GOVERNMENT OF INDIA
MINISTRY OF RAILWAY

INDIAN RAILWAYS STANDARD SPECIFICATION FOR UNDERGROUND RAILWAY JELLY FILLED TELECOM QUAD CABLES FOR SIGNALLING & TELECOM INSTALLATIONS

0. FOREWORD

0.1 This specification is issued under fixed serial no. IRS:TC 30 followed by the year of original adoption as standard or in the case of revision the year of last revision.

Adopted - 1983, First revision - 1995,
Second revision - 1996
Third revision - 1997
Fourth revision - 2005

0.2 This specification requires reference to the following Indian Railway Specification (IRS), Indian Standard Specification (IS), British Standard Specifications (BS), American Standard Specifications (ASTM) and Association of German Electrical Engineers Specification (VDE).

IS: 723	Steel Countersunk head wire nails.
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables.
IS: 5831	PVC insulation and sheath of electric cables.
IS: 10810	Methods of test for cables.
IS: 8130	Conductors for insulated electric cables flexible cords.
IS: 9938	Recommended colours for PVC insulation for LF wires and cables.
IS: 2067	Wrought aluminium wire for electrical purposes.
IS: 2633	Method for testing uniformity of coating on zinc coated articles.
IS: 2335	Method of drift expending test on metallic tubes
IS: 2328	Method for flattening test on metallic tubes
BS: 6234	Polythene Insulation and sheath of electric cables.
BS: 3533	Polythene insulated telephone distribution cables.
BS: 6469	Insulating and sheathing materials of electric cables.
ASTM: D- 883	Definition of terms relating to plastics.
ASTM: D-1047	Cold bend test.
ASTM:D-1248	Standard Specification for Polyethylene Plastics moulding and extrusion materials.
ASTM: D-1693	Standard method of test for environment stress cracking of type I Ethylene plastics.
VDE: 0472/6.65	Recommendations for testing of insulated cables & flexible cords.
IRS:TC–41/97 with latest amendment	Polythene insulated polythene sheathed jelly filled telephone cable with poly-al moisture barrier.

IRS:S – 23/88	Electrical and electronic based Signalling and Interlocking Equipments (Tentative).
IRS:S – 63/89 with latest amendments	PVC Insulated cables for Railway signalling

0.3 Whenever in this specification, any of the above mentioned specifications are referred by number only without mentioning the year of issue, the latest issue of that specification is implied; otherwise the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and does not include all the necessary provisions of a contract.

1. SCOPE:

1.1 This specification covers the requirements of the physical and electrical characteristics of Polyethylene insulated, polythene inner sheathed, PVC intermediate sheathed, Aluminium screened in the form of wire/strip/ welded Aluminium tubing, galvanised steel armoured in the form of tape & PVC jacketed for telecom quad cables required for signalling & telecom installations

1.2 The cables covered in this specification are suitable for use where the combination of ambient temperature and temperature due to loads results in a conductor temperature not exceeding 70ºC.

2. TERMINOLOGY

2.1 For the purpose of this specification terminology given in IRS:S 23, in addition to the following, shall apply;

2.2 **ROUTINE TESTS:**
Tests carried out on each cable length to check the requirements which are likely to vary during production.

2.3 **TYPE TESTS:**
Tests carried out to prove conformity with the specification. These are intended to prove the general qualities and design of a given type of cable.

2.4 **ACCEPTANCE TESTS:**
Tests carried out on samples taken specifically from a lot for the purpose of acceptance of the lot.

2.5 **QUAD:** An assembly of four separately insulated conductors of a cable.

2.6 **LOT:**
The product of same type and category manufactured by the same factory during the same period, using the same process and materials.

3. GENERAL REQUIREMENTS:

3.1 CONDUCTOR:

3.1.1 The conductor shall be composed of plain annealed high conductivity copper wire(s) complying with IS:8130 except for the requirements mentioned in this specification. The dimensions and resistance of conductors shall be in accordance with the values given below :

Diameter mm. (Nominal)	Tolerance mm.	Maximum resistance Ohm/Km. At 20ºC	
		Each Core	Loop
0.90	± 0.02	28	56

3.1.2 The conductor shall be uniformly drawn, circular in cross-section, uniform in quality, free from splits, cracks, corrosion and other surface imperfections.

3.1.3 No joints shall be made in the conductor except in very exceptional cases. When it is necessary to join conductors during manufacture, it shall fulfill the requirements of clause 3.1. The joints shall be soldered, brazed or welded with smooth surfaces. The particulars of such joints shall be mentioned by the manufacturer in the routine test certificate.

3.1.4 The tensile strength of a 250 mm length of conductor containing a joint shall not be less than 95% of that of a similar sample of conductor not containing a joint.

3.1.5 The resistance of 100 cm length of conductor containing joint/s shall not be more than 101.2% of that of an adjacent sample of conductor not containing joint/s.

3.2 INSULATION (DIELECTRIC) :

3.2.1 Each conductor shall be insulated with solid polythene of one of the types specified below. Recycled or reclaimed material shall not be used.

Density :	Melt Flow Index:
Type II (MDPE) (0.926 to 0.940 gm/cc) Type III (HDPE) (0.941 to 0.959 gm/cc)	Max. 1.0 gm/10 minutes (at 190^{o}C, 2160 gm Load)

Test values for these parameters shall be as per standards specification ASTM: D-1248 or BS: 6234. These values are applicable to the raw materials used and not for materials removed from the cables.

3.2.2 The insulation shall be applied by extrusion in one continuous process and shall be homogeneous and free from joints and repairs. It shall fit closely on the conductor but shall not adhere to it so that it is possible to remove it without damage to the conductor.

3.2.3 **INSULATION THICKNESS:**

Conductor diameter nominal	Minimum diameter of insulated conductor	Nominal thickness of insulation t_1
0.90 mm	1.55 mm	0.325 mm

Thickness of insulation shall not fall below nominal value t_1 by more than 0.2 t_1.

3.2.4 The colour scheme of Polyethylene insulated quads shall be as per Table given below:-

Quad No.	Colour of the conductor insulation			
	A-Wire	B-Wire	C-Wire	D-Wire
1	White	Orange	Red	Grey
2.	White	Blue	Red	Grey
3.	White	Brown	Red	Grey
4.	White	Green	Red	Grey
5.	White	Yellow	Red	Grey
6.	White	Black	Red	Grey

Note:- Wire A and wire B shall form a pair. Similarly wire C and wire D shall form a pair.

3.2.5 The colour scheme shall conform reasonably with the standard colour shown in IS:9938.

3.2.6 The insulation resistance of each insulated conductor shall not be less than 5000 M ohm/Km at room temperature.

3.2.7 Unless otherwise specified by the purchaser there shall be six quads in the cable.

3.2.8 The insulated conductor shall be subjected to spark test at 3 KV AC (RMS) or 4.5 KV DC. There shall not be more than one spark over per 5 Km length of the insulated conductor on insulating line. The test shall be done at extrusion stage.

3.3 **QUADDING:**

3.3.1 Four conductors insulated as above shall be stranded to form a star quad each, two conductors diagnonally opposite forming one pair and the remaining two diagonally opposite conductors forming the second pairs of the quad. Polythylene centre strings of required diameter may be used. The quad shall be held together firmly by means of an open helical whipping of cotton/nylon yarn or colored tape of suitable material of appropriate thickness.

3.3.1.1 The lays of the conductors forming the quads shall differ for adjacent quads. The lay of the conductor shall be so chosen as to ensure that the cross-talk between the pairs in the cable is minimum.

3.3.2 The colour scheme of the quad whipping shall be in accordance with the Table given below :

Quad Number	Colour Scheme
1	Orange
2	Blue
3	Brown
4	Green
5	Yellow
6	Black

3.3.3 The colour of the quad whipping shall conform reasonably with the colour shown in IS:9938.

3.4 **LAYING UP:**

3.4.1 The quads shall be assembled to form a symmetrical core with a right lay. Polyethylene strings of required diameter may be used as fillers, if necessary, for proper circular core formation.

3.4.2 Each quad shall retain its position in the cable with reference to the other quads. The manufacturing process shall be such that there is no physical displacement of the quads, either during manufacture of the cable or during its subsequent handling.

3.5 **FILLING COMPOUND (JELLY):**

3.5.1 **COMPATIBILITY OF PE INSULATION AND FILLING COMPOUND:**
The cable core shall be fully filled with a suitable water resistant compound like Jelly which is fully compatible with the polythene insulation of the conductors. The compatibility between the polythene and the filling compound shall be established by the tests as per Annexure-I of the specification. The compatibility shall be assessed for each colour of insulation as per clause 3.2.4.

3.5.2 **CORE WRAPPING: A**fter application of the filling compound a closed helical or longitudinal lapping of a polyester tape shall be laid over the cable core. The tape may be impregnated or flooded with jelly to meet the water penetration test requirements.

3.6 **POLY-AL LAMINATE MOISTURE BARRIER:**

3.6.1 Polythene coated aluminium tape shall be applied longitudinally on the quad with a minimum overlap of 6mm. The thickness of aluminium tape shall be 0.2mm ±10% and that of polythene/copolymer coating on each side 0.05mm nominal. The thickness of composite tape shall be 0.3mm ±15%.

3.6.2 The laminate shall be bonded to the inner surface of the polythene sheathing extruded over it by any suitable method. The Poly-Al laminate shall be mechanically and electrically continuous.

3.6.3 **PEEL STRENGTH:** The peel strength of polythene from the Aluminium shall not be less than 25 gm per mm width when tested as per Annexure-A (III). This test shall be applicable on raw material Poly-Al tape only.

3.7 **INNER SHEATH:**

3.7.1 Inner sheath shall be reasonably circular, free from pinholes, joints and other defects. The nominal thickness of sheath shall be 2.0mm (excluding Poly-Al laminate). The minimum thickness shall not be less than 75% of the specified nominal thickness. The average of six measurements, equally placed around the circumference, shall not be less than 85% of specified nominal value. The variation between the maximum and the minimum diameter at any cross section shall not be less than 3.0mm.

3.7.2 The inner PE sheath shall be subjected to spark test at 11 KV AC (RMS) or 17 KV DC during extrusion. There shall not be any spark over.

3.7.3 Cable shall be sheathed with the polythene grade 03C or H03C as per BS: 6234, and containing a suitable anti-oxidant system. The material shall be virgin as per ASTM-D-883 and meet the requirements specified below:

i) Melt Flow Index- Shall not be more than 1.0 g/10 minutes (190ºC, 2160 gm load)

ii) Density- For 03C shall be 0.910 to 0.940 gm/cc.
For H03C, shall be 0.941 to 0.959 gm/cc.

iii) Anti-oxidant - OIT test in a copper pan at 199ºC as per the method in Annexure-A (v) and the value to be recorded, the value should be such that the requirement of Cl. 5.8.36 of this specification is met.

NOTE: The Melt Flow Index & Density test shall be applicable on raw material while (OIT) shall be applicable on completed cable.

3.8 **SCREENING:**

3.8.1 The cores with inner sheath shall be surrounded by a reasonably close fitted screen of Aluminium in the form of wires/strips/welded aluminium tubing.

3.8.2 The aluminium used for screening shall contain not less than 99.5% aluminium and shall generally conform to IS:2067-75

3.8.3 The number and the size of the aluminium wires/strips used for screening shall be such as to comply with the requirements of Cl. 5.9.9 If the Aluminium wires/strips used for screening are laid in two layers, they shall be in opposite directions.

3.8.4 The layer of the aluminium wires/strips used for screening shall be compact and the length of the lay shall be high. It shall also be ensured that the screening wires/strips are as close as practicable so that inner sheath is not visible throughout the length of cable.

3.8.5 The minimum tensile strength of Aluminium screen shall be 15 Kg / Sq mm.

3.8.6 The innermost layer of the screening shall have left hand lay and the successive layer shall be laid with opposite lay.

3.8.7 Drift expansion test to IS: 2335-1985 shall be carried out on a test piece of length, twice the external dia of the tube by conical mandrel having height three times its base diameter. The test piece shall show no crack or flaw until the outside diameter of the expanded end is increased by at least 30%. This test is applicable where welded aluminium tubing is used for screening.

