Template for submitting comments/inputs on draft Standard of GR on "Solid Polythene Insulated Fully Filled, Polythene Sheathed Underground Telecom Cables (TEC 68090:2026).

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

Clause No.	Clause Description	Comments, if any	Remarks, if any

Note: The comments/inputs on the draft GR (Standard No. TEC 68090:2026) may furnished in the above format through email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in and ddgfla.tec@gov.in at the earliest and within prescribed time period.

वर्गीय आवश्यकताओं के लए मानक

सं. टीईसी 68090:2026

STANDARD FOR GENERIC REQUIREMENTS

TEC 68090:2026

सॉलड पॉलथीन इंसुलेटेड फुल्ली फल्ड, पॉलथीन शीथेड अंडरग्राउंड टेलीकॉम केबल्स

Solid Polythene Insulated Fully Filled, Polythene Sheathed Underground Telecom Cables

ISO 9001:2015

दूरसंचार अ भयांत्रिकी केंद्र
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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

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HISTORY SHEET

Sr. No.	Standard / document No.	Title	Remarks
1	(Old No. GR/CUG-01/03AUG 2003)	Solid Polythene Insulated Fully Filled, Polythene Sheathed Underground Telecom Cables	TEC 68090:2003(Old No. GR/CUG-01/03AUG 2003) was withdrawn on 22.12.2025
2	TEC 68090:2026	Solid Polythene Insulated Fully Filled, Polythene Sheathed Underground Telecom Cables	First issue

REFERENCES

S. NO.	Document No.	Title/Document Name
1)	ASTM D 92	Flash and fire points by Cleveland open cup
2)	ASTM D 883	Definition of terms relating to plastics.
3)	ASTM D 924	Test method for power factor and dielectric constant of electrical insulating liquids.
4)	ASTM D 1169	Test method for specific resistance (resistivity) of electrical insulating liquids.
5)	ASTM D 1248	Polyethylene plastics, molding and extrusion materials.
6)	ASTM D 1693	Test method for environmental stress cracking of ethylene plastics.
7)	ASTM D 2633	Methods of testing thermo plastic insulations and jackets for wire and cable.

8)	ASTM D 4565	Standard Methods of Testing Physical and Environmental performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.
9)	BS: 6234	Polythene insulation and sheath of electric cables.
10)	IEC :28	International standard of resistance for copper.
11)	IS:2633	Method for testing uniformity of coating on zinc coated articles.
12)	IS:3975	Mild steel "Wires, formed wires and tapes for armouring of cables.
13)	IS:9938	Recommended colours for PVC insulation for LF wires and cables
14)	IS:12444	Continuously cast and rolled electrolytic copper wire rods for electrical conductors.

Note:

Unless otherwise explicitly stated, the latest approved issue of the standard/GR/IR, with all amendments in force, listed in references, on the issuance date of this GR/IR applicable.

CHAPTER 1

1.0 Scope:

1.1 This GR governs the constructional requirements and technical properties of twisted pair underground telecom cables with solid polythene insulated copper conductors, core fully filled with filling compound, and with poly-al laminate moisture barrier bonded to the polythene sheath. The cable will be either unamoured or armoured and jacketed as required.

1.2 Cables for use in ducts will omit the Clauses 11 and 12 on armouring and jacketing. The length of the duct cables will be indicated in the purchase order or by the actual user subsequent to the order. The tolerance on length (Clause 17.4) will not be applicable duct cables

2.0 GENERAL REQUIREMENTS:

2.1 This document deals with the technical requirements and does not include all the terms and provisions of a contract.

2.3 Number of Pair: The cable shall be in sizes from 5 pairs to 2400 pairs and the preferred Sizes are indicated in Table-I. The nominal conductor diameter shall be 0.40. 0.50, 0.63 and 0.90 mm.

3.0 CONDUCTOR:

3.1 Each conductor shall consist of a solid, round wire of annealed, high-conductivity Copper, smoothly drawn, nominally circular in section, uniform in quality and resistance, and free from defects. The quality of copper shall conform to IEC: 28 or: 12444.

3.2 The resistance of conductor, and the resistance unbalance of pairs shall meet the requirements in Clause 18.1

3.3 The joints in the conductor shall be kept to a minimum and shall fulfil the following conditions:-

3.3.1 The resistance of a 100 cm length of conductor containing a joint shall not be more than 101.25% of that of an adjacent shall be of conductor not containing a joint.

3.3.2 The tensile strength of a 25 cm length of conductor containing a joint shall not be less than 90% of that of an adjacent sample of conductor not containing a joint.

4.0 INSULATION:

4.1 Each conductor shall be insulated with solid polythene of type specified below:-

4.1.1 The conductor insulation shall be made of insulating-grade polyethylene, using 100% virgin material, in accordance with ASTM D883.

4.2 The insulation shall be of materials adequately stabilized with an antioxidant copper inhibitor system sufficient to puss the oxidation induction time and other relevant tests stipulated in this GR.

4.3 The polythene shall conform to ASTM D1248 Type II or Ill, Class A, Category 4 or 5 and shall meet the parameters detailed below:-

i) Density - Type II (0.926 to 0.940 gm/cc)
- Type III (0.941 to 0.959 gm/cc)

ii) Flow rate (melt Flow Index) - Maximum 1.0 gm/l0 minutes (190°C, 2160 gm load)

iii) Dissipation factor (power factor) - Maximum 0.0005

iv) Dielectric constant (Permittivity) - Maximum 2.35

v) Volume resistivity - Minimum 1 x 10^{15} Ohm-cm

vi) Oxidation Induction Time (0IT) - Minimum 60 minutes, when tested in an aluminium pan at 200°C as per the method in Annexure - IV

4.4 The insulation shall be uniform and smooth, and shall be coloured as in Table 2. The colour shall be identifiable under normal lighting conditions and shall generally conform to IS: 9938.

4.5 The grade of pigment used for colouring the polythene shall be such that the coloured insulation meets the specified requirements.

4.6 The thickness of insulation shall be adequate to meet the electrical and mechanical Requirements of this GR.

4.7 Joints, if any, in the insulated conductor shall be covered with non-hygroscopic dielectric material to leave no portion of the conductor exposed. Such joints shall be of a quality, adequate to meet all the specified electrical and mechanical requirements.

4.8 **Integrity of Insulation:** The insulated conductor shall be subjected to spark test at 4.5 kV DC or 3 kV AC RMS for all conductor sizes. There shall not be more than one spark over per 5 km of the insulated conductor, when assessed on bobbin basis on the insulating line. The test will be at the extrusion stage.

5.0 PAIRING:

5.1 Two insulated conductors shall be twisted together with uniform lay to form a pair. The length of the lay of any pair shall be different from that of adjacent pairs. The lay of various pairs shall be so chosen as to satisfy the capacitance unbalance requirements as per Clause 18.4 and cross-talk requirements as per Clause 18.5 of this GR. To the exten1 possible, the lay of any pair may be limited to 150 mm. The manufacturer may use at his discretion a system of non-uniform lay for pairs etc., if the requirements of the GR are guaranteed.

6.0 CABLE CORE:

6.1 **50 and 100 pairs Super Units:** 10 or 20 pairs shall be stranded to form a group called a Unit. This 83sembly shall be as per Table-2. Each unit shall have an open helical lapping of polyester/poly-propylene/polythene tape of thickness 0.02 mm minimum. The lay of

the tape shall not exceed 100 mm. The tape shall be coloured as in Table-3 for the identification of the units, the colour of the tape shall be distinguishable under normal lighting conditions.

6.1.1 5 Nos. of 10 pair units shall be assembled to form a 50 pair super unit.

6.1.2 A 100 pair super unit will comprise of 5 Nos. of 20 pair units and a spare pair. This spare pair shall he added in an interstice or in the center, but shall not be within any unit. The numbering of the units shall be clockwise from the running end. Each super unit shall have an open helical lapping of polyester/polypropylene/polythene tape of thickness 0.02 mm minimum and coloured as in Table-4 for identification the colour of the tape shall be distinguishable under normal lighting conditions.

6.2 Cables – Laying up:

6.2.1 5 pair cable: 5 pairs shall be stranded in accordance with Table-2 to form the cable core.

6.2.2 10, 20, 50 and 100 pair cables shall be laid up as for unit/super units described in clause 6.1 above. The 100 pair cable shall not have any spare pair.

