D 885

## 8.0 TESTS:

8.1 Manufacturer will submit the following documents during type test & acceptance test to inspecting authority

8.1.1 Statement of deviation, obtained from the specification at the time of type testing if any.

8.1.2 Statement of raw material used in offered lot and at the time of type testing.

8.1.3 Routine test results as per Cl. 8.4 on all the offered drums should be submitted during type & acceptance tests.

8.1.4 During acceptance test, sampling percentage figure shall be rounded off to the next higher integer.

8.1.5 New firms shall have

- a. Current DOT type approval for manufacturing of Optical Fibre Cable.
- b. DOT/ CACT valid approval of all raw material used wherever applicable

## 8.2 TYPE TESTS :

### SAMPLING PLAN FOR TYPE TEST

S.No.	Type of Test	Clause numbers	Sampling
<b>I.</b>	<b>Test on fibre &amp; finished cable</b>		
1.	Optical characteristic of fibre		
a)	Cut off wave length on 2 M fibre section	Cl. 5.1.2	Test should be conducted on all fibres of both drums.
b)	i) Fibre attenuation before cabling	Cl 5.1.3 (a)	Test should be conducted on all fibres of left over spool from same fibre ID.
	ii) Fibre attenuation after cabling	Cl 5.1.3 (b)	Test should be conducted on all fibres of both drums.
c)	Nominal dia., nominal cladding dia., cladding non-circularity, mode field concentricity error	Cl 5.1.4	-- do--
d)	Primary coating (for natural coloured/ un coloured fibre)	Cl. 5.1.5	-- do--
e)	Chromatic dispersion	Cl. 5.1.6	-- do--
f)	Proof test	Cl 5.1.7	Test should be conducted on all fibres of leftover spool from same fibre ID. Note : In case of non availability of test facilities, fibre manufacturer's certificate shall be submitted for particular lot/ batch.
g)	Change in attenuation	Cl 5.1.8	Test should be conducted on all fibres of both drums.
h)	Polarisation Mode dispersion	Cl. 5.1.9 (a)(i)	Fibre manufacturer's certificate shall be submitted for the particular lot/ batch.
		Cl. 5.1.9 (a)(ii)	Test should be conducted on all fibres of both drums.

S.No.	Type of Test	Clause numbers	Sampling
i)	Strippability force	Cl. 5.1.9 (b)	Test should be conducted on all fibres of leftover spool from same fibre ID. Note : In case of non availability of test facilities, fibre manufacturer's certificate shall be submitted for particular lot/ batch.
j)	Fibre curl	Cl. 5.1.9 (c)	Fibre manufacturer's certificate shall be submitted for the particular lot/ batch.
k)	Fibre microbend	Cl. 5.1.9 d)	Test should be conducted on all fibres of both drums.
l)	Fibre materials	Cl. 5.1.9 e)	Documents/ certificates of fibre manufacturer are to be submitted by cable manufacturer of particular fibre used in the cable.
m)	Dynamic Tensile Strength of fibre	Cl. 5.1.10	Test should be conducted on all fibres of both drums. In case of non availability of test facilities, fibre manufacturer's certificate/ documents shall be submitted.
n)	Dynamic Fatigue of fibre	Cl. 5.1.11	
o)	Static Fatigue of fibre	Cl. 5.1.12	
p)	Tests/ Certificates	Cl. 5.1.13, 5.1.14, 5.1.15 & Cl. 5.1.16	Should be submitted
2.	Mechanical Test		
a)	Tensile Strength Test	Cl. 5.3.1	Test will be conducted on single loop after splicing of all fibres on both drums.
b)	Compressive stress, Cable bend, Impact, Torsion, Kink, Repeated bending test & Cable abrasion test	Cl. 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7, 5.12	On both drums.
c)	Change in attenuation after mechanical tests	Cl. 5.3.8	On both drums.
3.	Temperature Cycle test	Cl 5.4	Two cycle test will be done on one drum.
4.	Water Penetration Test	Cl. 5.5	On top end and bottom end of both the drum.
5.	Drip Test	Cl. 5.6	On both drums