3.8.8 Flattening test to IS: 2328-1983 shall be carried out on a test piece of not less than 50mm long, cut from each selected tube. The test tube when close-flattened with the weld bead position equidistant from the flattening places shall not show any visible crack or flaw in the weld region. This test is applicable where welded aluminium tubing is used for screening

3.9 **PROTECTION:**

3.9.1 The aluminium screen shall be wrapped with a single layer of woven tape impregnated with Barium chromate with minimum 20% overlap.

3.9.2 The tape used shall be fine woven cloth tape of about 0.15mm thickness.

3.10 **INTERMEDIATE SHEATH:**

3.10.1 Further protection for the screening shall be provided by extruded PVC sheath over screening. It shall be circular.

3.10.2 The nominal thickness (t_s) of intermediate sheath shall be 1.0 mm.The smallest of measured values shall not fall below the nominal value (t_s) by more than ($0.1mm+ 0.1t_s$). The average thickness shall not fall below the nominal thickness t_s.

3.10.3 The PVC used for intermediate sheath shall meet the requirements of ST-1 (General purpose sheath for use at maximum rated conductor temperature 70ºC) compound of IS:5831-84, except for the requirements mentioned in this specification. Re-cycled or re-claimed material shall not be used.

3.10.4 The colour of the intermediate sheath shall be grey.

3.10.5 The PVC used for intermediate sheath shall meet the requirements as indicated in CL.5.8.

3.10.6 The Intermediate PVC sheath shall be subjected to spark test at 6 KV AC (RMS) or 9 KV DC for all conductors sizes. There shall not be any spark over .

3.10.7 **DENSITY/SPECIFIC GRAVITY OF PVC INTERMEDIATE SHEATH:**
The test shall be conducted on PVC intermediate sheath in accordance with BS: 6469 latest or any other approved method. The test sample shall be taken from finished cable and the value shall not exceed 1.47.

3.11 **ARMOURING:**

3.11.1 The galvanised steel tape armouring conforming to IS:3975 shall be applied tightly over the intermediate sheath with two layers. The armour shall be free from rust, blooming, oxidation, cracks, splits etc.

3.11.2 The sheathed cable shall be armoured with two applications of Galvanised steel tape conforming to IS: 3975, each applied helically in the same direction with a gap in the first tape of 25%±10% of the width of the tape, the second tape evenly covering the gap of first tape. In any case, the overlap of second tape over the first tape shall not be less than 20% of the width of tape. The intermediate sheath shall not be visible throughout the length of the cable.

3.11.3 The direction of the lay of the armour shall be opposite to that of the outermost layer of screening.

3.11.4 When joints in tapes are necessary, they shall be made by brazing or welding and any surface irregularity shall be removed. A joint in any tape shall not be less than 300 mm from a joint in any other armour tape in the completed cable. The tape shall be continuous throughout the length of cable.

3.11.5 The thickness of armour tape shall be as under :-

Conductor diameter nominal	Nominal thickness of armour tape
0.90 mm	0.8mm± 10%

3.12 **OUTER SHEATH:**

3.12.1 The outer sheath shall be applied by extrusion in one continuous process over the armouring and shall be homogenous and free from joints and repairs.

3.12.2 The PVC used for outer sheath shall meet the requirements of ST-1 (General purpose sheath for use maximum rated conductor temperature 70ºC) compound of IS:5831-84, except for the requirements mentioned in this specification. Re-cycled or re-claimed material shall not be used.

3.12.3 The colour of the outer sheath shall be black.

3.12.4 The thickness of PVC outer sheath shall be determined in accordance with the procedure laid down in IS:10810 (Part-6). The average thickness shall not be less than the nominal value (t_s) specified below and the smallest of the measured values shall not fall below the nominal value by more than (0.2mm + 0.2 t_s).

Conductor diameter nominal	Nominal thickness of PVC outer sheath
0.90 mm	2 . 0 mm

3.12.5 The PVC used for outer sheath shall meet the requirements as indicated in Cl. 5.8

3.12.6 The outer sheath shall be subjected to spark test at 15 KV AC (RMS) or 23 KV DC. There shall not be any spark over.

3.12.7 **DENSITY/SPECIFIC GRAVITY OF PVC OUTER SHEATH:** The test shall be conducted on PVC outer sheath in accordance with BS: 6469 latest or any other approved method. The test sample shall be taken from finished cable and the value shall not exceed 1.47.

3.13 The cross-sectional view of 4 quad & 6 quad cable shall be as per Fig.1& 2 respectively.

4. MARKING:

4.1 The following information shall be legibly and indelibly indicated at every meter or less throughout the length of the cable by embossing or engraving/indenting on outer sheath of the cable. All the marking shall be in white or yellow colour. The marking shall be clear, distinct and visible to the naked eye from a distance of about 1 meter; the size of marking shall be of minimum 3 mm.

a) Name or trade mark of the manufacturer,
b) IRS: TC 30-05
c) Month & year of manufacture
d) Cable Drum No.
e) Sequential length marking at every meter with an accuracy of ±0.2%

4.2 The following information shall be stenciled on the cable drum in black paint over yellow painted background.

a) Manufacturer's name, brand name or trade mark.
b) IRS: TC 30-05
c) Type of cable
d) Nominal diameter of conductor
e) Cable drum number
f) Number of lengths on drums (if more than one)
g) Length of the cable on the drum (length of each piece to be indicated in case there is more than one length).
h) Initial and final sequential length marking
i) Direction of rotation of drum (by means of an arrow)
j) Approximate gross weight
k) Country of manufacture
l) Month and year of manufacture
m) Address of consignee
n) Purchase order No. and Railway
o) Store away from fire/boiler
p) Not be hung except by bar through center.

5. TESTS AND PERFORMANCE REQUIREMENTS:

5.1 Unless otherwise specified, all tests shall be carried out under ambient atmospheric conditions.

5.1.1 For inspection of material, relevant clause of IRS:S-23 shall also apply.

5.2 **TYPE TESTS:** The following shall constitute type tests and shall be carried out once in three years or earlier at the discretion of the inspecting authority.

a) Physical tests for conductor (Cl. 3.1.1 to 3.1.5, 5.5)
b) Physical test for Armour tapes (Cl 5.6, 3.11)
c) Test for thickness of insulation and sheaths (Cl.5.7)
d) Physical test for PE Insulation, PE Inner Sheath, PVC Intermediate , Outer Sheath, Screening and other tests on completed cable [Cl. 3.2.4, 3.2.5, 3.3, 3.4, 3.8.3 to 3.8.8, 3.9, 3.10.7, 5.8 except (5.8.8, 5.8.14, 5.8.15, 5.8.17 to 5.8.22, 5.8.24, 5.8.27 to 5.8.31 & 5.8.34)]
e) Visual Inspection and marking (Cl. 3.2.2, 3.2.5, 3.6.2, 4.0 and 5.8.22)
f) Electrical tests (Cl. 5.9) except 5.9.2.4
g) Physical tests for Poly-Al Laminate Tape (Cl. 5.8.37)
h) Test on raw materials
   i) Polythene for Conductor Insulation (Cl. 5.8.14, 5.8.15, 5.8.19 to 5.8.21& 5.9.2.4)
   ii) Filling Compound (5.8.24, 5.8.27, 5.8.28, 5.8.30 to 5.8.32 & 5.8.34)
   iii) Poly-Al Tape (Cl. 3.6)
   iv) Polythene for Inner Sheath (Cl. 3.7.3 i & ii)
   v) Aluminium Wire (Cl. 3.8)
   vi) Barium Chromate Tape (Cl. 3.9.2)
   vii) Galvanised Steel Tape (Cl. 5.6.1 to 5.6.4)
i) Test on Insulated Conductor & compatibility of PE insulation and filling compound (Cl. 5.8.2.3, 5.8.8, 5.8.17,5.8.18, 5.8.29 & Annexure-I (i, ii, iii & iv)
j) In process Test (Cl.3.2.8, 3.7.2, 3.10.6 & 3.12.6)
k) Water Penetration Test (Cl. 5.8.23)

5.2.1 At least two drums shall be taken statistically from the lot. There shall be no failure. Sampling plan for type tests is enclosed as Table-3 (Clause 5.2).

5.3 **ACCEPTANCE TESTS:–** The following shall constitute acceptance tests:

a. Physical Tests for conductor (Cl. 5.5)
b. Physical Tests for Armour Tape (Cl. 5.6)
c. Tests for Thickness of Insulation & Sheath (Cl. 5.7)
d. Physical Tests for PE Insulation, Inner PE Sheath, Intermediate & Outer PVC Sheath & other tests on completed cable (Cl. 3.8.3 to 3.8.8, 3.9, 3.10.7, 5.8.1,5.8.2, 5.8.4, 5.8.11, 5.8.13, 5.8.16,5.8.25, 5.8.26 & 5.8.32)
e. Visual inspection & marking (Cl. 3.3, 3.4,3.11, 3.12, 4.0 & 5.8.22)
f. Electrical Tests (Cl. 5.9 except Cl. 5.9.2.4)
g. Physical Tests for Poly-Al Laminate Tape (Cl. 3.6 except Cl. 3.6.3)
h. Water Penetration Test (Cl. 5.8.23)
i. Any other tests at the description of inspecting authority to ensure that the offer is in conformity with the requirement of the specification.

5.3.1 Sampling plan shall be as Table-2 (Clause 7) .

5.3.2 For conductor diameter and resistance, thickness of insulation, and sheaths, zinc coating of armour tape, fire resistance, high voltage, shrinkage, thermal stability, melt flow index, visual inspection and electrical tests, there shall be no failure.

5.3.3 For annealing, %elongation and tensile strength test of insulation, sheaths and armour, not more than one specimen of a sample shall fail. If more than one specimen of a sample fails, the lot shall be rejected. If only one specimen has failed, two further samples of the same drum shall be tested. There shall be no failure.

5.4 **ROUTINE TESTS:** The following shall constitute Routine Tests: -

a) Physical Tests for conductor (Cl. 3.1.1 to 3.1.5, 5.5)
b) Physical Tests for Armour Tapes (Cl. 5.6)
c) Physical Tests for PE Insulation & Sheath, PVC Intermediate, Outer Sheath& Jelly (Cl. 5.8.1 to 5.8.2, 5.8.4, 5.8.11, 5.8.16, 5.8.22, 5.8.23 & 5.8.32)
d) Electrical Tests (Cl. 5.9 except 5.9.2.4)
e) Spark Test (Cl. 3.2.8, 3.7.2, 3.10.6 & 3.12.6) to be conducted on entire lot of material offered for inspection.
f) Process Flow Chart – to be documented in such a way that linkup/back trace history of each drum shall be identified from the outer sheathing stage to the insulation stage.

5.4.1 Electrical tests except high voltage test (Cl. 5.9.1) & IR (Cl. 5.9.2.2 & 5.9.2.3) to be done on 100% basis. High voltage tests (Cl.5.9.1) & IR tests (Cl. 5.9.2.2 & 5.9.2.3) under routine tests (Cl. 5.4) shall be done at least on 20% of the offered lot for inspection.

5.4.2 The results of routine test shall be made available to the inspecting authority along with the inspection call letter.

5.5 PHYSICAL TEST FOR CONDUCTOR:

5.5.1 DIMENSIONS:

The diameter of the conductor (s) shall be measured on a sample from the finished cable. The measurement shall be made at least at three different points (at intervals of not less than 100mm) with two readings at 90º along the length of the sample. The values shall meet the requirements given in Clause 3.1.1.

5.5.2 ANNEALING TEST:

A sample of wire taken from finished cable, when tested as described in IS:10810 (Part-1), shall have elongation at fracture of not less than 23% for nominal wire diameter of 0.9mm.

5.6 PHYSICAL TEST FOR ARMOUR TAPES:

5.6.1 DIMENSIONS:

The dimensions of armour tapes shall be measured in accordance with the procedure laid down in IS:10810 (Part-36). The measured values shall meet the requirements of Cl. 3.11.5 of this specification.

5.6.2 TENSILE STRENGTH AND ELONGATION TESTS:

5.6.2.1 Steel tapes removed from the completed cable shall be tested as per IS: 10810 (Part- 37) and shall have the following values:-

i) Tensile strength 25 to 45 Kg/Sq mm
ii) Elongation - 10%

5.6.2.2 Steel tapes taken from raw material lot shall be tested as per IS: 10810 (Part-37) and shall have the following values: -

i) Tensile strength 30 to 45 Kg/Sq mm
ii) Elongation - 10%

NOTE: In either case the load shall be increased gradually at a uniform rate and the rate of straining shall not be greater than 75mm/minute.