6.2.3 For other sizes, the requisite number of super units shall be assembled as indicated Table-5 to form the core. The numbering of super units in a layer shall be as in Table-4.

6.3 Defective Pairs:

6.3.1 Cables not having any spare pair: Cable with any defective pair will not be acceptable.

6.3.2 Cable having any spare pair: Cables with defective pairs will be accepted subjected to the following conditions:-

i) The total number of defective pairs in a cable shall be equal to or less than 50% of the spare pairs in the cable.

ii) The number of defective pairs in any super unit shall not be more than one.

iii) The acceptance of such cable will be decided by the purchasing authority.

iv) The cables offered for prototype evaluation shall not contain any defective pair in any of the cables.

6.3.3 Any pair, if it does not conform to any of the specified requirements is considered as a defective pair; however, in the case of any pair showing earth fault by contact to the poly-al tape, the cable will be outright rejected.

7.0 FILLING COMPOUND:

7.1 The cable core shall be filled with tilling compound of type petroleum jelly or Absorbent Thyrotrophic Gel The compound shall be compatible with the insulation, binder sand tapes used in the cable. The compound shall be of homogeneous and uniformly mixed material containing an anti-oxidant. It shall not contain dirt, metallic particles or other foreign matter. It shall meet the requirements of Clause 20 of this GR.

7.2 The compatibility between the insulation and filling compound shall be as per Clause 22 of this GR.

8.0 CORE WRAPPING:

8.1 After application of the filling compound, at least one closed helical or longitudinal application of a non-hygroscopic and non-wicking polyester tape or tape of any other Suitable material shall be provided over the cable core. Application of a flooding compound below and above the core wrapping tape is recommended.

9.0 SCREEN:

9.1 An aluminium tape coated with polythene/copolymer on both sides shall be applied over the cable core with a minimum overlap of 3 mm for the cables whose specified maximum diameter over sheath is less than 30 mm, and a minimum overlap of 6 mm for the cables whose specified maximum diameter over sheath is equal to or above 30 mm. The thickness of the a1uminum tape shall be 0.2 mm ± 10% and that of polythene/copolymer coating on each side 0.05 mm nominal. The thickness of the composite tape shall be 0.3 mm ± 15%.

9.2 The aluminium tape shall he sealed at the overlap and bonded to the inner surface of the polythene sheath extruded over it. The tape shall be electrically continuous throughout the length of the cable. The screen may be corrugated, if desired by the manufacturer for better performance.

9.3 The peel strength of the polythene/copolymer coating from aluminium shall not be less than 25 gm/mm width when tested as per Annexure-I.

10.0 SHEATH:

10.1 The cable shall be sheathed with polythene conforming to type 03C or H03C of BS 6234, and shall contain a suitable antioxidant system. The

material shall be virgin, as per ASTM D-883 and shall meet the requirements specified below:-

i) Melt How Index - Shall not be more than 1.0 gm/10 minutes (190°C, 2160 gm load).

ii) Density - For 03C, shall be 0.910 to 0.940 gm/cc - For H03C, shall be greater than 0.940 gm/cc.

iii) Oxidation Induction Time (OIT) - Minimum 30 minutes, when tested in aluminium pan at 200°C as per the method in Annexure-IV.

Note:- The sheathing/jacketing compound is required to be source approved. The source approval certificate shall clearly indicate the density and the type of polyethylene approved. The density range for various types of raw material are given below:-

LDPE: 0.910 to 0.925 gms/cc;

MDPE: 0.926 to 0.940 gms/cc;

HDPE: above 0.940 gms/cc.

The above densities are after giving necessary correction for carbon black content.

10.2 The sheath shall be reasonably circular, and free from pin-holes and other detects The variation· between the maximum and the minimum diameter at any cross section conform to the following:-

Specified maximum diameter Over sheath (in mm)	Maximum variation(in mm)
Up to 40	3.0
Above 40 and up to 68	4.0

Above 68	5.0

10.3 The thickness of sheath shall conform to Table-6. The minimum thickness shall not be less than 75% of the specified nominal. The average of six measurements at each end, equally placed around the circumference, shall not be less than 85% of the specified nominal value.

10.4 **Integrity of Sheath:** The sheath shall be spark tested at the voltage given in Table-6. There shall be no spark-over. This is an on line test.

10.5 The maximum diameter of cable for different sizes/gauges over the sheath shall be as per Table- 7.

11.0 ARMOURING:

11.1 When armouring is required, bedding and armour shall be provided over the sheath to be followed by the jacket specified in Clause 12.0.

11.2 **Bedding:** Two close helical lappings of polythene or poly-propylene tape shall be applied over the sheath to provide sufficient mechanical protection during armouring. Each tape shall be applied with a minimum 5% overlap. The second tape shall cover the overlap of the first tape about evenly. The thickness of the tape shall be such that it shall meet the requirement of the Clause 23.5.1 of the GR. The width of the tape is left to the discretion of the manufacturer.

11.3 **Armour:**

11.3.1 This shall be of two applications of galvanized steel tape conforming to IS: 3975, both applied helically in the same direction with a gap in

the first tape of 15% to 35% of the nominal width of the tape, the second tape evenly covering the gap of the first tape. In any case, the overlap of the second over the first tape shall not be less than 15% of the nominal width of the tape on either side. The raw material GS tape when tested as per IS: 3975 shall meet the following requirements:-

i) Tensile strength -300 to 450 MPa
ii) Elongation - Min. 10%
iii) Dip Test - Shall withstand a minimum of 2, one minute dips when tested in a copper sulphate solution prepared as per IS: 2633.

11.3.2 The thickness of GS tape shall conform to Table 8. The width is left to the discretion of the manufacturer. However, the width of both the tapes in the cable shall be same.

11.3.3 The steel tape of the required width shall be galvanized; it should not be slit to a smaller width after galvanization, as in that case, there will not be zinc coating on the cut edge/edges.

11.3.4 The joints in the armouring tape shall be kept to the minimum. Wherever joints are made, adequate corrosion protection shall be provided on both the sides and edges.

12.0 JACKET:

12.1 The armoured cable shall be tightly jacketed with polythene conforming to the requirements as specified for sheath in Clause 10.1. The nominal thickness of the jacket shall be as per Table-9. The minimum and average thickness shall be regulated as in Clause 10.3.

12.2 The jacket shall be reasonably circular, and free from pin-holes and other defects.

12.3 The jacket shall be spark tested as per Table-9. There shall be no spark-over. This is an on line test.

12.4 The maximum diameter of cable for different sizes/gauges over jacket shall be as per Table-7.

13.0 IDENTIFICATION AND LENGTH MARKINGS:

13.1 To enable proper identification of the cable, the following markings shall be embossed or engraved on the polythene jacket in case of armoured cable, and on the sheath for un-armoured cables. All the markings shall be in white or yellow colour.

a) Telephone handset emblem
b) Name of manufacturer
c) Month and Year of manufacture in the form of MMYY, where MM is month and YY is year.
d) No. of pairs/conductor size (Ex: 100 pairs/0.63 mm)
e) Length marking
f) BSNL /MTNL/User Organization
g) Specific cable serial number uniquely to identify each cable length.

13.2 The markings shall be clear, distinct and visible to the naked eye from a distance of about 1 metre; the size of markings shall be minimum 3 mm.

13.3 The markings shall be at intervals of one metre and shall be throughout the length. The running length marking is critical.

13.4 The finished cables and components shall meet all the test requirements specified later in this GR.

14.0 PRE-CONNECTORISATION:

14.1 The cable shall be preconnectorised when so desired by the user. The materials and techniques used for preconnectorisation shall be got approved from the purchaser before supply.

15.0 SEALING OF ENDS:

15.1 Immediately after completion of the electrical tests, the ends of the cable shall be sealed by thermo shrinkable end caps of adequate wall thickness. Alternatively, ends may be sealed by enclosing them in rubber or PVC caps of wall thickness not less than 1.8 mm. The cap shall be of robust construction, and tight fit. The cap shall be coloured black and shall be secured to the sheath/jacket with appropriate hose clips or ties or black adhesive tape or heat shrinkable sleeves.

15.2 After the cable is approved by TQA, the ends of the cable may be sealed as above, and hot stamping with TQA stamp or affixing tamper-proof sticker at the ends shall be done.