S.No.	Type of Test	Clause numbers	Sampling
6.	Physical test	Cl. 5.2.1, Cl. 5.2.8, Cl. 5.2.6.2, Cl. 5.2.6.4, Cl. 5.2.5	To be done on both the ends of both the drums.
7.	Spark Test	Cl. 5.2.6.6	In process test result on both cable drums shall be submitted. Test on one drum will be conducted, and armoring of the cable will be earthed at the time of conduction of this test.
8.	Visual inspection Test	Cl. 5.2.7, 5.2.9, 5.8, 5.9 & 6.5	On both the drums.
9.	Check of easy removal of sheath	Cl. 5.13	On both the drums.
10.	Check of the effect of aggressive media on the cable surface	Cl. 5.14	On both the drums.
11.	To check the quality of the loose tube a) Embrittle test of loose tube	Cl. 5.15 (a)	On all loose tubes of both the drums.
	b) Kink resistance test on loose tube	Cl. 5.15 (b)	On all loose tubes of both the drums.
12.	Drainage test for loose tube	Cl. 5.16	On both the drums.
13.	Lightening Test	Cl. 7.7	On one drum.
14.	Termite test for the cable	Cl. 7.8	On one drum.
15.	Testing of aramid/ glass yarn	Cl. 7.9	On both drums (if used).
16.	Test on inner & outer HDPE sheath		
a.	OIT	Cl. 7.2 c)	1 sample each from both the drums.
b.	Carbon black content	Cl. 7.2 d)	-- do --
c.	Carbon black dispersion,	Cl. 7.2 e)	-- do --
d.	ESCR	Cl. 7.2 f)	-- do --
e.	TS & Elongation	Cl. 7.2 g) & h)	2 samples each from both the drums.
17.	Test on FRP		
a.	TS & Elongation	7.4 a), b)	2 samples each from both the drums.
b.	FRP dia.	7.4 e)	-- do --
c.	Min. Bend Radius	7.4 f)	-- do --



S.No.	Type of Test	Clause numbers	Sampling
18.	Test on loose tube made of Polypropylene or PBTP		
	TS & Elongation OR	7.3.1 c), d)	On all the six loose tubes from both the drums.
	TS & Elongation	7.3.2 c), d)	
<b>II.</b>	<b>Test on Raw Materials</b>		
19.	Test on stainless steel tape		
a.	Thickness,	Cl. 7.1 a)	5 samples from coil used for manufacturing cable for type test.
b.	T.S. & Elongation	Cl. 7.1 c)	
c.	Thickness of copolymer	Cl. 7.1 d)	
d.	Chemical composition	Cl. 7.1 b)	1 sample from coil used for manufacturing cable for type test
e.	Resistivity	Cl. 7.1 e)	
f.	Force of adhesion.	Cl. 7.1 f)	5 samples from coil used for manufacturing cable for type test.
20.	Test for PE granules		
a.	Density	Cl. 7.2 a)	1 sample from the same bag used for manufacturing cable for type test
b.	MFI	Cl. 7.2 b)	
c.	Dissipation factor	Cl. 7.2 i)	
d.	Volume resistivity	Cl. 7.2 j)	
e.	Dielectric constant	Cl. 7.2 k)	
f.	Brittle Temperature	Cl. 7.2 l)	
g.	Moisture content	Cl. 7.2 m)	
h.	Relative permittivity	Cl. 7.2 n)	
21.	Test for secondary coating material : Note : Tests as per S.No. 21.1 or 21.2 are to be conducted depending upon type of materials of loose tubes.		
21.1	Test for Polypropylene		
a.	Density	7.3.1 a)	1 sample from the same batch used for manufacturing cable for type test
b.	MFI	7.3.1 b)	
c.	OIT	7.3.1 e)	
d.	ESCR	7.3.1 f)	
21.2	Test for PBTP		
a.	Density	7.3.2 a)	1 sample from the same batch used for manufacturing cable for type test
b.	MFI	7.3.2 b)	
c.	Melting point	7.3.2 e)	
d.	Water absorption	7.3.2 f)	1 sample to be prepared from the same bag used for manufacturing cable for type test
e.	Hardness	7.3.2 g)	
f.	Tensile Modulus	7.3.2 h)	
g.	Flexural Modulus	7.3.2 i)	