5.6.3 TESTS FOR ZINC COATING:

5.6.3.1 TEST FOR MASS OF ZINC COATING:

5.6.3.1.1 This test shall be carried out in accordance with the procedure laid down in IS:10810 (Part-41). The weight of zinc coating shall be 210 g/sq.meter on each side.

5.6.3.2 **TEST FOR UNIFORMITY OF ZINC COATING:**

5.6.3.2.1 This test shall be carried out in accordance with the procedure laid down in IS: 10810 (Part-40). The sample shall not show any red deposit of copper upon the base metal with two dips of one minute each in copper sulphate solution prepared as per IS: 2633.

5.6.4 **WINDING TEST (FOR GALVANISED TAPES):**

5.6.4.1 The sample shall be tested in accordance with the procedure laid down in IS:10810 (Part-39). Zinc coating of the tape shall be sufficiently adherent to the base material. Compliance is checked on gauge length of 200 mm. sample. Zinc coating shall show no cracks and no particles of the coating shall be detached by rubbing with a bare finger.

5.6.5 **TEST FOR CLOSENESS OF ARMOUR:**

5.6.5.1 A window shall be cut at least 1.5 meters from the end or at any place in the finished cable without disturbing the armour. The armour shall satisfy Cl. 3.11.2.

5.7 **TEST FOR THICKNESS OF INSULATION AND SHEATHS:**

5.7.1 Determination of the thickness of insulation of round cores and sheath shall be made on a representative sample of the cable approximately one meter long taken from the drum length of the cable.

5.7.2 The measurement in case of conductor insulation, inner, intermediate and outer sheath shall be made at three different points at intervals of not less than 75mm along the length of the sample and at each point the minimum thickness of the insulation, inner, intermediate & outer sheath shall be measured along with two more readings made at equidistant points around the periphery. The minimum thickness at any point and the average thickness at the three points selected shall comply with the requirements given in clauses 3.2.3, 3.7.1, 3.10.2 & 3.12.4.

5.8 **PHYSICAL TESTS FOR PE INSULATION, PE INNER SHEATH, PVC INTERMEDIATE AND OUTER SHEATH:**

5.8.1 **TENSILE STRENGTH AND ELONGATION AT BREAK:**

5.8.1.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-7). The speed of separation of jaws of tensile testing machine shall be between 400 mm to 500 mm/minute. The material shall fulfill the requirements indicated below;

	SHEATHS		INSULATION
a). BEFORE AGEING	PE	PVC	
i) Tensile strength min, kg/cm^2.	70	150	100
ii) Elongation min. %	300	200	300
b). AFTER AGEING			
(In air oven at 80± 2^o C for 168 hours)			
i). Tensile strength min, kg/cm^2.	--	150	-
ii). Elongation min. %	--	200	-

5.8.1.2 The maximum variation after ageing shall be ± 20% of the values obtained before ageing. For test before and after ageing, samples shall be from the same drum. However, values after ageing for tensile strength and % elongation shall not be less than given in clause 5.8.1.

5.8.1.3 The values of all the four samples in case of each sheath shall be averaged and then % variation calculated.

5.8.1.4 For acceptance test, the sample shall be kept in air oven at 130º C ±2ºC for 5 hours.

5.8.1.5 Tensile Strength & Elongation at Break for Polythene Sheath and Insulation shall be carried out before ageing only and value shall comply as per the Table given in sub clause 5.8.1.1

5.8.2 **SHRINKAGE TEST:**

5.8.2.1 This test shall be conducted in accordance with IS: 10810 (Part -12). During test no cracks shall occur.

5.8.2.2 For PVC Intermediate and Outer Sheath shrinkage shall not exceed 2% of original length and temperature shall be 150±2ºC for 15 minutes.

5.8.2.3 For PE Insulation, temperature shall be 100±2ºC for a period of 24 hours and average shrinkage of 4 samples of length 150mm of each colour of insulation shall not exceed 6.35mm.

5.8.2.4 **For PE Sheath tests shall be carried out as under: -**
A sample shall be cut from the cable sheath, 50 mm long measured along the axis, 12mm wide and the same thickness as the cable sheath. The specimen with the laminate removed, shall be placed in a convective type circulating air oven operating at a temperature of 100±1ºC for a period of 24 hours. At the end of this period, the shrinkage as measured in lengthwise direction shall not exceed 5%.

5.8.3 **HOT DEFORMATION TEST:**

5.8.3.1 This test shall be conducted in accordance with IS:10810 (Part-15). The max. depth of indentation shall be 50%. The test temperature shall be 80ºC for four hours. This test shall not be applicable in case of insulation.

5.8.4 **LOSS OF MASS TEST:**

5.8.4.1 This test shall be conducted in accordance with IS:10810 (Part-10). The sample shall be kept in air oven at 80ºC ± 2ºC for 168 hours. The loss of mass shall not be more than 2 mg/ sq cm. This test shall not be applicable in case of insulation.

5.8.4.2 For acceptance test the sample shall be kept in air oven at 130ºC ±2ºC for 5 hours.
The loss of mass shall be within the limits as indicted above.

5.8.5 **COLOUR FASTNESS TO DAYLIGHT EXPOSURE:**

5.8.5.1 This test shall be conducted in accordance with IS:10810 (Part-18). The minimum rating shall be 4. This test shall be applicable in case of PVC intermediate & outer sheath.

5.8.6 **COLOUR FASTNESS TO WATER:**

5.8.6.1 A piece of about 100 mm long is cut into small pieces and immersed for 48 hours in about 10 times its own volume of distilled water at 70ºC ± 2ºC. At the end of the period, the water shall be examined. It shall be free from any trace of colour.

5.8.7 **BLEEDING AND BLOOMING TEST:**

5.8.7.1 This test shall be conducted in accordance with IS:10810 (Part-19). There shall be no appreciable staining of indicator compound. This test shall not be applicable in case of insulation.

5.8.8 **COLD BEND TEST:**

5.8.8.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-20). The sample shall be cooled in air in refrigerator at a temperature of –15ºC ± 2ºC. There shall be no signs of cracks or scales. This test is applicable in case of insulated conductor.

5.8.9 **COLD IMPACT TEST:**

5.8.9.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (part-21). The sample shall be cooled in air in refrigerator at temperature of –5ºC ±2ºC and tested. There shall be no scales or cracks. This test shall not be applicable in case of insulation.

5.8.10 **HEAT SHOCK TEST:**

5.8.10.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-14). The sample shall be placed in an oven at temperature 150ºC ± 2º C for one hour. There shall be no signs of cracks or scales. This test shall not be applicable in case of insulation.

5.8.11 **THERMAL STABILITY TEST:**

5.8.11.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-60). The time taken for the Universal indicating paper to change colour from a pH value of 5 to a pH value of 3 shall be measured, or the test continued for the specified duration without the colour change occurring. The colour change point shall be considered to have been reached when the red colouring of the universal indicating paper characteristic of a pH value of 3 is just becoming visible. The universal indicating paper shall be renewed towards the end of the expected time every 5 to 10 minutes, so that the change point is better visible.

5.8.11.2 The time taken for the universal indicating paper to change colour from a pH value of 5 to a pH value of 3 shall be 40 minutes in case of sheaths. However, this test is not applicable in case of insulation.

5.8.12 For tests from clause 5.8.3 to clause 5.8.11, at least of two samples shall be taken from each type of material in each colour used. There shall be no failure.

5.8.13 **FLAME RETARDANT TEST (FIRE RESISTANCE TEST):**

5.8.13.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-61). After the test there shall not be visible damages on the test specimen within 300 mm from its upper end.

5.8.14 **MELT FLOW INDEX TEST:**

5.8.14.1 The test shall be conducted in accordance with the procedure laid down in IS: 10810 (Part-23). The maximum Melt Flow Index shall be as per clause 3.2.1 and 3.7.3.

5.8.15 **VISCAT SOFTENING POINT TEST:**

5.8.15.1 This test shall be conducted in accordance with the procedure laid down in IS:10810 (Part-22). Viscat softening point shall be minimum 85ºC. This test shall not be applicable in case of sheaths.

5.8.16 **BEND TEST:**

5.8.16.1 The bend test shall be carried out on a sample of finished cable with open ends. The sample shall be bent around a drum having diameter 10 times that of finished cable to make one complete turn. It shall then be unwound and the process repeated in the opposite direction. This cycle of operation shall be carried out twice.

5.8.16.2 The length of sample shall be sufficient to give at least one complete turn around the test drum. The bending shall be carried out at reasonably uniform speed between 15 and 30 seconds per half cycle.

5.8.16.3 The cable shall, on close examination, reveal that the cable serving is free from splits, the armour not noticeable displaced and the sheaths free from splits and cracks.

5.8.17 **RESISTANCE TO COMPRESSION TEST:**

5.8.17.1 Two lengths of insulated conductor shall be uniformly twisted so that there are 10 x 360º twists of 100 mm. Not more than 50 mm. in the middle of the twisted pair shall be placed between the flat rigid metal plates coated with polythene on the inside surface. A compressive force of minimum 200N shall be applied between the plates. One minute after the application of the force, there shall be no electrical contact between the insulated conductor. The contact test shall be made at 12 volts DC with a suitable indicator.

5.8.18 **RETRACTION OF INSULATION TEST:**

5.8.18.1 Retraction of insulation on insulated conductor when cut at a point not less than one meter from one end at room temperature shall not exceed 2.5 mm after one minute.

5.8.19 **DENSITY TEST:**

5.8.19.1 The density of the Polythylene insulation shall be tested in accordance with the procedure laid down in ASTM:D 1248. For MDPE (Type-II) the density shall be between 0.926gm/cc to 0.940gm/cc and for HDPE (Type-III) density shall be 0.941gm/cc to 0.959 gm/cc.

5.8.20 **POWER FACTOR TEST:**

5.8.20.1 The Power Factor of the Polythene Insulation shall be tested in accordance with the procedure laid down in ASTM: D-1248 and maximum Power Factor shall be 0.0005 at 1 MHz . This test is applicable on PE insulation moulded sheet made from the raw material PE granules.

5.8.21 **PERMITIVITY TEST:**

5.8.21.1 The permittivity of polythene insulation shall be tested in accordance with procedure laid down in ASTM D – 1248. The maximum permittivity shall be 2.35 at 20 degree C and at 1 MHz. This test is applicable on PE insulation moulded sheet made from the raw material PE granules.

5.8.22 **VISUAL INSPECTION TEST:**

5.8.22.1 The physical condition of the cable shall be visually inspected by transferring it to another drum. The cable shall be reasonably circular throughout its length and shall be free from any physical defects. The whole length shall comply the requirements of clauses 3.11.1 to 3.11.4, 3.12.1, 3.12.3, 3.12.6 & 4. The measured length of cable on any drum shall not be less than one meter of the declared length.

5.8.23 **WATER PENETRATION TEST:**

One metre of cable shall be supported horizontally and one metre head of water shall be applied for 14 days (type test) and 7 days (acceptance test) at ambient temperature. During this time no water shall have seeped from the cable sample. The test shall be conducted as per method out lined in Annexure – A (IV)

5.8.24 **FLASH POINT :** (Applicable for filling compound i.e. Jelly)

The flash point of filling compound (petroleum jelly) when tested as per ASTM D 92 shall not be less than 200 degree C.

5.8.25 **CARBON BLACK CONTENT :** (Applicable on Inner PE Sheath)

The Carbon Black Content of inner PE sheath shall be determined as per BS: 6234 and shall be 2.5% ±0.5% by weight.

5.8.26 **CARBON BLACK DISPERSION:** (Applicable on Inner PE Sheath)

The Carbon Black Dispersion in inner PE sheath shall conform to BS: 6234 and shall not be more than rating four.

5.8.27 **COLOUR:** (Applicable on filling compound i.e. Jelly)

The compound shall not obscure the identification of the colour of insulation of the conductors

5.8.28 **HANDLING:** (Applicable on filling compound i.e Jelly)

Compound shall be readily removable from the insulated conductors by wiping. It shall be free from unpleasant odour and have no toxic or dermatic hazards. Supplier's certificate shall be submitted by the Cable Manufacturer.