16.0 INSPECTION:

16.1 The cable shall be tested and examined at the manufacturer's works. The manufacturer shall provide the necessary stable

voltage and testing apparatus and shall afford all facilities and assistance required for the purpose. Where considered necessary, the purchaser may test the cables in his premises with his testing equipment.

16.2 The raw materials used for the manufacture shall be tested from TEC/ CACT / NABL accredited Laboratory.

16.2.1 The inspector shall have the power to reject any wire/other materials which appear to him to be of unsuitable description or of unsatisfactory quality.

16.3 Notice shall be given to the Inspector when the cables are ready for inspection and tests.

16.4 The manufacturer shall supply certified copies of results of all the tests carried out on each drum length.

16.5 Prototype evaluation will be carried out in accordance with the latest Type Approval Procedure of TEC. The Test Plan and the Schedule of Tests for different contexts are at Appendix-1 and Appendix-2 respectively.

17.0 PACKING and MARKING: The length of cable in each drum shall be flexible, and will be determined by the purchaser.

17.1 The end with the clockwise direction of rotation of the colour scheme of the units in the cable shall be indicated by bands of red colour. Suitable self-adhesive tapes may be used for the purpose.

17.2 Various components of the wooden drums may be assembled using nails, provided that any nail which comes through into the cable space shall be properly and effectively clinched.

17.3 The nominal length of cable (except duct cable) fur different sizes shall be as per Table-I. A tolerance of +10% to -25% on nominal length is permissible. Normally one nominal length shall be wound on a drum.

17.3.1 If any short lengths are acceptable to the purchasing authority, the details of such cables, price and quantity shall be indicated by him. In such cases, a maximum of two short lengths of the same size /gauge of cable for the same consignee can be wound on one drum provided both the ends of both the cables are distinctly marked. Adequately supported and accessible for tests.

17.4 After the cable wound on a drum as above, has been tested and approved by the inspector, it shall be prepared for dispatch to destination in such a manner as to comply with the following:-

17.4.1 The drums shall be effectively lagged with stout and closely fitting battens so as in prevent damage to the cable during storage or transit.

17.4.2 Both ends of the cable(s) on the drum shall be kept inside the drum secured and protected. The ends of the cable(s) shall be easily accessible for testing.

17.4.3 The cable ends shall be so fastened and secured to the drum that during the process of transit, rolling, etc., the cable is not loosened or displaced.

17.4.4 The batten or battens on the drum which should be removed to obtain access to the ends of the cable must be indicated clearly by painting them with red paint.

17.5 The following details shall be clearly indicated on each drum/package in good oil paint, preferably, by black colour.

a) Manufacturer's name

b) The consignee's full address

c) Description of the content including size/gauge/length and type of cable. The type of cable of this GR shall be indicated as PIJF. The length markings shall include initial final and actual length of cable(s).

d) Gross weight

e) Rolling mark

f) "Not to be slung except by bar through Centre".

g) The details provided on polythene sheath/jacket as per Clause 13.1 (g) and any other markings (these markings are also to be shown in the column provided for the purpose in the invoices in which the quantity and description of contents of each package shall be clearly and separately stated).

17.5.1 In case, the cables are transported by ship, the following marking shall also be clearly stenciled on the drum in good oil paint:-

"STOW AWAY FROM BOILERS "

18.0 ELECTRICAL TESTS: The following tests shall be conducted on the completed cable. The cable shall be tested on an automatic test set for resistance, resistance unbalance, capacitance, capacitance unbalance, cross-talk and attenuation. The average /RMS value specified is the average/RMS of the individual values of the pairs in the cable/super unit

tested. In case of 200/400 pairs cable, two SUs of 50 pairs shall be tested as one group of 100 pairs.

18.1 Conductor Integrity Test:

18.1.1 All the conductors in the completed cable shall be tested for continuity and absence of crossed pairs and contacts. No conductor shall have contact with poly-al tape.

18.1.2 Conductor Resistance: The resistance of conductors and the tolerance of individual values shall meet the requirements of Table-11. The temperature correction factor is indicated in Table-11. The temperature correction for resistance shall be made using the following equation:

$$\text{Resistance at } 20°C = \frac{\text{Resistance at } t\ ^{\circ}C}{[1 + 0.00393\ (t-20)]}$$

18.1.3 Conductor Resistance Unbalance: The conductor resistance unbalance (RU) shall not exceed the values listed in Table-12.

18.1.3.1 The percentage RU of any individual pair tested shall be calculated as follows:-

$$\% \text{ Resistance Unbalance} = \frac{(R1 - R2)}{(R1 + R2)} \times 100$$

Where, R 1 and R2 are the resistances of individual conductors of the pair under test and R1 is higher than R2.

18.2 Poly-al Tape: The poly-al tape shall be tested for continuity, and its resistance value noted.

18.3 **Mutual Capacitance**: The average mutual capacitance of the pairs measured at any frequency between 800 to 1000 Hz shall be 52 ± 3 nF/km. However, the mutual capacitance of individual pairs shall be within the limits of 52 ± 4.5 nF/km.

18.4 **Capacitance Unbalance:**

18.4.1 The pair to ground capacitance unbalance at any frequency between 800 to 1000 Hz shall not exceed the following values:

Average 750 pF/km

Individual 3000 pF/km

18.4.2 The pair to pair capacitance unbalance measured at only frequency between 800 to 1000 Hz for all combinations of pairs in each unit of a super unit or cable shall not exceed the following limit.

Average…….50 pF/km

Individual combination…….. 200 pF/km

18.4.3 The measured value shall be corrected as follows:-

i. Capacitance unbalance pair to ground - The measured value shall be divided by L/1000, Where L is the length of the cable tested in metres.

ii. Capacitance unbalance pair to pair - The measured value shall be divided by:-

1/2 (L/1000+√L/1000)

Where L is the length of cable tested in metres

18.4.4 For these tests, the cable lengths less than 100 metres shall be considered as 100 metres.

18.5 Cross -talk: Equal Level Far End Cross-Talk (ELFEXT) and Near End Cross-Talk (NEXT) at 150 kHz of the cable shall meet the requirements indicated in 18.5.1 and 18.5.2 respectively. The measurement will be made on pair combinations as indicated in clause 18.4.2.

18.5.1 ELFEXT: The individual and RMS values shall be equal to or better than 55 dB/km and 67.8 dB/km respectively.

The RMS dB is given by

RMS (dB) = $10 \log_{10} * \sum 10^{-m\,(I,j)/10}/n]$

where m(i,j) = Cross-talk values between the i and j pairs

n = number of pair combinations

18.5.1.1 For length other than one km, the measured value shall be corrected by $10\log_{10}L/1000L$, being the cable length tested in metres.

18.5.2 NEXT: The individual value between pairs shall be equal to or better than 55 dB, when corrected to a unit length of 1 km.

18.5.2.1 NEXT Correction: No correction is necessary if cable lengths of 300 metres or more are tested. For other lengths. The NEXT value shall be corrected with the following formula:-

$$Nx = No - 10 \log_{10}[1-e^{-4\infty.1x}/1-e^{-4\infty lo}]$$

where, ∞ = Average attenuation in Nepers per km

Nx = Next in dB corrected to a unit length of 1 km

No = Measured value for length (10) in dB

1x = 1 km

lo = length of cable tested in km

e =2.71828

19.5.2.2 Lengths less than 150 meters shall not be tested for this parameter.

18.6 **Attenuation:** The average attenuation of the pairs at 20°C at 150 kHz shall not exceed the values given below:

Conductor dia	Attenuation
0.40 mm	12.00 dB/km
0.50mm	8.25 dB/km
0.63 mm	6.30dB/km
0.90mm	4.40dB/km

18.6.1 Temperature correction for attenuation shall be made using the following equation:

$$\text{Attenuation at } 20^{\circ}C = \frac{\text{Attenuation at } t^{\circ}C}{[1 + 0.0018\,(t - 20)]}$$

18.7 **Insulation Resistance:** The insulation resistance measurement shall be made with a DC voltage of magnitude not less than 500 V after steady electrification for one minute. The insulation resistance values between each conductor in the cable and all the other conductors connected together and to the screen and earthed shall not be less than 5000 Mega ohm-km. (cable length in km x observed insulation in (Mega ohms) at room temperature.