S.No.	Type of Test	Clause numbers	Sampling
22.	Test on FRP		
a.	Water absorption	7.4 c)	1 sample from the same coil of FRP used for manufacturing cable for type test
b.	Young modulus	7.4 d)	
c.	Flexural strength	7.4 g)	
d.	Flexural Modulus	7.4 h)	
e.	Coefficient of thermal expansion	7.4 i)	
23.	Test on filling compound		
a.	Cone penetration	7.5 a)	1 sample from the jelly barrel used for manufacturing cable for type test.
b.	Oil separation	7.5 b)	
c.	Flash Point	7.5 c)	
d.	Drop Point	7.5 d)	
e.	O.I.T	7.5 e)	
f.	Density	7.5 f)	
24.	Test on flooding compound		
a.	Cone penetration	7.6 a)	1 sample from the jelly barrel used for manufacturing cable for type test.
b.	Oil separation	7.6 b)	
c.	Flash Point	7.6 c)	
d.	Drop Point	7.6 d)	
e.	Density	7.6 e)	

### 8.3 ACCEPTANCE TESTS:

#### SAMPLING PLAN FOR ACCEPTANCE TEST

S. No.	Type of test	Clause No.	Sample size (Number of drums)
I.	Optical characteristics of fibre		
a)	Cut-off wavelength	5.1.2	To be done on 10% the number of offered drums subject to minimum of 1 drum.
b)	Fibre attenuation after cabling	Cl 5.1.3 (b) ii) & iv)	To be done on 10% the number of offered drums subject to minimum of 1 drum.
		Cl 5.1.3 (b) i) & iii)	On 20% of the offered drums on all the fibres with a check of optical continuity by the OTDR, subject to minimum of 1 drum.

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S. No.	Type of test	Clause No.	Sample size (Number of drums)
c)	Nominal dia., nominal cladding dia., cladding non- circularity, mode field concentricity error	Cl 5.1.4	To be done on 10% the number of offered drums subject to minimum of 1 drum.
d)	Primary coating (of natural coloured/ uncoloured fibre)	Cl. 5.1.5	To be done on 10% the number of offered drums subject to minimum of 1 drum.
e)	Chromatic dispersion	Cl. 5.1.6	-- do --
f)	Polarisation Mode dispersion	Cl. 5.1.9 (a) ii)	To be done on 10% the number of offered drums subject to minimum of 1 drum.
g)	Change in attenuation --- & Fibre Microbend	Cl. 5.1.8 & 5.1.9 d)	Test should be done on one drum per lot.
II.	Mechanical Tests		
a)	Tensile Strength Test	Cl. 5.3.1	To be done on 2.5% of the number of offered drums subject to minimum of 1 drum, by splicing all the fibre.
b)	Compressive stress, Cable bend, Impact, Torsion, Kink test, Repeated bending test	Cl. 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7,	To be done on 5% of the number of offered drums subject to minimum of 1 drum. Test should be done on all the fibres.
c)	Change in attenuation after mechanical tests	Cl. 5.3.8	-- do --
d)	Cable abrasion test	5.12	To be done on 5% of the number of offered drums subject to minimum of 1 drum.
III.	Water Penetration Test	Cl. 5.5	20% of the no. of offered drums, subject to minimum of 2 drums. Test to be conducted on both top and bottom end of the cable.
IV.	Drip Test	Cl 5.6	2.5% of the number of offered drums, subject to minimum of 1 drum.
V.	Physical Tests	Cl 5.2.1(a), 5.2.5, 5.2.6.2, 5.2.6.4, 5.2.8	10% of the no. of offered drums, subject to minimum of 2 drums. Tests are to be conducted on both ends of the drums)