5.8.29 **THERMAL STRESS CRACKING:** (Applicable on insulated conductor taken from insulated bobbins)
10 lengths of insulated conductor of 10cm each removed from the insulated bobbins of each colour obtained after extrusion from the extruder shall be wrapped on their own diameter with a minimum of 10 contiguous turns closely wound in a length of 2cm at 70±1ºC for 14 days. After the period they shall be removed from the oven and observed for cracks with naked eyes. There shall be no cracks.

5.8.30 **VOLUME RESISTIVITY:** (Applicable for filling compound i.e. jelly).
The volume resistivity measured at 100 degree C by the method described in ASTM D 1169 or any other approved method shall not be less than $1x10^{10}$ ohm – cm.

5.8.31 **PERMITTIVITY**: (Applicable for filling compound i.e. jelly)
The Permittivity at 1 MHz when tested as per ASTM: D-924 shall not be greater than 2.3 at 20° C.

5.8.32 **SPECIFIC DENSITY:** (Applicable for filling compound i.e. jelly)
The value of specific density of jelly at raw material stage shall between 0.90± 0.05 gm/cc at 25°C and for jelly removed from the finished cable shall be between 0.90± 0.09 gm/cc at 25°C.

5.8.33 **DRIP TEST:** (Applicable on completed cable):
When tested as the method described in Annexure-A (II) of the specification, there shall be no dripping of Filling Compound.

5.8.34 **STABILITY:** (Applicable on Filling Compound i.e. Jelly).
When held at a temperature of 65±1ºC for 5 days, the compound shall not show any separation of the constituents of the filling compound. The tests shall be conducted as per method outlined in Annexure-A (I).

5.8.35 **ENVIRONMENTAL STRESS CRACKING:** (Applicable for inner PE sheath of completed cable)
Test specimen without laminate cut from the polythene inner sheath shall be subjected to an environmental stress cracking test as described in ASTM: D1693 when tested with 10% IGEPOL solution at 50 ±1º C for 48 hours. There shall be no failure.

5.8.36 **OXIDATION INDUCTION TIME TESTS:** (Applicable for each colour of PE Insulation and Inner PE sheath taken from completed cable).
The induction time on oxygen when tested with copper pan as per the method described in Annexure-A (V) of this specification shall not be less than 15 minutes in case of polythene sheath and shall not be less than 30 minutes in case of each colour of polythene insulation removed from the finished cable.

5.8.37 **BOND STRENGTH:** (Applicable on Poly-Al bonded inner PE sheath from completed cable)
The bond strength of the Poly-Al Laminate to the Polythene Sheath and at the overlap shall meet the requirements indicated in Annexure-A (III) of the specification.

5.9 **ELECTRICAL TESTS:**

5.9.1 **HIGH VOLTAGE TEST:**

5.9.1.1 This test shall be conducted on complete drum length. The cable shall withstand an AC voltage of 2 KV (rms). The AC voltage used for testing shall be approximately of sine waveform at a frequency between 40 and 60 Hz.

5.9.1.2 The insulation shall be capable of withstanding for ten seconds without intermittent or permanent breakdown, when the above voltage is applied between a conductor and all other conductors bunched together.

5.9.1.3 All the conductors shall be bunched together and 2 KV rms applied between them and the steel armouring connected with screening wires for ten seconds. There shall be no intermittent or permanent breakdown of the dielectric.

5.9.2 **INSULATION RESISTANCE TEST:**

5.9.2.1 This test shall be carried out on drums which have been subjected to the high voltage test.

5.9.2.2 Insulation resistance test may be conducted on factory length between each conductor and all other conductors in accordance and shorted with the armouring in air at the prevailing temperature. The drum shall be in the test room at a reasonably constant temperature for sufficient time to ensure that the core insulation is at ambient temperature. The DC test voltage shall be 500 volts and shall be applied for one minute. The value of insulation resistance shall not be less than 5000 mega ohms/Km at room temperature irrespective of the size of the conductor.

5.9.2.3 **WET IR TESTS:**
A three-meter length of cable shall be taken and all cores removed without damage to the insulation. These cores shall be immersed in water at 50±2º for a period of not less than 2 hours. The insulation resistance between each conductor and water in which the cores are immersed shall than be measured by using a suitable insulation tester. The measurement of insulation shall be made after one-minute electrification at 500 volt DC. The value of insulation resistance shall not be less than 5000 Mega ohm per km.

5.9.2.4 **VOLUME RESISTIVITY:** (Applicable on PE insulation moulded sheet made from the raw material PE granules.)
The volume resistivity at room temperature shall be conducted on Polythelene Insulation in accordance with the procedure laid down in ASTM: D 257. The volume resistivity shall not be less than $1x10^{15}$ Ohm-cm.

5.9.3 **CONDUCTOR RESISTANCE TEST:**

5.9.3.1 Conductor resistance shall be measured on complete length. The cable drum under test shall be at reasonably constant temperature for sufficient time to ensure that the cable temperature is equal to the ambient temperature. The measurement shall be carried out to an accuracy of at least one part in hundred.

5.9.3.2 The DC resistance of the conductor shall be measured at room temperature. It shall be corrected to 20º C by means of the appropriate factors given in Table-1.

5.9.3.3 The corrected resistance shall not exceed the value given in Cl. 3.1.1.

5.9.3.4 The maximum loop resistance of any pair in a finished cable shall not exceed the average value by more than 2%.

5.9.3.5 The maximum specific resistance of the conductor shall be 17.241 ohm cm.

5.9.4 **MUTUAL CAPACITANCE TEST:**

5.9.4.1 The mutual capacitance of the pairs shall have nominal value of 0.05 microfarad per Km. In any length the average value of mutual capacitance of all the pairs shall not differ by more than ± 5% from nominal value. The mutual capacitance of any pair shall not differ by more than ± 12% from the nominal value.

5.9.5 **CAPACITANCE UNBALANCE TEST:**

5.9.5.1 The capacitance unbalance measurements between pairs in the same quad and between pairs in the adjacent quads shall be made for all the pairs at 800 Hz to 1000 Hz at ambient temperature on each length of cable. All conductors other than those under test shall be connected to the screen and earthed.

5.9.5.2 The capacitance unbalance/km shall not exceed the value given below:

Between pairs in the same quad - 300 pf
Between pairs in the adjacent quad - 300 pf
Between any pair and earth - 1500 pf

Length shorter than 500 meters shall satisfy the same condition as length of 500 meters.

5.9.6 **CHARACTERISTIC IMPEDANCE:**

5.9.6.1 The characteristic impedance of any pair shall be in accordance with the table below :

Conductor diameter	Frequency	Characteristic impedance
mm.	KHz.	Ohms ± 15 %
0.90	0.8	470
0.90	5.0	195

5.9.7 **CROSS TALK TEST:**

5.9.7.1 The cross talk test shall be carried out at 150 KHz.

5.9.7.2 **FAR END CROSS TALK :**

5.9.7.2.1 **FAR END CROSS TALK (ELFEXT):**

The RMS and individual value shall be better than 67.8 dB/km and 55.0 dB/km respectively.

The RMS dB is given by

$$\text{RMS (dB)} = 10 \log_{10} \left[\frac{\sum 10^{-m(i,j)/10}}{n} \right]$$

where m (i,j) = cross talk value between the i and j pairs

n = number of pair combinations

5.9.7.2.1.1 For lengths other than 1 Km, the measured value shall be corrected by 10 $\log_{10}$L/1000, L being the cable length, tested in meters

5.9.7.3 **NEAR END CROSS TALK:**

5.9.7.3.1 The near end cross talk between adjacent pairs shall be better than 55 dB.

5.9.8 **ATTENUATION TEST:**

5.9.8.1 The test shall be conducted at 150 KHz. The average attenuation of the pairs shall not exceed the value listed below at 20º C.

Conductor diameter	Attenuation
0.90 mm	4.4 dB/Km

Attenuation at 20ºC = Attenuation at TºC/ {1+0.0018 (T-20)}

T being the ambient temperature.

5.9.8.2 The value of attenuation shall not exceed 2 dB/km for any frequency in the frequency range 300 Hz – 3400 Hz at 20°C.

5.9.9 **REDUCTION FACTOR TEST:**

5.9.9.1 The reduction factor shall be measured in accordance with Cl. 507 of VDE specification 0472/6.65.

5.9.9.2 The screening of the cable shall be suitable so as to give a reduction factor in the field intensity of 50 volts to 450 volts per km as specified below :

Conductor diameter in mm	Reduction factor (maximum)
0.90	0.10

6. PACKING:

6.1 The cable shall be wound on strong wooden drums of suitable size treated with ASCU fungicide. The timber used for the manufacture of drums shall be seasoned, reasonably straight grained, uniform in thickness, free from insect attack, splits, warping and other defects which may reduce the overall strength of the drums.

6.2 The drums shall be of general construction as shown in Fig.3. The dimensions D, X, X_1 and Y shall be suitable for the size of the cable and the ratio of X_1 to Y shall not be greater than 0.65. Dimensions D shall not be less than 20 times the overall diameter of the cable. The size of drum must be such that the cable when packed the outer most layer of cable is 50 mm below the flange tip.

6.3 Nails used in the manufacture of the drums shall be of the clout headed type to IS:723. They shall be properly clenched and shall be so driven as to avoid splitting of the wood. The end shall not protrude into the surface where the cable has to be wound.

6.4 The thickness of batons fitted on the circumference of the cable drum shall not be less than 25 mm and the gap between the batons shall not be more than 5 mm to cater for unevenness in the wooden surface.

6.5 Flange made of wooden planks shall not be less than 25 mm thick. Wooden planks shall be closely fitted and gap in between planks shall not be more than 5 mm to cater for unevenness in the wooden surface.

6.6 Steel boss shall be fitted with its diagonal at right angles to wooden planks of flange and shall not be fitted over not less than 2 wooden planks of flange.

6.7 Steel boss shall be painted with red oxide.

6.8 Hexagonal head bolts shall be used for fitting of steel boss. The bolt diameter shall not be less than 10 mm.

6.9 Steel strapping of not less than 12mm wide and 0.6mm thick shall be used.

6.10 **MANUFACTURED LENGTH:**

Unless otherwise specified, the cable shall be supplied either in length of 500 meters or 1000 meters. The tolerance shall be +5%, -2% irrespective of the length of cable. Non-standard length, each not less than 200 meters shall be acceptable up to 2% of the total quantity ordered. Unless otherwise specified by the purchaser the tolerance on total quantity shall be ± 2%.

6.11 Before dispatch the drums shall be effectively lagged with suitable closely fitted batons of thickness 25 mm minimum. Every baton shall be secured to prevent it from getting displaced or damaged during transit and storage. The lagging shall further be strengthened by steel straps bound circumferentially over the drum. The steel strapping of not less than 12 mm wide and 0.6mm thick shall be used.

6.12 The flange portion of drum shall be made of two batons. The thickness of each baton shall be 25 mm for flange dia. upto 1070 mm. If the flange dia. exceeds 1070 mm, the baton thickness shall be 37.5 mm.

6.13 The batons on the drums to be removed for obtaining access to the cable end shall be painted red.

6.14 Both the ends of the cable shall be firmly secured and brought to the outer layer of the drum with suitable protective arrangement to prevent damage during testing and transit. In the inside portion of one side flange, suitable arrangement to guide lower end of the cable upto the top must be provided. The initial and final sequential length marking shall be properly visible at the outer layer. The batons coming above the top and bottom SLM shall be marked with red paint.

7. SAMPLING:

7.1 All cable drums having cable of same conductor diameter, number of cores and similar construction shall constitute a lot.

7.2 For taking samples, drums shall be chosen at random from the lot. From each of these drums, one sample of cable shall be taken. The length of the sample shall be sufficient so as to provide test pieces of required length as laid down in various test clauses.

7.3 The number of drums to be random selected for taking samples shall be as per column 3 of table 2. The number of drums has been expressed as a percentage of the total number of drums in the lot.

7.4 The number of the test pieces to be taken from each sample shall be as per column 4 of Table 2.

7.5 The lot shall be offered to the inspecting authority within two months of the month of manufacture.

8. INFORMATION TO BE SUPPLIED BY THE PURCHASER:

8.1 IRS Specification number. (Default number IRS:TC 30-05)
8.2 Number of quads – Four quads or six quads. (Default 6 quads)
8.3 Size of conductor. (Default 0.9mm)
8.4 Any other requirements. (Default cable length 1000 meters)

In case any of the above information is not provided by the purchaser, default value shall be assumed.