18.8 **Dielectric Strength:**

18.8.1 The insulation between conductors shall withstand for 3 seconds a DC potential indicated below:

2.4 kV for 0.40 & 0.50 nun conductors

3.5 kV for 0.63 & 0.90 mm conductors

18.8.2 The insulation between the conductors and shield shall withstand for 3 seconds a DC potential of 5 kV for 0.40 & 0.50 mm and 10 kV for 0.63 & 0.90 mm conductors.

19.0 MECHANICAL TEST ON CONDUCTOR:

19.1 **Annealing Test:** When a sample of conductor from the completed cable, 250 mm long, is slowly and steadily stretched, the elongation at break shall not be less than the appropriate value given in Table-10.

20.0 TESTS ON FILLING COMPOUND:

20.1 **Stability:** When held at a temperature of 65 ± 1°C for 5 days, the compound shall not show any separation of the constituents of the filling compound. The test shall be conducted as per method outlined in Annexure-II.

20.2 **Colour:** The compound shall not obscure the identification of the colour of the insulation of the conductors.

20.3 **Handling:** The compound shall be readily removable from the insulated conductors by wiping. It shall be free from unpleasant odour and shall have no toxic or dermatic hazards.

20.4 **Volume Resistivity**: The Volume resistivity, measured at 100°C by the method described in ASTM D 1169 or any other approved method shall not be less than 1×10^{10} Ohm-cm.

20.5 **Permittivity**: The permittivity at 1 MHz when tested as in ASTM D 924 shall not be greater than 2.3 at 20°C.

20.6 **Flash Point:** The flash point of filling compound when tested as per ASTM D 92, shall not be less than 200°C.

21.0 TESTS ON INSULATED CONDUCTORS:

21.1 **Retraction of Insulation:** When cut at a point not less than one metre from one end of the insulated conductor on the bobbin, the retraction of the insulation on the conductor at room temperature shall not exceed 2.5 mm after one minute.

21.2 **Resistance to Compression:** Two lengths of insulated conductor shall be uniformly twisted under light tension so that there are 10x 360° twist in a length of 100 mm. Not more than 50 mm in the middle of the twisted pair shall be placed between two flat rigid metal plates coated with polythene on the inside surface. A compressive force of 200 N (minimum) shall be applied between the plates. One minute after the application of the force, there shall be no electrical contact between the insulated conductors. The test shall be made at 12 V DC with a suitable indicator.

21.3 **Shrink Back of Insulation:** 200 mm specimen shall be cut from the centre of 1500 mm length and then reduced to 150 mm by trimming each end of the specimen. The 150 mm specimen shall be placed in a convection type air circulating oven for 24 hours at a temperature of 100 ± 1°C. A minimum of six samples shall be tested at a time. The total shrinkage from both ends shall be measured at ambient temperature. The average shrinkage of six samples shall not exceed 6.35 mm.

21.4 **Thermal Stress Cracking**: 10 lengths of insulated conductor of 15 cm shall be wrapped on their own diameter with a minimum of 10 contiguous turns of the insulated samples closely wound. It shall be suspended in an air oven maintained at 70 ± 1°C for 14 days. After this period, they shall be removed from the oven and observed at ambient temperature for cracks with naked eye. There shall be no cracks.

21.5 **Cold Bend**: 10 samples of the Conductor with insulation shall be tested in accordance with ASTM D 2633 (Cold bend test), after conditioning at a temperature of -40°C for one how with mandrel diameter equal to the diameter of the insulated conduct. There shall not be more than one failure out of ten samples.

22.0 COMPATIBILITY OF INSULATION AND FILLING COMPOUND:

22.1 **Absorption of filling Compound:** For this test, 15 cm centre length of insulation carefully removed from conductors, shall be weighed (about 2 gm) corrected to 1 mg. The lengths (suitably coiled and bent. if necessary) shall be placed in a test tube or beaker full of filling compound with its end one centi metre above the level of filling compound and maintained at 70 ±1˚C for 14 days. At the end of this period, the insulation samples shall be removed, the surface shall be wiped clean and again weighed at ambient temperature & accurately. Increase in weight shall not be more than 10%.

22.2 **Elongation and Tensile Strength:** 10 long lengths of insulation shall be carefully removed from the conductor and made into two sets of 10 half-lengths. The first set shall be tested as per ASTM D 1248. The percentage elongation at break and tensile strength shall be

noted and averages worked out. These values shall not be· less than 300% and 100 kg/cm^2 respectively. The second set shall be aged in a test tube or beaker full of filling compound at 70 ± 1°C for 14 days. After ageing, the insulation shall be removed from the compound and gently wiped free of compound, and then tested for tensile properties as per the' other set. The average percentage elongation at break and tensile strength after ageing shall not change by more than 30% and 15% respectively of the values before ageing.

22.3 **Environmental Stress Cracking**: 10 lengths of insulated conductor of 150 mm each shall be immersed in filling compound for 24 hours at 70 ± 1°C. The insulated conductors shall then be removed from the compound and wiped clean at ambient temperature. Each conductor shall then be wrapped around its own diameter for a minimum of 10 contiguous turns closely wound. They shall then be suspended in an oven maintained at 70 ± 1°C fur 14 days. At the end of this period, they shall be removed from the oven and observed at ambient temperature for cracks with naked eye. There shall be no cracks.

23.0 TESTS ON COMPLETED CABLES:

23.1 **Drip Test:** When tested as in Annexure-III, there shall be no dripping of filling compound.

23.2 **Oxidation Induction Time:** The induction time in oxygen with an aluminium pan tested by the method in Annexure-IV shall not be less than 30 minutes for each colour of insulation removed from the conductor of the completed cable.

23.3 **Bond Strength of composite sheath:** The bond strength of the poly-al laminate to the polythene sheath and at the overlap shall meet the requirements indicated in Annexure-I.

23.4 **Tests on Sheath:** For the tests in this section, the polythene sheath shall be stripped off the laminate.

23.4.1 **Tensile Strength and Elongation**: The samples of polythene removed from the cable sheath shall meet the following requirements when tested in accordance with BS 6234:

Tensile strength	--	Min. 70 kg/cm²
Elongation	--	Min. 300%

23.4.2 **Environmental Stress Cracking:** The specimen cut from the polythene sheath shall meet the environmental stress cracking test as described in ASTM D 1693, when tested with 10% Igepal solution at 50 ± 1°C for 48 hours. There shall be no failure.

23.4.3 **Shrinkage Test**: A specimen shall be cut from the cable sheath 50 mm long measured along the axis and 12 mm wide and placed in a convection type air circulating oven at a temperature of 100 ± 1°C for a period of 24 hours. At the end of this period, the shrinkage as measured at ambient temperature in the lengthwise direction shall not exceed 5%.

23.4.4 **Carbon Black Content**: The carbon black content of sheath shall be determined as in BS 6234, and shall be 2% to 3% by weight.

23.4.5 **Carbon Black Dispersion:** The carbon black dispersion in sheath shall conform to BS 6234.

23.4.6 **Oxidation induction Time:** The induction time in oxygen when tested with an aluminium pan as per the method in Annexure-IV shall not be less than 25 minutes.

23.5 PROPERTIES OF ARMOURING:

23.5.1 The thickness of bedding tape removed from the completed cable shall not be less than 0.05 mm.

23.5.2 The galvanized steel tape removed from the completed cable shall meet the following requirements:-

a) The thickness of the tape shall be as per Table-8.
b) The tensile strength shall be 250 to 450 MPa.
c) The elongation shall not be less than 8%.
d) The tape shall withstand two dips of one minute when tested in a copper sulphate solution prepared as per IS 2633.
(e) The tape should be free from rust/bare patches.

23.6 PROPERTIES OF JACKET:

23.6.1 The jacket shall meet the test requirements as per Clause no. 23.4.

23.7 WATER PENETRATION:

23.7.1 This test shall normally be conducted at the sheathing stage on the sheathed cable. In case, the cable has already been armoured or jacketed, the bedding tape, the steel tape and jacket, as applicable, have to be removed at the point of application of water.

23.7.2 One metre of the cable shall be supported horizontally and one metre head of water applied at ambient temperature. The test duration shall be as indicated below:-

Type tests	--	4 days
Acceptance tests for bulk supplies	--	7 days

23.7.3 During the above period no water shall have seeped from the cable sample. The procedure for this test is indicated in Annexure-V.