S. No.	Type of test	Clause No.	Sample size (Number of drums)
VI.	Visual Inspection	Cl. 5.2.7, 5.2.9, 5.8, 6.5	5% of the no of offered drums, subject to minimum of 1 drum.
VII.	Spark test	Cl.5.2.6.6	Results for the entire lot offered for inspection shall be submitted. Inspecting authority shall conduct on one drum spark test randomly from the offered lot while rewinding the drum. Armouring should be earthed while conducting the spark test.
VIII.	Tests on finished Cable	Cl. 7.2 (a), (b), (d), (e), (f), (g) & (h)	One drum per lot of finished cable.
		7.4 a), b), c), e) Cl. 7.3.1(c), (d) OR Cl. 7.3.2 (c), (d)	One drum per lot of finished cable.
IX.	Test on Raw Materials	Cl. 7.5 (f), Cl. 7.6 (e)	To be done on one sample of jelly used for manufacturing the same lot of cable.
X.	Test on continuity of armouring		Check of electrical continuity of armouring of all the drum by Multimeter.
XI.	Test certificate on raw materials	Cl. 5.2.6.1, Cl. 7.1, Cl. 7.2, Cl 7.3.1 or 7.3.2, Cl. 7.4, Cl.7.5 & Cl. 7.6	Test certificate of raw material manufacturers should be submitted of particular lot/ batch used for manufacturing the cable by cable manufacturer.

#### 8.4 ROUTINE TESTS :

Routine test result for Cl. 5.2.1(a), 5.1.3(a), 5.1.3 (b), 5.2.6.2, 5.2.6.4, 5.2.6.6, 5.5 & 5.6 on all the offered drums.

#### 9. INSPECTION:-

##### 9.1 GENERAL:

9.1.1 Inspection and testing shall be carried out by the inspecting authority nominated by the purchaser to ensure that all the requirements of this specification are complied with for the acceptance of the materials offered by the supplier for inspection.

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9.1.2 The purchaser or his nominee shall have free access to the works of the manufacturer and to be present at all reasonable times and shall be given facilities by the manufacturer to inspect the manufacturing of the cables at any stage of manufacture. He shall have the right to rejection whole or part of any work or material that does not conform to the terms of this specification or any other specification or requirement applicable and may order the same to be removed/replaced or altered at the expense of the manufacturer. All reasonable/complete facilities considered necessary by the inspecting authorities for the inspection of the cables shall be supplied by the manufacturer free of cost.

9.1.3 The manufacturer shall supply the cable samples and samples of the raw materials free of charge as required by the inspecting authority and shall at his own cost prepare and furnish the necessary test pieces and appliances for such testing as may be carried out at his own premises in accordance with this specification. Failing the existence of facilities at his own premises for the prescribed tests, the manufacturer shall bear the cost of carrying out the tests in an approved laboratory, workshop or test house.

## 9.2 TESTS BY THE MANUFACTURER AND TEST CERTIFICATE:

9.2.1 Before any supply of the cables covered by this specification are offered for inspection, the manufacturer shall carry out the routine tests on each individual cable drum as specified in Cl.8.4 in addition to any other manufacturing tests which have to be carried out by him.

9.2.1 The test certificate incorporating the results of the routine tests shall be produced and supplied prior to each lot offered for inspection. In case the inspecting authority observes as a result of the tests carried out by him that the recorded test results supplied to him are not reasonably accurate for the lot offered for inspection, he may reject the complete lot at his discretion and call upon the manufacturer to have the cables type tested before any further supplies are inspected or accepted.

## 9.3 SAMPLING:

9.3.1 For the type tests, the manufacturer or the supplier shall submit to the Inspecting authority at least two complete cable drums of standard lengths to carry out the tests as detailed in the specification. Other necessary tests pieces of the cable or its constituent material shall also be drawn as samples out of these selected samples.