TABLE-1

TEMPERATURE CORRECTION FACTOR FOR CONDUCTOR RESISTANCE FOR ANNEALED HIGH CONDUCTIVITY COPPER (Clause 3.1.1)

Temp. Deg C 1.	Correction factor 2.	Temp. deg C 1.	Corre. Factor 2.	Temp deg C 1.	Corre. factor 2.	Temp. deg C 1.	Corre. factor 2.	Temp. deg C 1.	Corre. Factor 2
5.	1.0638	17	1.0122	29	0.9653	41	0.9225	53	0.8834
5.5	1.0618	17.5	1.0101	29.5	0.9634	41.5	0.9208	53.5	0.8818
6.	1.0593	18	1.0081	30	0.9615	42	0.9191	54	0.8803
6.5	1.0571	18.5	1.0060	30.5	0.9597	42.5	0.9174	54.5	0.8787
7.	1.0549	19.	1.0040	31.	0.9579	43.	0.9158	55.	0.8772
7.5	1.0526	19.5	1.0020	31.5	0.9560	43.5	0.9141	55.5	0.8757
8.	1.0504	20.	1.0000	32.	0.9542	44..	0.9124	56.	0.8741
8.5	1.0482	20.5	0.9980	32.5	0.9524	44.5	0.9107	56.5	0.8726
9.	1.0460	21.	0.9960	33.	0.9506	45.	0.9091	57.	0.8711
9.5	1.0438	21.5	0.9940	33.5	0.9488	45.5	0.9074	57.5	0.8696
10.	1.0417	22.	0.9920	34.	0.9470	46.	0.9058	58.	0.8681
10.5	1.0395	22.5	0.9900	34.5	0.9452	46.5	0.9048	58.5	0.8667
11.	1.0373	23.	0.9881	35.	0.9434	47.	0.9025	59.	0.8651
11.5	1.0352	23.5	0.9862	35.5	0.9416	47.5	0.9009	59.5	0.8636
12.	1.0331	24.	0.9843	36.	0.9398	48.	0.8993	60.	0.8621
12.5	1.0309	24.5	0.9823	36.5	0.9380	48.5	0.8977	60.5	0.8606
13.	1.0288	25.	0.9804	37.	0.9363	49.	0.8961	61.	0.8591
13.5	1.0267	25.5	0.9785	37.5	0.9346	49.5	0.8945	61.5	0.8576
14.	1.0246	26.	0.9766	38.	0.9328	50.	0.8929	62.	0.8562
14.5	1.0223	26.5	0.9747	38.5	0.9311	50.5	0.8913	62.5	0.8547
15.	1.0204	27.	0.9728	39.	0.9294	51.	0.8897	63.	0.8532
15.5	1.0183	27.5	0.9709	39.5	0.9276	51.5	0.8881	63.5	0.8518
16.	1.0163	28.	0.9690	40.	0.9259	52.	0.8863	64.	0.8503
16.5	1.0142	28.5	0.9671	40.5	0.9242	52.5	0.8850	64.5	0.8489

Table-2: SAMPLING PLAN FOR ACCEPTANCE TEST (Clause 7) No. IRS: TC 30-05

SN	Tests	Sample size (Nos. of drums)	Nos. of test pieces to be taken from each sample.
1.	Conductor diameter (Cl.5.5.1)	10% subject to minimum one drum from each lot.	All insulated conductors
2.	Overlap & continuity of Poly-Al Tape (Cl. 3.6.1 & 3.6.2)	-do-	One sample from each sampled drum..
3.	Annealing test (Cl. 5.5.2)	-do-	All Insulated conductors.
4.	T.S. & % Elongation of Armour (Cl.5.6.2.1)	-do-	Both the tapes from each sampled drum.
5.	Winding test (Cl.5.6.4)	-do-	-do-
6.	Mass of Zinc coating test (Cl. 5.6.3.1)	-do-	-do-
7.	Uniformity of zinc coating (Cl. 5.6.3.2)	-do-	-do-
8.	Dimensions of Steel Tapes (Cl. 5.6.1)	-do-	-do-
9.	Test for closeness of tapes (Cl. 5.6.5)	-do-	Both the tapes from each sampled drum.
10.	Thickness of insulation and sheaths (Cl. 5.7)	-do-	100% of the sampled drum.
11.	T.S. & % Elongation of PVC sheaths (Cl. 5.8.1) i) Before ageing ii) After ageing	 4% subject to minimum of one drum from each lot. -do-	 4 samples each from each sheaths from sampled drums -do-
12.	Loss of Mass test of sheaths (Cl. 5.8.4)	4% subject to minimum of one drum from each lot.	-do-
13.	T.S. & % Elongation of insulation (Cl. 5.8.1)	10% subject to minimum of one drum from each lot.	Minimum two samples from each colour used.
14.	Shrinkage test of PE insulation (Cl. 5.8.2.3)	4% subject to minimum of one drum from each lot.	Min. four samples of each colour from each sampled drum.
15.	Shrinkage test of PVC sheaths (Cl. 5.8.2.2)	4% subject to minimum of one drum from each lot.	Minimum one sample from each sampled drum.
16.	Thermal stability test of PVC sheaths (Cl. 5.8.11)	Min. of 1drum from each lot Max. of 2 drums from each lot	Minimum two samples from each sheath for each sampled drum.
17.	Bend test (Cl. 5.8.16)	Min. of 1 drum from each lot Max. of 2 drums from each lot	One sample from sampled drum.

18.	Density/specific gravity of PVC Sheaths (Cl. 3.10.7)	4% subject to min. of one drum from each lot.	Min. one sample from each sampled drum.
19.	T.S. & % Elongation of PE sheath before ageing only (Cl. 5.8.1.5)	4 % subject to min. of one drum from each lot.	Min. two samples from each sampled drum.
20.	Shrinkage test of PE sheath (Cl. 5.8.2.4)	4% subject to min. of one drum from each lot.	Min. one sample from each sampled drum.
21.	Number of size, compactness & lay direction of aluminium wires (Cl. 3.8.3, 3.8.4 & 3.8.6)	10% subject to min. of 1 drum from each lot.	All sampled drums.
22.	Tensile strength of aluminium wires/ strips/ welded aluminium tubing (Cl. 3.8.5)	10 % subject to min. of 1 drum from each lot.	Minimum 5 wires or 2 strips/tubing from each sampled drum.
23.	Drift Expansion test of welded aluminium tubing (Cl. 3.8.7)	5% subject to min. of 1 drum from each lot.	Min. 2 samples from each sampled drum.
24.	Flattening test of welded aluminium tubing (Cl. 3.8.8)	-do-	-do-
25.	Dimensions & Overlap of Barium Chromate Tape (Cl. 3.9)	10 % subject to min. of 1 drum from each lot.	All sampled drums.
26.	Flame Retardant Test (Cl. 5.8.13)	4% subject to min. of one drum from each lot.	Min. one sample from each sampled drum.
27.	Visual Inspection test (Cl. 5.8.22, 3.3 & 3.11)	5% subject to min.2 drums from each lot.	All sampled drums.
28.	Conductor resistance & loop resistance tests (Cl. 5.9.3) except 5.9.3.5	20% subject to minimum 2 drum from each lot.	All insulated conductors & pairs of all quads of sampled drums.
29.	High voltage tests (Cl. 5.9.1)	-do-	All insulated conductors
30.	Mutual capacitance test (Cl. 5.9.4)	-do-	-do-
31.	Capacitance unbalance test (Cl. 5.9.5)	-do-	-do-
32.	Characteristic impedance test (Cl. 5.9.6)	-do-	-do-
33.	Cross-talk test (Cl. 5.9.7)	-do-	-do-
34.	Attenuation test (Cl.5.9.8)	-do-	-do-
35.	Insulation resistance test (Dry) (Cl.5.9.2.1 & 5.9.2.2)	-do-	-do-

36.	Reduction factor test (Cl. 5.9.9)	5% subject to minimum of 2 drums from each lot.	2 conductors from one drum. The conductors may be selected randomly without repeating the same colour code or conductor from drums in the lot.
37.	Water Penetration Test (Cl. 5.8.23)	20% subject to minimum of 5 drums from each lot.	All sampled drums.
38.	Insulation Resistance Test (Wet) (Clause No. 5.9.2.3)	4% subject to minimum of 1 drum from each lot.	Minimum one conductor selected from each colour of insulated conductor of sampled drum.
39.	Carbon Black Content of PE inner sheath (Cl. 5.8.25)	Minimum of 1 drum from each lot.	All sampled drums.
40.	Carbon Black Dispersion of PE inner sheath (Cl. 5.8.26)	Minimum of 1 drum from each lot.	All sampled drums.
41.	Drip test (Cl. 5.8.33)	Minimum of 1 drum from each lot.	Minimum one sample each from inner and outer end of the sampled cable drum.
42.	Water Penetration Test (Cl. 5.8.23) (from middle portion of the drum)	Minimum of 1 drum from each lot. (One meter sample to be taken from exactly middle portion of the sampled cable drum).	One sample from the sampled drum from the lot.
43.	Conductor diameter (Cl.5.5.1)	Minimum of 1 drum from each lot. (Sample taken for W.P.T test at S.No. 42 shall be tested).	All insulated conductors.
44.	Overlap & continuity of Poly-Al Tape (Cl. 3.6.1 & 3.6.2)	Minimum of 1 drum from each lot. (Sample taken for W.P.T test at S.No. 42 shall be tested).	Minimum one sample from each sampled drum.
45.	Specific resistance tests (Cl. 5.9.3.5)	4% subject to minimum of one drum from each lot.	One sample of each colour of insulation from sampled drums.
46.	Specific Density of jelly (Cl. 5.8.32)	Minimum of one drum from each lot.	Minimum one sample from each sampled drum.

NOTE:- The shortage in cable drum length on account of tests at S.No. 42 to 44 above shall be accepted as good length in the lot in addition to short length permissible in the specification.

TABLE-3 : SAMPLING PLAN FOR TYPE TEST (CLAUSE 5.2)

I. RAW MATERIALS

SN	Raw Material	Cl. No. Of Spec.	Test	Sampling
1.	Polythene for conductor insulation	3.2.1, 5.8.19	Density	1 sample from the same bag used for manufacturing cable for type test.
		3.2.1,5.8.14	Melt Flow Index	- do -
		5.8.20	Dissipation factor (Power factor)	- do -
		5.8.21	Permittivity (Dielectric constant)	- do -
		5.9.2.4	Volume resistivity	- do -
		5.8.15	Viscat softening point test	- do -
2.	Filling Compound	5.8.34	Stability	1 sample from the jelly barrel used for manufacturing cable for type test.
		5.8.28	Handling/ Toxic / dermatic hazards	Compound supplier's test certificate to be furnished.
		5.8.30	Volume resistivity	1 sample from the jelly barrel used for manufacturing cable for type test.
		5.8.32	Specific Density	- do -
		5.8.31	Permittivity	- do -
		5.8.24	Flash point	- do -
		5.8.27	Colour	- do -
3.	Poly-Al Tape Laminate.	3.6.1	Thickness	5 samples from the coil used for manufacturing cable for type test
		3.6.3	Peel strength	- do -
4.	Polythene for inner sheath	3.7.3(i)	Melt Flow index	1 sample from the bag used for manufacturing cable for type test
		3.7.3(ii)	Density	- do -

5.	Aluminium wires/strips/welded aluminium tubing for screening	3.8.2	Purity of Aluminium	Supplier's tests certificate to be furnished or the test to be performed if facility exists at firm's premises.
		3.8.5	Tensile strength	5 samples each from wires/strips/welded aluminium tubing from the coil/lot used for manufacturing cable
6.	Barium Chromate Tape	3.9.2	Thickness & Width	5 samples from coil used for manufacturing cable for type test.
7.	Galvanized Steel Tape	Cl. 5.6.1 & 3.11.5	Dimension (Thickness & Width)	5 samples from coil used for manufacturing cable for type test.
		5.6.2.2	Tensile strength	- do -
		5.6.2.2	Elongation at break	- do -
		5.6.3.2	Dip test (Test for uniformity of zinc coating)	- do -
		5.6.3.1	Mass of zinc coating	- do -
		5.6.4	Winding test	- do -

II. PHYSICAL TESTS ON COPPER CONDUCTORS:

SN	Clause No.	Test	Sampling
1.	5.5.1 & 3.1.1	Conductor diameter	All insulated conductors from both the drums of 6 Quad & 4 Quad Cable.
2.	5.5.2	Annealing of copper conductor	-do-
3.	3.1.2 & 3.1.3	Circularity of copper conductor in cross section, uniform in quality, free from splits, cracks, corrosion and other surface infection. No joint shall be made in copper conductor. Joint can be made in exceptional cases. In that case, the manufacturer has to give details of joints made in conductor during routine test.	-do-
4.	3.1.4 & 3.1.5	Resistance and tensile strength with and without joint.	One joint each in each colour of insulated conductors to be made from both the drums of 6 & 4 Quad cables.