23.8 CABLE BEND TEST:

23.8.1 The test shall be taken on the completed cable. In the case of armoured cable the jacket, Armour and bedding shall be removed.

23.8.2 The cable sample shall be coiled around a mandrel having a diameter of 12D for at least one complete turn, 'D' being the diameter of the cable under test. The sample shall then be straightened and observed. The sheath shall not ripple and there shall be no damage in sheath.

TABLE-I

NOMINAL LENGTH OF CABLE

Size of the cable in pairs	Length in metres per drum for cables of conductor diameter

	0.40 mm	0.50 mm	0.63 mm	0.90 mm
5 (UA)	-	1000	- -	-
10	-	1000	- -	-
20	-	1000	1000	1000
50(UA)	-	1000	1000	1000
50 (A)	-	1000	1000	500
100	-	500	500	400
200	-	400	400	200
400	400	400	200	200
800	200	200	200	-
1200	200	200	-	-
1600	200	200	-	-
2000	200	200	-	-
2400	200	-	-	-

Note: The purchaser may also specify the length of cable as per his requirement

TABLE - 2

COLOUR SCHEME FOR CONDUCTOR INSULATION

Pair No.	1st Wire(Tip)	2nd wire(Ring)
1	White	Blue
2	White	orange
3	White	Green
4	White	Brown
5	White	Grey
6	Red	Blue
7	Red	orange
8	Red	Green
9	Red	Brown
10	Red	Grey
11	Black	Blue
12	Black	orange
13	Black	Green
14	Black	Brown
15	Black	Grey
16	Yellow	Blue
17	Yellow	orange
18	Yellow	Green
19	Yellow	Brown
20	Yellow	Grey
Spare pair	Natural	Blue

1) 5 pairs cable, 10 and 20 pair units will follow the colour code for pairs 1 to 5, 1 to 10 and 1 to 20 respectively. The spare pair will be coloured as indicated in the table for 101 pair super units only.

2) The number of the pairs with respect to the colour scheme is for the purpose of identification of pairs. The actual numbering sequence of pairs may not be insisted upon. The pairs may be displaced during manufacture.

TABLE – 3

COLOUR SCHEME FOR BINDER FOR UNIT IDENTIFICATION

Unit Number	Colour of Binder
I	Blue
2	Orange
3	Green
4	Brown
5	Grey

Note: The numbering of units shall be clock-wise at running end.

TABLE - 4

COLOUR SCHEME FOR BINDER FOR SUPER UNIT IDENITTFICATION

Position of super unit in the layer	Colour of Binder
First (Marker)	Red
Intermediate	White
Last (Reference)	Black

Note: The numbering of super units shall be clock-wise at running end.

TABLE - 5

MAKE UP OF CABLE

Number of pair		Number of Units/super Units (SU)		
Nominal	Actual	Centre layer	1st layer	2nd layer
5	5	5 pairs	-	-
10	10	1x10(unit)	-	-
20	20	1x20(unit)	-	-
50	50	5x10(units)	-	-
100	100	5x20(units)	-	-
200	200	4x50(SU)	-	-
400	400	2x50(SU)	6x50(SU)	-
800	808	2x100(SU)	6x100(SU)	-
1200	1212	3x100(SU)	9x100(SU)	-
1600	1616	1x100(SU)	5x100(SU)	10x100(SU)
2000	2020	1x100(SU)	6x100(SU)	13x100(SU)
2400	2424	2x100(SU)	8x100(SU)	14x100(SU)

Note: The assembly of units/super units in a cable may be modified to ensure cable circularity after approval by TEC. Mixing of different types of units/super UNITS in a cable is not permissible.

TABLE-6

POLYTHENE SHEATH THICKNESS AND SPARK TEST VOLTAGES

Specified dia. of cable over sheath (mm)		Normal sheath thickness (mm) (excluding poly-al laminate)	Spark Test Voltage kV	
Above	Upto		RMSAC	DC
----	30	2.0	11	17
30	40	2.2	11	17
40	50	2.4	11	17
50	60	2.6	13	20
60	70	2.8	13	20
70	----	3.0	13	20

Table-7

DIAMETER OVER SHEATH AND OVER JACKET

No. of Pairs in the cable		Maximum Diameter (mm)							
		Over sheath for conductor size (mm)				Over jacket for conductor size (mm)			
Nominal	Actual	0.40	0.50	0.63	0.90	0.40	0.50	0.63	0.90
5	5	-	11.0	-	-	-	-	-	-
10	10	-	13.2	-	-	-	20.2	-	-
20	20	-	17.0	19.0	25.0	-	24.0	26.0	32.0
50	50	-	22.0	25.5	35.0	-	29.0	32.5	42.5
100	100	-	28.0	34.0	47.0	-	36.0	42.0	55.5
200	200	-	37.5	46.0	65.0	-	45.5	54.0	73.0
400	400	41.5	49.0	62.0	88.0	49.5	57.5	71.0	98.0
800	808	56.0	68.0	85.0	-	65.5	77.5	94.5	-
1200	1212	70.0	82.0	-	-	80.0	92.0	-	-
1600	1616	77.0	94.0	-	-	87.0	104.0	-	-
2000	2020	85.0	105.0	-	-	95.0	117.7	-	-
2400	2424	95.0	-	-	-	105.0	-	-	-

Note: Diameter Over Sheath: The specified maximum diameter over sheath shall be strictly adhered to in the case of unamoured / duct cables.

TABLE – 8

THICKNESS OF GALVANISED STEEL TAPE

Specified minimum diameter of cable over polythene sheath	Thickness(mm)
Upto 40 mm	0.5 ± 10%
Above 40 mm	0.8 ± 10%

Note: In cases where the manufacturer is able to make a cable in diameter over sheath in less than or equal to 40 mm, there is no objection to use 0.5 mm GS tape as armour.

TABLE - 9

POLYTHENE, JACKET THICKNESS AND SPARK TEST VOLTAGES

Specified dia. of cable over Polythene Jacket		Nominal thickness Polythene Jacket	Spark Test Voltage kV	
Above	Upto		RMSAC	DC
---	46 mm	1.4 mm	8	12
46 mm	64 mm	1.8 mm	10	15
64 mm	---	2.2 mm	11	17

TABLE- 10

CONDUCTOR DIAMETER, RESISTANCE AND ELONGATION

Normal Diameter (mm)	Resistance per km. of cable conductor at 20 deg. C(ohms)	Tolerance on Resistance (ohms/km)	Minimum % Elongation of conductor samples taken from completed cables
0.40	135	+/-8	15
0.50	86	+/-6	15
0.63	58	+/-4	18
0.90	28	+/-2	18

TABLE - 11

CORRECTION FACTOR FOR CONDUCTOR RESISTANCE

Temp. in °C at which Conductor Resistance is measured	Multiplier constant for conversion to 20°C	Temp. in ˚Cat which Conductor Resistance is measured	Multiplier constant for conversion to 20˚C
10	1.0409	31	0.9586
11	1.367	32	0.9550
12	1.0325	33	0.9514
13	1.0283	34	0.9478
14	1.0241	35	0.9443
15	1.0200	36	0.9408
16	1.0160	37	0.9374
17	1.0119	38	0.9339
18	1.0079	39	0.9305
19	1.0039	40	0.9271
20	1.0000	41	0.9238
21	0.9961	42	0.9204
22	0.9922	43	0.9171
23	0.9883	44	0.9138
24	0.9845	45	0.9105
25	0.9807	46	0.9073
26	0.9770	47	0.9041
27	0.9732	48	0.9009
28	0.9695	49	0.8977
29	0.9658	50	0.8945
30	0.9622		-

TABLE - 12

CONDUCTOR RESISTANCE UNBALANCE

Nominal dia. of Conductor(mm)	Maximum Percentage unbalance	
	Average	Individual
0.40	1.5	3.0
0.50	1.0	2.5
0.63	1.0	2.0
0.90	1.0	2.0

ANNEXURE-I

PEEL STRENGTH OF POLY-AL TAPE AND BOND STRENGTH OF COMPOSITE SHEATH

1. A parallel sided test piece 150 mm long and 13 to 16 mm wide of the poly-al tape or sheath be cut longitudinally from the poly-al tape or sheath in one operation using a sharp punch.