9.3.2 For acceptance tests, the sampling plan shall be as indicated in Cl. 8.3 unless otherwise specified by the purchaser. The drum of the sample sizes shall be selected at random from the total number of drums offered for inspection. The percentage figure shall be rounded off to the next higher integer.

## 10. WARRANTY:

The manufacturer shall warrant the material supplied by this specification to be free from defects in design, material & workmanship under ordinary use & service, his obligation under this warranty being to replace free of cost of the defective material

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within one year after delivery to the purchaser.

**11. REJECTION:**

In case, the cables tested and inspected in accordance with this specification fail to pass the test or comply with the requirements of this specification, , the whole consignment shall be rejected.

**12. INFORMATION TO BE FURNISHED BY SUPPLIER WITH THE OFFER:-**

The supplier shall supply the following information along with his offer:-

12.1 Complete test results.

12.2 Copies of "Manufacturers specification" for raw materials used in the cable construction which are not specifically covered by the specifications.

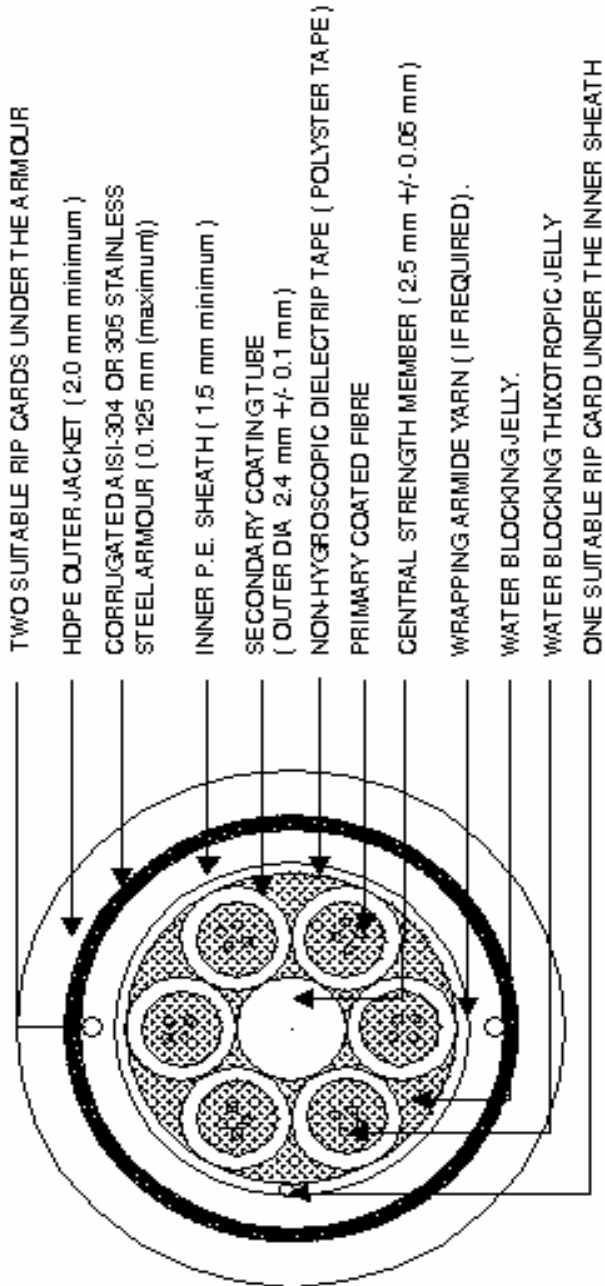


FIG -1

<b>F . D . S . O</b>
CONSTRUCTIONAL DIAGRAM OF 24 FIBRE ARMoured OPTIC FIBRE CABLE

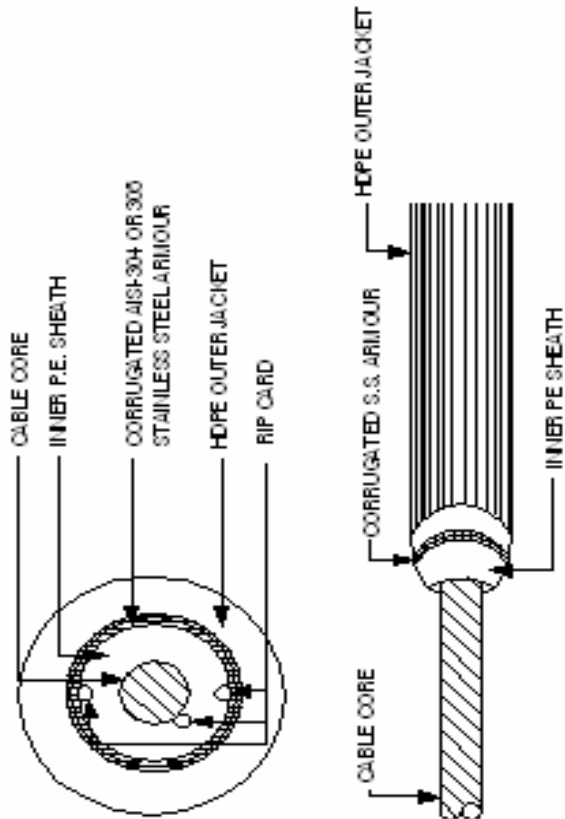


FIG -2

**P. D. S. O**

CROSS SECTIONAL  
VIEW OF ARMoured  
OPTIC FIBRE CABLE



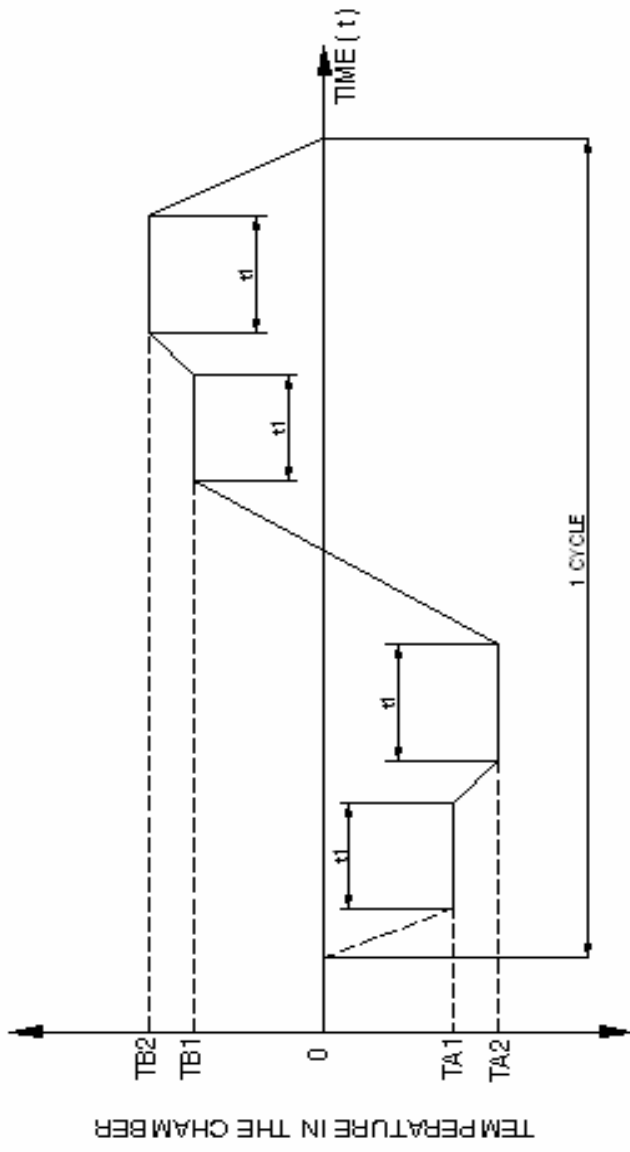


FIG -3

**R . D . S . O**  
 TEMPERATURE CYCLING  
 TEST

A = START OF FIRST CYCLE

NOTES