III. INSULATED CONDUCTORS & COMPATIBILITY OF FILLING COMPOUND (EACH COLOUR TO BE TESTED)

SN	Clause No.	Test	Sampling
1	5.8.17	Resistance to compression	No. of sets such that at least one conductor for each colour is tested.
2	5.8.18	Retraction of insulation	One sample from each bobbin of each colour of insulation.
3	5.8.2.3	Shrink back of insulation	A minimum of 4 samples of each colour of insulated conductor from each bobbin.
4	5.8.8	Cold bend	10 samples of each colour of insulated conductor from each bobbin.
5	5.8.29	Thermal stress cracking	-do-
6	Ann.I – (i)	Absorption of Filling Compound	One set (approx. 20 samples) each colour of insulation from each bobbin.
7.	Ann.I – (ii) Ann.I-(iii)	Tensile strength & Elongation at break (i) Before ageing (ii) After ageing	(i) 10 samples of each colour of insulation from each bobbin (ii) 10 samples of each colour of insulation shall be taken from the samples tested for absorption
8	Ann.I- (iv)	Environmental stress cracking	10 samples each of each colour of insulated conductor from each bobbin.

IV. IN-PROCESS PRODUCTION TESTS:

SN	Clause Number	Tests	Sampling
1	3.2.8	Spark test on insulated conductor	Manufacturing records to be checked up
2	3.7.2	Spark test on inner Polythene sheath	-do-
3	3.10.6	Spark test on PVC intermediate sheath	-do-
4	3.12.6	Spark test on PVC outer sheath	-do-

V. TESTS ON COMPLETED CABLES:

SN	Clause Number	Tests	Sampling
1.	3.2.3	Thickness of PE insulation & dia of insulated conductors.	All insulated conductors of both the drums.
	3.2.4, 3.2.5,3.3 & 3.4	Colour, & lay of pairs of each Quad	Both the drums of 6 Quad & 4 Quad Cables.
2.	3.6.1	Overlap of Poly-Al Tape	-do-
	3.6.2	Continuity of Poly-Al Tape	-do-
3.	5.8.33 (Annexure-A (II)	Drip test	One sample each from each end from both the drums of 6 and 4 Quad cables.
4.	5.8.32	Specific Density of Jelly	Minimum one sample from the offered lot.
5.	5.8.36 (Annexure-A (V))	Oxidation Induction test	One sample each of each colour of insulation from both the drums of 6 and 4 Quad cables.
6.	5.8.37 (Annexure. A (III))	Bond strength between i) Poly-Al at Over lap	5 samples each from both the drums of 6 and 4 Quad cable
		ii) Poly-Al & Sheath	-do-
7.		Polythene for Inner Sheath	
	3.7.1	Thickness	Both the drums of 6 & 4 Quad cables.
	5.8.1.1 a (i)	i) Tensile Strength	4 samples each from both the drums of 6 and 4 Quad cables.
	5.8.1.1a (ii)	ii) Elongation at Break	-do-
	5.8.35	iii) Environmental Stress Cracking (ESCR)	2 samples each from sheath from both the drums of 6 and 4 Quad cables.
	5.8.2.1 & 5.8.2.4	iv) Shrinkage	-do-
	5.8.25	v) Carbon Black Content	1 Sample each from sheath from both the drums of 6 Quad & 4 Quad cables.
	5.8.26	vi) Carbon Black Dispersion	-do-
	5.8.36	vii) Oxidation Induction	-do-

	(Annexure-A (V))	test	

8.	3.9	Protection (Barium Chromate Tape)	
	3.9.1	Overlap	Both the drums of 6 and 4 Quad cables.
	3.9.2	Width	Both the drums of 6 and 4 Quad cables.
	3.9.2	Thickness	Both the drums of 6 & 4 Quad Cables.
9.	3.8	Screening (Aluminium)	.
	3.8.3 & 3.8.6	Laying of Al Wire	Both the drums of 6 quad and 4 quad cables.
	3.8.4	Compactness of Al Wire	-do-
	3.8.5	Tensile strength	Minimum 10 wires or 5 strips/welded aluminium tubing from both the drums of 6 and 4 Quad Cables.
	3.8.7	Drift Expansion Test	5 samples each of welded aluminium tubing from both the drums of 6 Quad & 4 Quad cables.
	3.8.8	Flattening Test	-do-
10.	5.6	Galvanized Steel Tape	
	3.11.2	Gap in the application of the first tape	Both the drums of 6 and 4 Quad cables.
	3.11.2	Overlap of 2nd tape over the first one on either side	-do-
	3.11.5	Thickness	2 Samples each from inner and outer steel tape from both the drums of 6 and 4 quad cable
	5.6.2.1	Tensile strength	-do-
	5.6.2.1	Elongation at break	-do-
	5.6.3.2	Dip Test (test for uniformity of zinc coating)	-do-
	5.6.3.1	Mass of zinc coating	-do-

	5.6.4 5.6.5	Winding test Closeness & direction of lay of Armour	-do- Both the drums of 6 Quad & 4 Quad Cables.
11.		PVC Intermediate, Outer Sheath , PE Insulation & Inner Sheath	
	3.10.7	Density of PVC Inter & Outer Sheaths	2 Samples from each sheath from both the drums of 6 & 4 Quad cables.
	3.10.2 & 3.12.4	Thickness of PVC Inter & Outer Sheaths.	4 Samples each from PVC intermediate and outer sheath from both the drums of 6 and 4 Quad cables
	5.8.1.1 (a) Before ageing	Tensile Strength and Elongation at Break	-do-
	5.8.1.1 (b) After ageing for PVC, Intermediate & Outer sheath	-do-	-do-
	5.8.1.1(a)(i)(ii) before aging for PE insulation	-do-	Minimum 4 samples from each colour of PE insulation from both the drums of 4 Quad cable.
	5.8.2.1& 5.8.2.2	Shrinkage test for PVC Intermediate and Outer Sheaths	1 Sample each from PVC intermediate & outer sheath from both the drums of 6 Quad & 4 Quad.
	5.8.2.1 & 5.8.2.3	Shrinkage test for PE Insulation	4 Samples each from each colour of insulation from both the drums of 6 Quad & 4 Quad cables.
	5.8.2.1 & 5.8.2.4	Shrinkage test for PE Inner Sheath	2 Samples each from both the drums
	5.8.3	Hot Deformation	1 Sample each from PVC intermediate & outer sheath of both the cables of 6 Quad & 4 Quad.
	5.8.4	Loss of Mass (before and after ageing)	4 Samples each from PVC intermediate and outer sheath from both the drums of 6 and 4 Quad cables
	5.8.5	Colour Fastness to day	1 Sample each from PVC intermediate

		Light Exposure	and outer sheath from 6 Quad & 4 Quad cable.
	5.8.6	Colour Fastness to Water	1 Samples each from each colour of insulation from both the drums from 6 Quad and 4 Quad cables.
	5.8.7	Bleeding and Blooming tests	1 Sample each from inner PE sheath, PVC intermediate and outer sheath from both the drums of 6 Quad and 4 Quad Cables. & 1 Sample each of each colour of insulation from both the drums of 6 & 4 Quad cables.
12.	5.8.9	Cold Impact Test	1 Sample each from inner PE sheath, PVC intermediate and outer sheath from both the drums one each of 6 and 4 Quad Cable.
12.	5.8.10	Heat Shock Test	One sample each from PVC intermediate and outer sheath from both the drums – one each of 6 quad and 4 quad cable.
14.	5.8.11	Thermal Stability Test	2 Samples each from PVC intermediate and outer sheaths from both the drums of 6 Quad & 4 Quad cables.
15.	5.8.13	Flame Retardant Test	1 Sample each from both the drums of 6 Quad and 4 Quad cables.
16.	5.8.16	Bend Test	-do-
17.	5.9.1.1 & 5.9.1.2	High Voltage between conductor to conductor.	Between a conductor and all other insulated conductors of both the drums of 6 and 4 Quad cables.
18.	5.9.1.3	High Voltage between all conductors and shield	Between all insulated conductors bunched together and the steel armouring with screening wires from both the drums of 6 and 4 Quad cable.
19.	5.9.2.1 & 5.9.2.2	Insulation Resistance (Dry)	Between each conductor and all other insulated conductors shorted with the armouring from both the drums of 6 and 4 Quad cable.
20.	5.9.2.3	Insulation Resistance (Wet)	Between conductor and water in which cores are immersed from both the drums of 6 and 4 Quad cable.
21.	5.9.3 (except 5.9.3.5)	Conductor Resistance and loop resistance	All insulated conductors and pairs of all Quads of 6 and 4 Quad cable.

22.	5.9.3.5	Specific Resistance	One insulated conductor of each colour of insulation from both the drums of 6 and 4 Quad cable.

23.	5.9.4	Mutual Capacitance	All pairs of insulated conductor of all Quads of 6 and 4 Quad cable.
24.	5.9.5	(a) Capacitance Unbalance (pair to pair) and adjacent pair of same and adjacent quad (b) Capacitance unbalance pair to ground	Between all pairs of insulated conductor in the same and adjacent quad of both the 6 and 4 Quad cable. Between all pairs of insulated conductor and earth of both the 6 and 4 Quad cable.
25.	5.9.6	Characteristic impedance	Between all pairs of insulated conductors of all the Quads of 6 and 4 Quad cable.
26.	5.9.7.2	Far End Cross Talk	Between all pairs of insulated conductors of all the Quads of 6 and 4 Quad cable.
27.	5.9.7.3	Near End Cross Talk	-do-
28.	5.9.8	Attenuation	-do-
29.	5.9.9.2	Reduction Factor	All the insulated conductors of all the Quads of 6 and 4 Quad cable.
30.	5.8.23	Water Penetration Test	From both the ends of both the drums of 6 and 4 Quad Cable.
31.	5.8.22	Visual Inspection	Both the drums of 6 and 4 Quad Cable to be visually inspected by rewinding it on to another drum to comply the requirement as given in relevant clause of 5.8.22.

ANEXURE-I

COMPATIBILITY OF POLYTHENE INSULATION AND FILLING COMPOUND

The cable core shall be fully filled with a suitable water resistant compound like Jelly, which is fully compatible with the Polythene insulation of the conductors.

The compatibility between the polythene insulation and the filling compound shall be established by the tests as per annexure below.

The compatibility shall be assessed for each colour of insulation as given in Table in clause no. 3.2.4. This test shall be conducted from the insulated bobbins of each colour of insulation at insulated conductor stage.

(i) **ABSORPTION OF FILLING COMPOUND**: For this test 15 cm length of insulation carefully removed from any conductor shall be weighed (about 2 gm) correct to 1 mg. The lengths (suitably coiled and bend, if necessary); shall be placed in a test tube or beaker full of filling compound with its ends 1 cm. Above the level of the compound and maintained at 70º C±1ºC for 14 days. At the end of this period, the insulation sample shall be removed; the surface shall be wiped clean and again weighed accurately. Increase in weight shall not be more than 10%.

(ii) **ELONGATION AND TENSILE STRENGTH**: 20 lengths of insulation shall be carefully removed from any conductor and made into 2 sets of 10 each. The first set shall be tested on a tensile machine keeping 50 mm between the grips and extending these at the rate of 250±50mm per minute. The percentage of elongation at break and the breaking load for the 10 lengths shall be noted and the average worked out. These values shall not be less than 300% and 100kg/cm sq respectively.