   The test piece taken for testing the strength of the bond between the sheath and aluminium tape shall exclude the overlap of aluminium tape.

   The test piece taken for testing the strength of the bond between the interfaces of the aluminium tape at the overlap shall include only the overlap of the tape.

2 (a) For testing peel strength of poly-al tape only, separate the aluminium and polythene of one end. Insert the aluminium in the fixed grip and polythene foil in the moving grip of the tensile tester.

(b) For testing bond strength of sheath, insert the aluminium in the fixed grip and polythene Sheath in the moving grip.

(c) For testing strength of bond at the overlap, insert the aluminum tape in the fixed grip and the Poly-al-Polythene sheath (other edge) in the other grip.

(d) For a, b & c, the grip can be brought closer up to 3 cm. An electrically operated tensile tester shall be used; the rate of separation between grips shall be 100 to 125 mm/minute and the steady force required to separate the materials shall be noted.

3. The initial separation of the poly-al tape or composite sheath to facilitate insertion in the grips can be made by immersing about 25 mm at the end of the

test piece in boiling industrial alcohol or acetic acid at 90°C (as an alternative) for about 30 seconds.

4. Sampling and Requirements:-

(a) Peel strength of the poly-al tape raw material shall be 25 gm/mm width (minimum) 5 samples shall be tested.

(b) Bond strength of the poly-al tape to sheath shall be 40 gm/mm width (minimum) and 60 gm/mm width (average) of 5 samples.

(c) Bond strength of the poly-al tape at overlap shall be the same as in (b) above on 5 samples.

ANNEXURE- II STABILITY TEST

1.0 About 5 gm of filing compound shall be filled in a glass container of about 10 mm diameter with both the ends open and held with the axis of the container in a horizontal plane The outer surface of the glass tube shall be covered with a copper wire mesh to ensure uniform temperature and prevent local hot spots.

1.1 This container shall be held horizontally by a string suspended vertically in a test of diameter 30 to 40 mm so that it hangs freely. The temperature of the jelly shall be monitored by a thermometer. The test tube shall then be placed in a constant temperature be maintained at 65±1°C for 120 hours.

1.2 The compound shall remain intact in the container after 120 hours, and shall not show any separation of the constituents of the compound.

ANNEXURE-III DRIP TEST

A test specimen of 30 cm length shall be cut from a completed cable. One end of the sheath shall be stripped for approximately 5 cm and the conductors shall be wiped clean of the filling compound and flared out at approximately 45° angle. The specimen shall then be suspended in an air oven with a clean glass disc placed directly below the flared end of the cable. The oven temperature shall be set at 65 ± 1°C for a period of 24 hours. At the end of the test period, the glass disc shall be examined for the presence of the filling compound. There shall be no dripping of filling compound.

ANNEXURE - IV

OXIDATION INDUCTION TIME (OIT) TEST

1.0 A short length section (approximately 30cm) of completed cable sealed at the ends/raw material (PE) for conductor insulation or sheath or jacket shall be placed in an oven at a. temperature of 70 ± 1°C for 14 days. The sample shall then be allowed to cool to room temperature for at least 16 hours. In the case of finished cable; samples shall be taken from the sheath, jacket and insulated conductors (one from each colour of insulation). The sample shall be clean and dry. The samples from the completed cables shall be wiped clean of filling compound using a dry cloth without using any solvent. Each sample shall then be individual tested by means of a differential scanning calorimeter (DSC) or by differential The analyzer (DTA). The test is based on ASTM D 4565.

2.0 INSTRUMENT TEST PROCEDURE:

2.1 Cell Cleaning: The cell shall be held at approximately 400°C for 10 minutes in nitrogen. The cell should be cleaned after standing overnight and between testing of different formulation

2.2 Temperature Calibration: This has to be done according to the instrument manual. The temperature scale should be adjusted until the determined melting point of pure indium metal is 156.6°C at a heat rate of 5°C per minute or any other heat rate as indicated in the manual of the equipment is permitted .

2.3 Aluminium Pan: Standard aluminium DSC pans as per ASTM D 4565 are required to hold specimens during testing. A fresh pan shall be used for each test.

2.4 **Sample Preparation:** Raw material polythene for insulation/sheath/jacket OR insulation removed from the conductor/sheath/jacket from the completed cable are to be taken for the test. The sample should weigh approximately 5 mg. Position the sample in the centre of the aluminium pan.

2.5 **Nitrogen Purge:** Place the sample pan and reference pan in instrument cell. Flush to 5 minutes with cylinder of nitrogen (99.6% extra dry grade) at 60 ± 10 cc per minute.

2.6 **Oxidation Test:** Rapidly increase the temperature of the sample (20°C per minute or greater) from 100°C or lower initial temperature to 200 ± 1°C. After thermal equilibrium is obtained (steady recorder signal) switch to 80 ± 20 cc per minute oxygen flow and simultaneously start time-base recording. The oxygen used for the test should be equivalent to or better than 99.6% extra dry grade.

2.7 **Induction Period:** The oxygen induction point shall be recorded as time zero, and the chart speed shall be sufficient to provide a clearly discernible slope at the start of the exothermic reaction. The test in the pure dry oxygen atmosphere shall continue until the exothermic peak is produced. The intersection of the tangent of the exothermic sloped line with the extended base line will be drawn. The time from time zero to this intersection point is read from the base line and recorded as the oxidative induction time.

ANNEXURE- V

WATER PENETRATION TEST

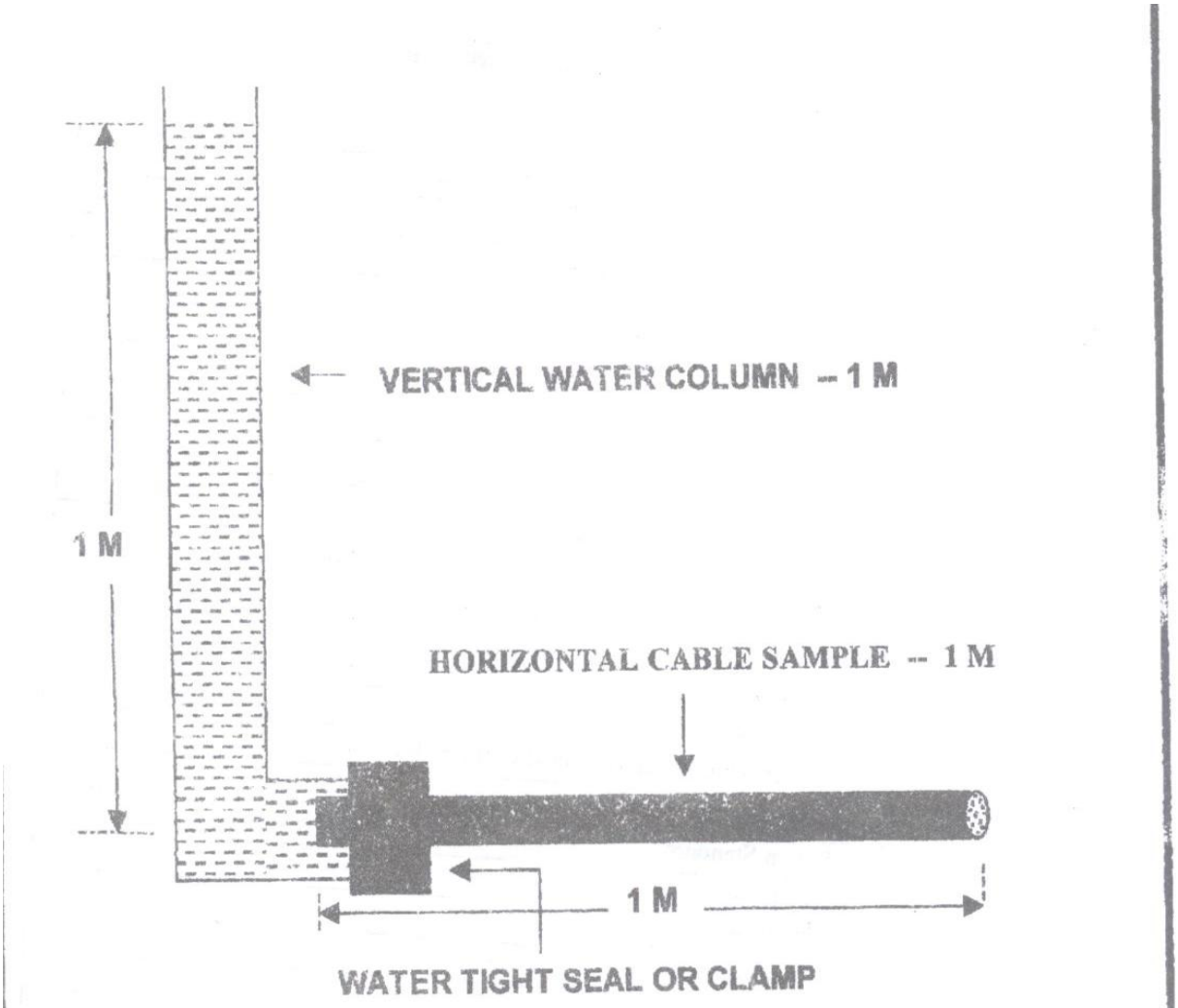
1.0 A test piece of 1 metre length shall be cut at or near the end of the cable.

2.0 **Testing Arrangement:**

2.1 This arrangement is shown in Figure-I. The sample under test is kept straight in horizontal plane. One end of the sample shall be connected suitably through a water tight gland to a water pipe containing 1 metre head of water. The connection shall be such that the cable sheath shall neither be squeezed tight nor shall it allow leakage of water at this point. The other end of the cable shall be free.

2.2 One metre head of water shall be applied at an ambient temperature for the duration or the test as per clause 23.7.2. No air bubble shall remain trapped in this pipe. Any bubbles that may be present initially shall be removed by agitating the water column using a thin wire for this purpose.

2.3 The test shall be deemed to have started after ensuring that the head of water 1 metre and all air bubbles have been eliminated, the sample shall not be disturbed during period under test. During this period, no water shall have seeped from the cable sample.



WATER PENETRATION TEST SET-UP

TC	GR. No.G/CUG-01/03 AUG 2003	FIG. 1

Above GR number to be updated

Appendix-1

TEST PLAN - TEC GR. NO. 68090

Section-I Raw Materials:-

Sl. No.	Raw material	Clause No. in the GR	Test	Sampling for	
				Prototype Evaluation	Regular Production
1.	Polythene for conductor insulation	4.3	a) Density	2 Nos- from Different bags	Test certificate for each supply cable Furnishing the test result
			b) Flow rate (Melt flow index)	2 Nos- from Different bags	
			c) Dissipation factor (power factor)	2 samples or test certificate from an approved laboratory	
			d)Dielectric constant (permittivity)	2 samples or test certificate from an approved laboratory	
			e)volume Resistivity	2 samples or test certificate from an approved laboratory	
			f)OIT	2 samples or test certificate from an	

				approved laboratory	
2.	Filling compound	20.1	Stability	2 Nos. from different barrels	---
		20.3	Toxic/ dermatic Hazards	2 samples or test certificate from an approved laboratory, or compound supplies test certificate	To be tested in any approved laboratory once in a year for each grade compound
		20.4	Volume resistivity	2 samples or test certificate from an approved lab.	---
		20.5	Permittivity	2 samples or test certificate from an approved lab.	---
		20.6	Flash Point	2 Nos. from different barrels or test certificate from an approved lab	---
3.	Poly-al Tape (Screen)	9.1	a) Thickness	5 Nos. from different coils	----

		9.2	b) Peel strength	5 Nos. from different coils	----
4.	Polythene for sheath and jacket	10.1 &12.1	a) Melt flow index	2 Nos. from different bags	---
			b) Density	2 Nos. from different bags	---
			C) OIT	2 Nos. from different bags	---
5.	Galvanized steel Tape	11.3.1	a) Tensile Strength	2 sample; one/ coil	---
			b) Elongation	2 sample; one/ coil	---
		11.3.2	c) Thickness	2 sample; one/ coil	---
		11.3.3	Dip Test	2 sample; one/ - coil	---

Section-II: Insulated conductors (Each colour to be tested)

Sl. No.	Clause No.	Test	Sampling for	
			Prototype Evaluation	Regular Production
1.	21.1	Retraction of insulation	One sample from one bobbin of each colour	Once a year – one sample per colour
2.	21.2	Resistance to compression	No. of sets such that at least one conductor of each colour is tested	Once a year
3.	21.3	Shrink back of insulation	A minimum of 6 samples per colour	Once a year
4.	21.4	Thermal stress cracking	10 samples per colour	Once a year samples/ colour
5.	21.5	Cold bend	10 samples per colour	Once a year samples/ colour
6.	22.1	Absorption of filling compound	One set per colour	Once of year
7.	22.2	Elongation and Tensile strength	10 sample per colour	Once a year sample/colour
8.	22.3	Environmental stress cracking	10 sample per colour	Once a year sample/colour

NOTE: - During regular production, the above tests from Sl.No.1 to SLNo.8 have to be carried out whenever there is a change of colour master batch grade/manufacturer.

Section-III: Tests in Process:-

Part-A: Joints in conductors

Sl. No.	Clause No.	Test	Sampling for	
			Prototype Evaluation	Regular Production
1.	3.3	Joints in conductor for resistance & tensile strength	5 joints/operator to be made	-

Part-B: Production – Line Tests

Sl. No.	Clause No.	Test	Sampling for	
			Prototype Evaluation	Regular Production
1.	4.8	Spark test on insulated conductor	Factory records to be checked up	On line test, to be verified on surveillance basis
2.	10.4	Spark test on sheath	Factory records to be checked up	On line test, to be verified on surveillance basis

3.	11.3.4	Galvanized Steel Tape Armouring	----	On surveillance basis for any rust/bare patches & also provision of corrosion protection at joints
4.	12.3	Spark test on jacket	Factory records to be checked up.	On line test, to be verified on surveillance basis.

Section-IV: Tests on Completed Cables (for each make of filling machine)

Part-A: Sample Tests

Sl. No.	Clause No.	Test	Sampling for	
			Prototype Evaluation	Regular Production
1.	6.1	Colour, Thickness & lay of unit binder tape	Each cable	Once in a month at random
2.	9.1	Overlap of poly-al tape	Each cable	Once in a month on surveillance basis
3.	23.1	Drip test	2 sample/cable –one from each end-5 cable	One sample /month for each size/gauge
4.	23.2	Oxidation Induction Time	2 cable at random one	i) Once in 6 month one cable-one

			sample/colour/cable	sample/colour. ii) Whenever there is a change in the colour master batch. Grade/ manufacturer.
5.	23.3	Bond strength between: a) Poly-al at overlap	5 samples/cable - 2 cables	Once in year, one cable 5 samples
		b) Poly-al and sheath	5 samples/cable - 2 cables	Once in year, one cable 5 samples
6.	23.4.1	Polythene sheath: a) Tensile Strength	5 samples/cable - 5 cables	Whenever there is a change in the grade of raw material – one cable -5 sample
		b) Elongation at break	5 samples/cable - 5 cables	Whenever there is a change in the grade of raw material – one cable -5 sample
	23.4.2	Environmental stress cracking (ESCR)	2 samples/cable - 5 cables	Once in 3 months and whenever there is a change in the grade of raw material - One

				sample/cable - 2 cables at random
	23.4.3	Shrinkage	2 sample/cable-5 cable	whenever there is a change in the grade of raw material
	23.4.4	Carbon black content	1 sample/cable-2 cable at random from 5cables	Once in 3 months and whenever there is a change in the grade of raw material – 2 samples
	23.4.5	Carbon black dispersion	1 sample/cable-2 cable at random from 5cables	whenever there is a change in the grade of raw material-2 sample
	23.4.6	Oxidation Induction Time	1 sample/cable-2 cable at random from 5cables	Once in 3 months and whenever there is a change in the grade of raw material – 2 samples
7.	11.2&23.5.1	Bedding Tape a) Thickness	1 sample/cable-2 cable	Once in a month - 5 sample at random