(iii) The second set of 10 samples shall be aged in a test tube or beaker full of filling compound and maintained at 70º C±1ºC for 14 days. After ageing as above, the 10 lengths shall be tested in a tensile testing machine for tensile properties in a similar manner as above.

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.

(iv) **ENVIRONMENTAL STRESS CRACKING:** 10 lengths of insulated conductor of 150mm each removed from the extruder, shall be immersed in filling compound for 24 hours at 70º C±1ºC and insulated conductors will then be removed from the compound and wiped clean. They will then be wrapped round its own diameter for a minimum of 10 contiguous turns closely wound in a length of 2 cm of insulated conductor. They will then be suspended in an

air oven maintained at 70º C±1ºC for 14 days. At the end of this period they will be removed from the oven and observed for cracks with naked eye. There shall be no cracks.

ANNEXURE-A

I. STABILITY TEST METHOD:

Experimental set up is indicated in fig. 4. About 5 grams filling compound is filled in a glass container with both ends open and held with the axis of container with both ends open and held with the axis of the container in a horizontal plan. The outer surface of the glass tube is covered with a copper wire mesh to ensure uniform temperature and prevent local hot spots.

This container is suspended vertically in (accurately weighed) test tube so that it hangs freely. The temperature of the jelly is monitored by a thermometer. The test tube is now placed in a constant temperature bath maintained at 65ºC±1º C for 120 hours.

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

(II) DRIP TEST:

The test specimen of 30cm in length shall be cut from a completed cable. One end of the sheath shall be stripped for approximately 5 cms. And the conductors with the jelly wiped clean shall be flared out approximately 45º angle. The same shall then be suspended in air oven with a glass disc placed directly below the flared end of the cable. The oven temperature shall be set at 65º C±1º C for a period of 24 hours. At the end of the test the compound which might have dripped. There shall be no dripping of filling compound.

(III) PEEL STRENGTH FOR LAMINATE AND COMPOSITE SHEATH & BOND STRENGTH:

1.0(a) A parallel sided test piece 150mm long and 13 to 16mm wide of the laminate or sheath shall be cut longitudinal from the Laminate or sheath in one operation using a sheath.

(b) Test piece taken for testing the strength of the bond between the sheath and Aluminium tape shall exclude the overlap of Aluminium foil. For small diameter cables, it may not be possible to get sheath test pieces 13 cms wide. In such cases test pieces of less width may be taken (excluded the Poly-Al Overlap).

(c) Test pieces taken for testing the strength of the bond between the interfaces of the Aluminium tape at the seal shall include only the overlap of the tape.

2.0 (a) For testing Peel Strength of Laminate only, separate the Aluminium and Polythene tape at one end. Insert the Aluminium in the fixed grip and Polythene tape 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 Bond Strength of Laminate at the overlap, insert the Aluminium tape in the fixed grip and Poly-Al – Polythene sheath (other edge) in the other grip. For 4.0 a, b & c of this item, the grip can be brought closer up to 3 cms. An electric operated tensile tester shall be used. Rate of separation between grips shall be 100 to 135 mm/min. and the steady force required to separate the materials shall be noted.

3.0 Initial separation of the Laminate or laminated sheath to facilitate insertion in the grips can be made by immersing about 25mm at the end of the test piece in boiling industrial alcohol for about 30 seconds.

4.0 **Sampling and Requirements: -**

(a) Peel Strength of the Laminate raw material shall be 25-gms/mm width (minimum). 5 samples shall be tested.
(b) Bond Strength of the Laminate to Sheath shall be 40gms/mm (Minimum) and 60gms/mm width (Average) on 5 samples.
(c) Peel Strength of the Laminate at overlap shall be the same as (b) above on 5 samples.

(IV) WATER PENETRATION TEST:

Sample Preparation: A piece of three-metre length shall be cut from the end of the cable. The inner one-meter length as indicated in the fig.5 shall then be cut for test ensuring minimum disturbance to the cable core during the cutting process. This inner 1 metre sample shall be subjected to the Water Penetration Test. The outer 2 metres shall not be used for this test. However, for acceptance test, piece of only one metre length shall be taken from the end of the cable drum for tests without discarding two-metre length.

Testing Arrangement: This arrangement is shown in fig.5. The sample under test is kept straight in a horizontal plane on a test bench prepared for this purpose. One end of the sample shall be connected suitably through a watertight gland to a water pipe containing 1 metre head of water. The connection shall be such that the cable sheath shall not be squeezed tight or shall in allow leakage of water at this point. The other end of the cable shall be free.

One metre head of water shall be applied for 7/14 days at ambient temperature. The pipe connecting the water tank to the cable shall be vertical. No air bubbles shall remain trapped in this pipe. Any bubbles that may be present initially should be removed by agitating the water column using a thin wire for this purpose.

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

(V) OXIDATION INDUCTION TEST:

A short length section (approximately 30 cms) of 10 pairs or larger cable shall be sealed at the ends and placed in an oven at a temperature of 68ºC±1º C for eight hours. The sample will then be allowed to cool down to room temperature for a total of twenty-four hours. After

equilibration, five samples shall be taken of each colour of insulation, each one from a different conductor. Each sample shall be wiped clean of grease and foreign objects using a dry cloth (without solvents). Each sample shall be individually tested by means of a Differential Scanning Calorimeter (DSC) or by Differential Thermal Analysis (DTA). The sample shall be clean and dry.

Instrument Test Procedure:
Cell Cleaning: Hold cell at approximately 400ºC for 10 minutes in nitrogen. Cell should be cleaned after standing overnight and between testing of different formulations.

Temperature Calibration:
The temperature scale should be adjusted according to the instrument manual until the determined melting point of pure indium metal is 156.6ºC at a heat rate of 5º C per minute.

Engineering Notes:

Dupont 990 with DSC Cell:
With instrument in isothermal mode, calibrate STARTING TEMPERATURE dial according to instrument manual alternatively, the dial may be set to a reading, which results in a corrected thermocouple read-out of 199ºC.

Perkin-Elmer DSC-I or DSC-2:
Run several pure metal standards (e.g. indium, tin, lead, zinc) through their melting point at a heating rate of 5ºC per minute. Plot melting temperature and interpolate to find the correct set point for 199ºC. Repeat calibration require only adjustment for the indium melt temperature.

Copper Pan Preparation:
Prepare fresh copper oxide coating by holding the pan in the flame of a fisher burner until it begins to glow (about 3 seconds). Remove the pan from the flame and immediately cool in a Gentle stream of air.

Sample preparation:
Remove the insulation from the conductor. Flatten the resin to bout 15 mils thickness (not critical), clip sample to approximate roundness, bout 2mm in diameter.

Sample should weigh approximately 1 to 2 mg. Position in center of oxidized copper pan, cover with clean 316 stainless steel screen (40 mesh) and crimp the pan.

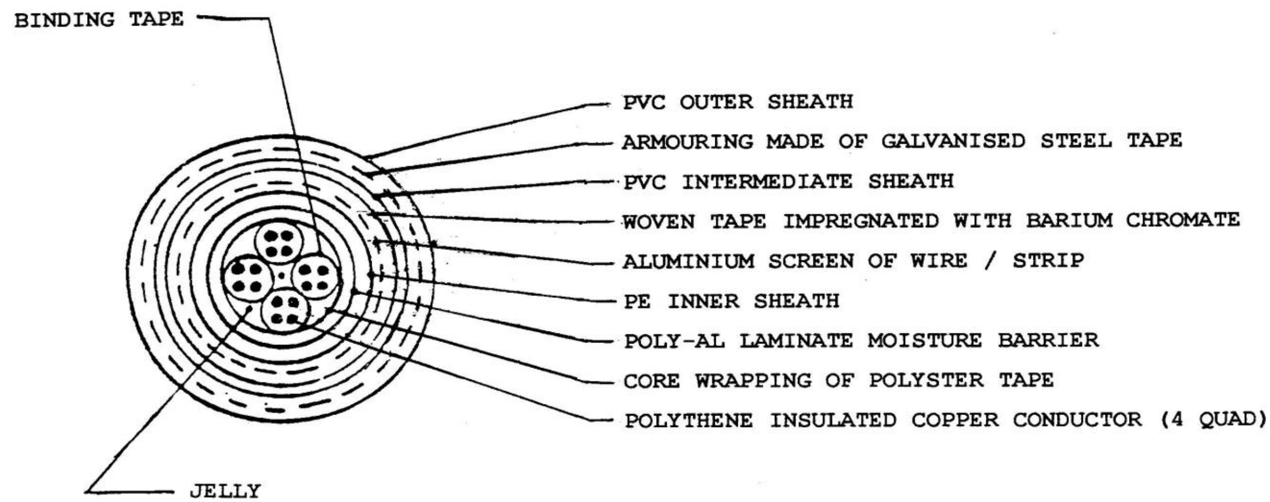
Nitrogen Purge:
Place sample pan in instrument cell. Flush 5 minutes with cylinder nitrogen at 60±10 cc per minute.

Oxidation Test: Rapidly increase sample temperature (20ºC±1ºC. After thermal equilibrium (steady recorder signal) simultaneously switch to 50±5cc/minute oxygen flow and start time-base recording. Other flow rates, 150cc/minute inclusive maximum, can be used. Record rate flow used. Oxygen should be equivalent to or better than 99.66 extra dry grade.

Induction Period: This 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 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 oxidation induction time.

IRS:TC 30-05

CLAUSE No.:3.13



CROSS SECTION VIEW OF THE UNDERGROUND RAILWAY 4 QUAD JELLY FILLED TELECOM QUAD CABLES FOR SIGNALLING & TELECOM INSTALLATION