		Width	1 sample/cable-2 cable	Once in a month - 5 sample at random
		Overlap	1 sample/cable-2 cable	Once in a month - 5 sample at random
8.	23.5.2	Galvanized steel tape: Thickness	1 samples/cable - 5 cables	Once in a month - 5 sample at random
		Width	1 samples/cable - 5 cables	Once in a month - 5 sample at random
	11.3.2	a) Gape in the application of the first tape	1 samples/cable - 5 cables	Once in a month - 5 sample at random
	11.3.1	b) Overlap of 2nd tape over the first one on either side.	1 samples/cable - 5 cables	Once in a month - 5 sample at random
	23.5.2	a) Tensile Strength	1 samples/cable - 5 cables	Once in a year -5 sample at random
		b) Elongation at break	1 samples/cable - 5 cables	Once in a year -5 sample at random

		c)Drip test	1 samples/cable - 5 cables	Once in 3 month - 5 sample at random
9.	23.6.1	Polythene jacker: a) Tensile Strength	5 samples/cable - 5 cables	Whenever there is a change in the grade of raw material – one cable -5 sample
		b) Elongation at break	5 samples/cable - 5 cables	Whenever there is a change in the grade of raw material – one cable -5 sample
		c) Environmental stress cracking (ESCR)	2 samples/cable - 5 cables	Once in 3 months and whenever there is a change in the grade of raw material - One sample/cable - 2 cables at random
		d) Shrinkage	2 sample/cable-5 cable	whenever there is a change in the grade of raw material
		e) Carbon black content	1 sample/cable-2 cable at random from 5 cables	Once in 3 months and whenever there is a change in the grade of raw material – 2

				samples
		f) Carbon black dispersion	1 sample/cable-2 cable at random from 5 cables	whenever there is a change in the grade of raw material-2 sample
		g) Oxidation Induction Time	1 sample/cable-2 cable at random from 5 cables	Once in 3 months and whenever there is a change in the grade of raw material – 2 samples
10.	10.3	Thickness of sheath	Each cable	10% of the cables offered in a day
11.	10.5	Diameter over sheath	Each cable	10% of the cables offered in a day
	10.2	Variation between the maximum and minimum diameter over sheath at any cross-section.	Each cable	10% of the cables offered in a day
12.	12.1	Thickness of Jacket	Each cable	10% of the cables offered in a day
13.	12.4	Diameter over Jacket	Each cable	10% of the cables offered in a day
14.	18.2	Resistance of poly-al tape	Each cable	10% of the cables offered in a day

15.	~~20.1~~ 19.1	Annealing of copper	5 conductor/cable-s cables	5 conductor/each gauge of conductor/day
16.	18.8.1	Dielectric strength between conductors	Each cable upto 100 pairs or 2 SUs in 200 pair cable or 1 SU from centre layer&1 SU from outer most layer (in sizes above 200 pairs)	Entire cable upto 100 pairs or 2 SU in 200/400 pairs cables or 1 SU in cables above 400 pairs. On 10% of the cable offered in a day.
17.	18.8.2	Dielectric strength between all conductors and shield	Each cable upto 100 pairs or 2 SUs in 200 pair cable or 1 SU from centre layer&1 SU from outer most layer (in sizes above 200 pairs)	Entire cable upto 100 pairs or 2 SU in 200/400 pairs cables or 1 SU in cables above 400 pairs. On 10% of the cable offered in a day.
18.	18.5.1	ELFEXT	Each cable upto 100 pairs or 2 SUs in 200 pair cable or 1 SU from centre layer&1 SU from outer most layer (in sizes above 200 pairs)	Entire cable upto 100 pairs or 2 SU in 200/400 pairs cables or 1 SU in cables above 400 pairs. On 10% of the cable offered in a day.
19.	18.5.2	NEXT	Each cable upto 100 pairs or 2 SUs in 200 pair cable or 1	Entire cable upto 100 pairs or 2 SU in 200/400 pairs

			SU from centre layer&1 SU from outer most layer (in sizes above 200 pairs)	cables or 1 SU in cables above 400 pairs. On 10% of the cable offered in a day.
20.	18.6	Attenuation	Each cable upto 100 pairs or 2 SUs in 200 pair cable or 1 SU from centre layer&1 SU from outer most layer (in sizes above 200 pairs)	Entire cable upto 100 pairs or 2 SU in 200/400 pairs cables or 1 SU in cables above 400 pairs. On 10% of the cable offered in a day.
21.	18.7	Insulation resistance	Bunch method-2 cables at random	~~One cable per~~ the Entire cable upto 100 pairs or 2 SU in 200/400 pairs cables or 1 SU cables above 400 pairs.
22.	23.8	Cable Bend Test	1 sample/cable-2 cable at random	One in 3 month-sample per each size/ gauge of cable.

Appendix-2

SCHEDULE OF TESTS - PROTOTYPE EVALUATION/ACCEPTANCE

Sl. No.	Context	Test to be covered	To be conducted by	Remarks
1.	Type Approval	All the section	TEC	The manufacturer will approach TEC with the following valid certificate ~~from QA~~. (a)Source approval Certificates for raw materials by TEC/ NABL accredited Lab. (b)Compatibility approval certificate (all the tests on insulated conductors as per sec. II of test plan), © Approvals for joints in conductors.
2.	Approval for the changes in Poly Ethylene (PE) for conductor insulation or filling compound (Jelly) or both; when a valid TAC exists.	Section II,III &Iv	Purchasing Authority	

3.	Approval for changes in raw materials as listed below; when a valid TAC exits. (a) Change in Poly-all tape (b) Change in Polythene for Sheath/Jacket c) Change in galvanized steel tape	i) Sec. IV Part-A Sl.Nos.2, 5 & 14 ii) Sec. IV Part-B Sl.No.6 i) Sec. III Part-B Sl.Nos2 & 4 ii) Sec. IV Part-A Sl.Nos.5(b), 6, 9 to 13 & 22 Sec. IV Part-A Sl. No. 8	Purchasing Authority Purchasing Authority Purchasing Authority	Once a material has been tested and approved by TQA, it can be used for any size/gauge of cable irrespective of the Group/TAC. 1. The applicable tests for sheath/jacket -will be carried out. 2. Once a particular type/grade of compound has I been tested and approved by TEC, the compound can be used for either sheath or jacket for any size/gauge of the irrespective of the Group/TAC. Remarks in as in 3(a) above.
4.	Extension of type Approval from unarmoured to armoured cable	i) Sec III Part-B Sl.No.3 ii) Sec. IV Part-A Sl.Nos.1, 2,3 & 7 to 22 iii) Sec. IV Part-B	TEC	----

	within the validity period			
5.	In case of extension of cable size (number of pairs or conductor size mm or both), the additional test cases pertaining to the bigger size of the cable shall only be carried out.	-do-	Purchasing Authority	----

NOTES:

1. The reference in column 3 are with respect to the test plan at Appendix-1.
2. For all approvals, 5 nominal/standard lengths out of 8 consecutive lengths, with reasons for not offering the remaining 3 lengths, will be offered.
3. The manufacturer shall approach TEC for Type Approval with valid
   (i) Source Approval Certificates,
   (ii) Compatibility Approval Certificates and
   (iii) Approval for Joints Conductors .
4. Once TAC is issued for armoured cables, it is deemed to cover un-armoured cables also of the corresponding size/group.

Abbreviations

AC	Alternating Current
ASTM	America Society for Testing and Materials
BS	British Standard
BSNL	Bharat Sanchar Nigam Limited
CC	Cubic Centimeter
cm	Centimeter
dB	Deci Bel
˚C	Degree Centigrade
DC	Direct Current
Dia	Diameter
DOT	department of Telecommunications
ELPEXT	Equal level Far End Cross Talk
Gm	Gram
GR	Generic Requirements
GS tape	Galvanized steel tape
IEC	International Electro technical Commission
IR	Insulation Resistance
IS	Indian standard Kilogram
Kg	kilogram

KHz	kilo Hertz
Km	kilometer
KV	kilo Volts
LF	Low Frequency
Mm	Millimeter
mm^2	Square Millimeter
MTNL	Mahanagar Telephone Nigam Limited
N	Newton
NF	Nano Farad,
Next	Near End Cross Talk
OIT	Oxidation Induction Time
%	Percent
PE	Polythene
pF	Pico Farad
PVC	Poly Vinyl Chloride
RMS	Root Mean Square
TAC	Type Approval Certificate
TEC	Telecommunication Engineering Centre
TQA	Telecom Quality Assurance