FIG.1

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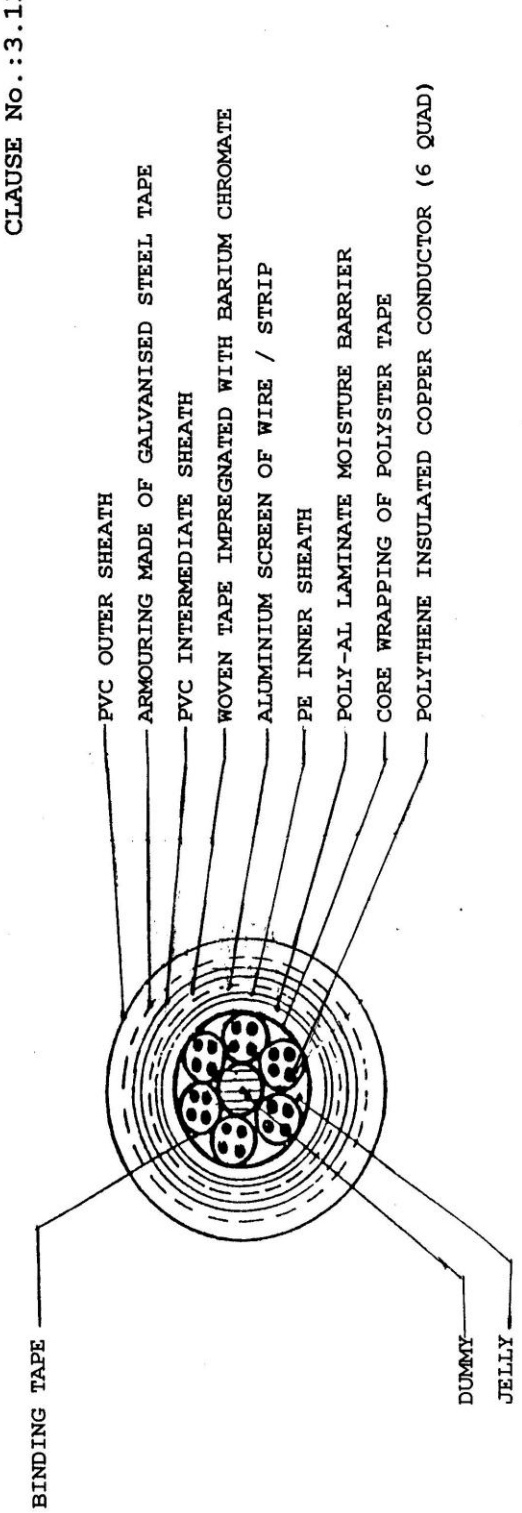
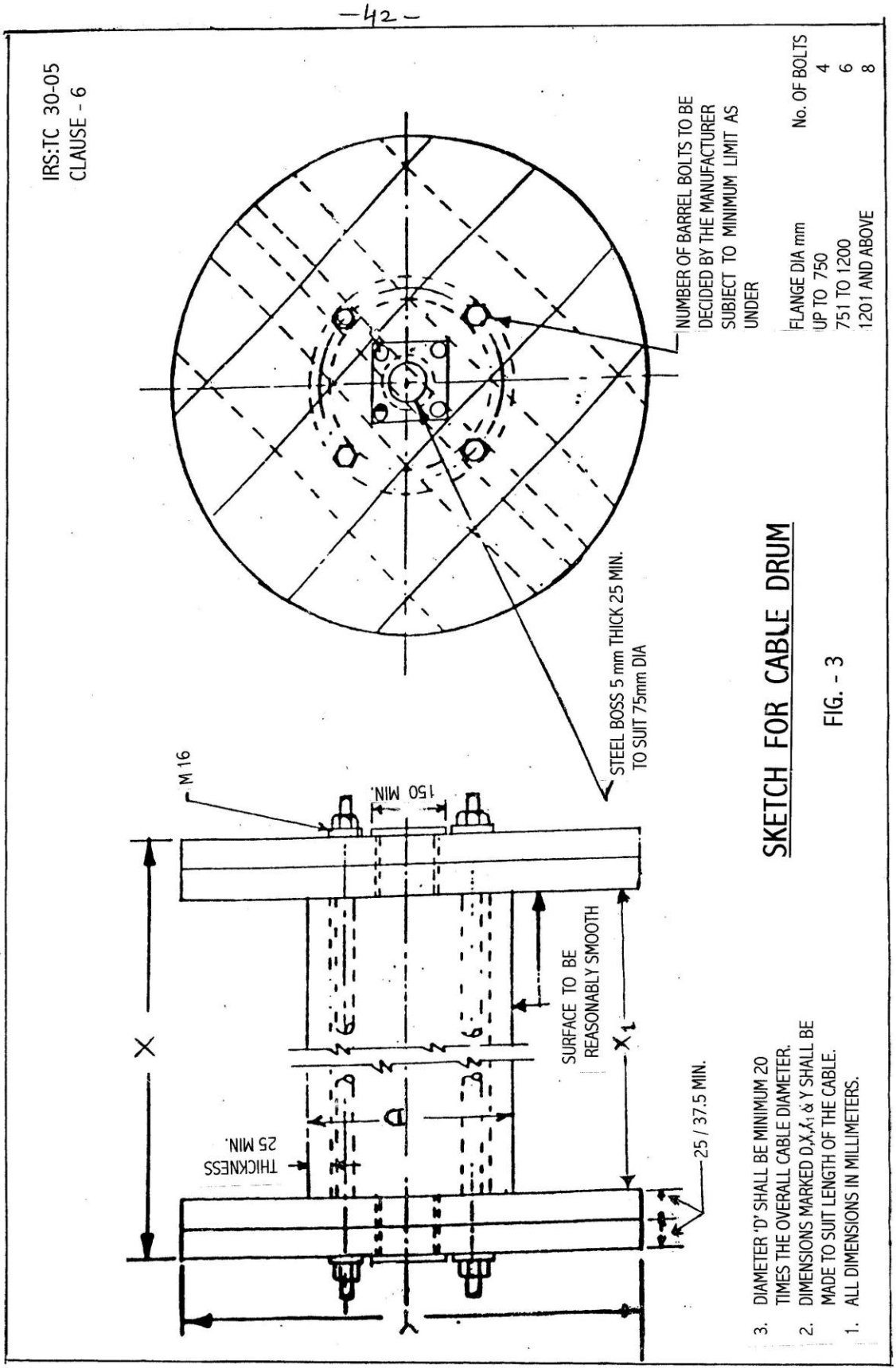
CLAUSE No.:3.13



CROSS SECTION VIEW OF THE UNDERGROUND RAILWAY 6 QUAD JELLY FILLED TELECOM QUAD CABLES FOR SIGNALLING & TELECOM INSTALLATION

FIG.2


-42-
IRS:TC 30-05
CLAUSE - 6
NUMBER OF BARREL BOLTS TO BE DECIDED BY THE MANUFACTURER SUBJECT TO MINIMUM LIMIT AS UNDER
FLANGE DIA mm
No. OF BOLTS
UP TO 750
4
751 TO 1200
6
1201 AND ABOVE
8
STEEL BOSS 5 mm THICK 25 MIN. TO SUIT 75mm DIA
M 16
150 MIN.
THICKNESS 25 MIN.
SURFACE TO BE REASONABLY SMOOTH
25 / 37.5 MIN.
SKETCH FOR CABLE DRUM
FIG. - 3
3. DIAMETER 'D' SHALL BE MINIMUM 20 TIMES THE OVERALL CABLE DIAMETER.
2. DIMENSIONS MARKED D, X, X1 & Y SHALL BE MADE TO SUIT LENGTH OF THE CABLE.
1. ALL DIMENSIONS IN MILLIMETERS.

STABILITY TESTING METHOD

ANNEXURE A-I
CLAUSE No. 5.8.34

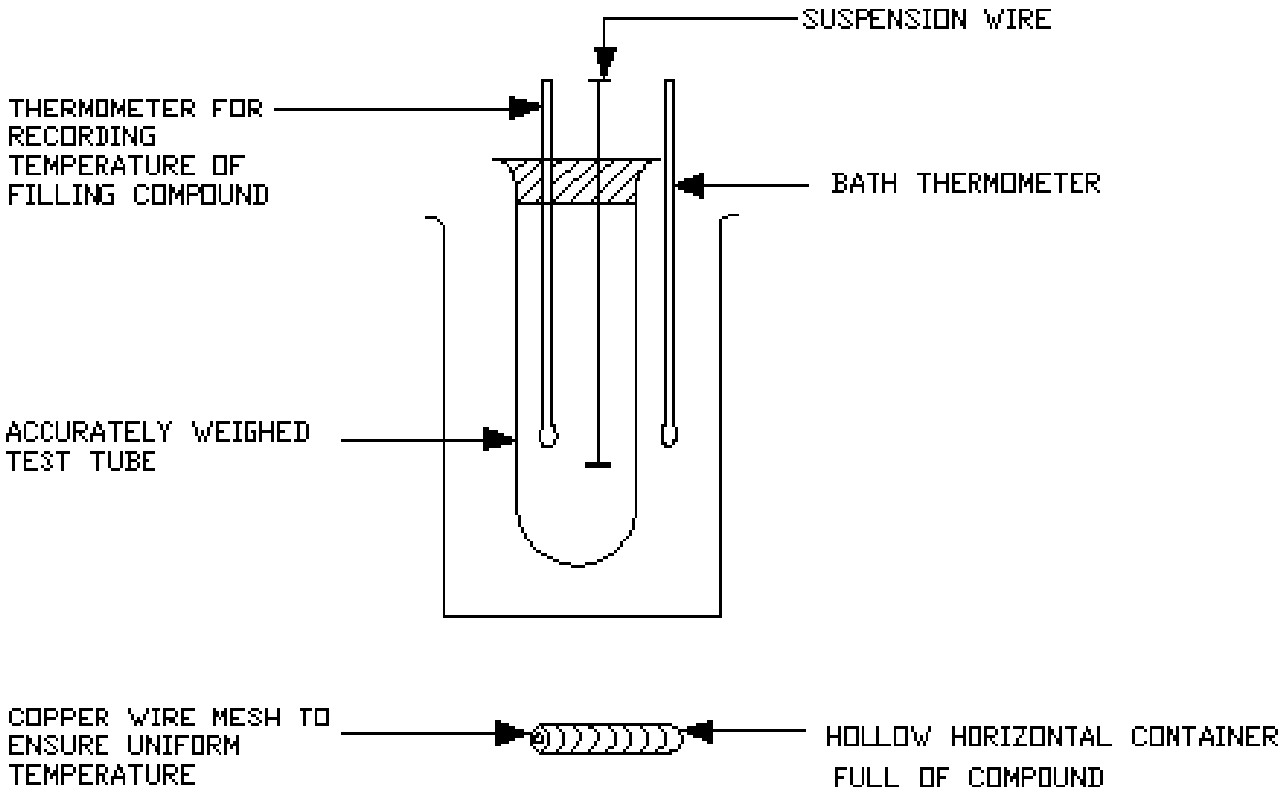


FIG. - 4

ANNEXURE A-IV
CLAUSE No. 5.8.23

WATER PENETRATION TEST

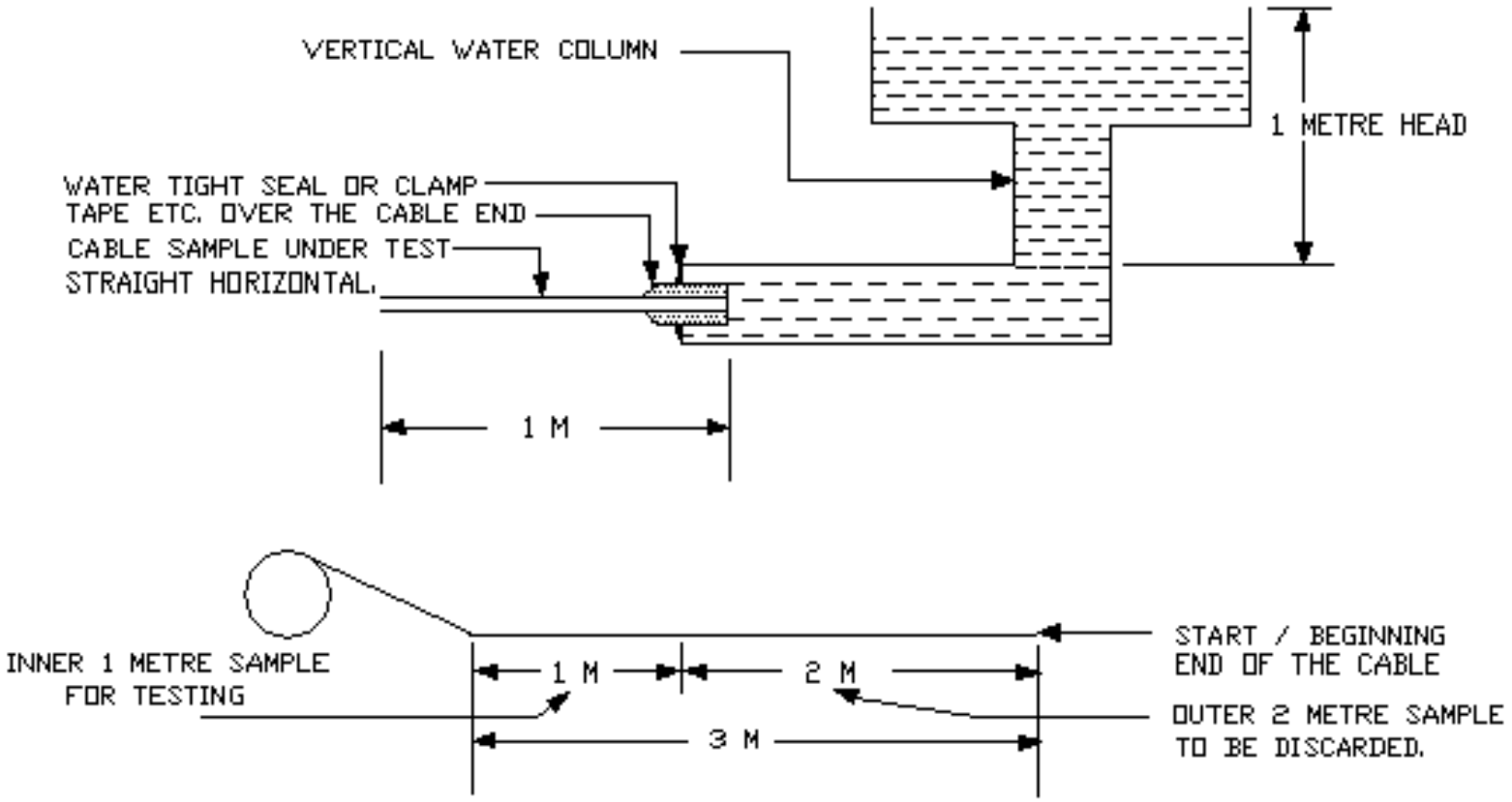


FIG. - 5