NO.IRS: TC 41-97

INDIAN RAILWAY STANDARD SPECIFICATION FOR POLYTHENE INSULATED POLYTHENE SHEATHED JELLY FILLED TEPEHONE CABLE WITH POLY-AL MOISTURE BARRIER.

0. FORWARD:-

0.1 This specification is issued under the fixed serial No. IRS: TC 41 followed by the year of original adoption as standard or in the case of revision, the year of last revision.

ADOPTED 1990, FIRST REVISION 1997.

0.2 This specification requires reference to the following standard specification:

TEC NO. G/ CUG-01/02 FEB. 96	Solid polythene insulated fully filled, polythen sheathed underground telecom cable.
IEC: 28	International standard of resistance for copper.
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables.
IS: 2633	Method for testing uniformity of coating on zinc coated articles.
BS: 6234	Polythene insulation & sheath of electric cables.
ASTM: D-1047	Cold bend test.
ASTM: D-1693	Test method for environmental stress cracking of ethylene plastics.
ASTM: D-1169	Test method for specific resistance (resistivity) of electrical insulating liquids.
VDE: 0472/6.65	Recommendations for testing insulated cables & flexible cords.
ASTM: D-1248	Polythene plastics moulding and extrusion materials.
ASTM: D-883	Definition of terms relating to plastics.
IS: 9938	Recommended colours for PVC insulation for LF wires and cables.
IS: 12444	Continuously cast and rolled electrolytic copper wire cods for electrical conductors.

TEC No. G/ CBD-01/02. NOV 94. Wooden cable drum for telecom cables.

0.3 Wherever in this specification any of the above mentioned specifications are referred to by number only the latest issue of that specification is implied; wherever the year of issue is mentioned, the particular issue referred to is meant.

1. SCOPE:

1.1 This specification covers the requirements and provisions of tests and inspection of twisted pair underground telecom cable with solid polythene (medium or high density) insulated copper conductors, fully filled core with water resistance compound and with poly-Al laminate moisture barrier bonded to the polythene sheath.

1.2 This specification deals with the technical requirements and does not include all the terms and provisions of the contract.

1.3 Cable shall be manufactured in cable sizes from 10 pair to 200 pairs with nominal conductor dia. 0.5, 0.63 and 0.9 mm. The standard cable sizes shall be 10, 20, 50, 100 and 200 pairs. Typical cross-section of 20 pair cable is shown in Fig. 1.

2. NUMBER OF PAIRS:

2.1 The cable shall be of different sizes varying from 10 to 200 pairs with nominal conductor dia 0.5 or 0.63 or 0.9 mm. The standard cable sizes shall be 10, 20, 50, 100 and 200 pairs armoured/ unarmoured.

3. CONDUCTOR:

3.1 Each conductor shall consist of 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 IS – 12444.

3.2 The joints in the conductor shall be either brazed or welded and shall be kept to a minimum and shall fulfill the following conditions:

3.2.1 The resistance of a 100 cm length of conductor containing joint sample of conductor not containing a joint.

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

3.3 The resistance of conductors and the tolerance on the individual values shall meet the requirements of Table-1. The temperature correction factor is indicated in Table – 2.

4. INSULATION:

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

4.1.1 Conductor insulation shall be polythene insulating grade and 100% virgin material as per ASTM – D 883.

4.2 Insulation shall be materials adequately stabilized with an anti oxidant/ copper inhibitor system sufficient to pass the oxidation induction and other relevant tests stipulated in this specification.

4.3 The polythene shall conform to ASTM-D 1248 type II or type III, class 'A', category 4 or 5 and meet the parameters detailed below:

i)	Density	Type II (0.926 to 0.940 gm/cc) Type III ().941 to 0.956 gm/cc)
ii)	Flow rate (melt flow index)	Maximum 1.0 gm/10 minutes (190°C. 2160 gm load)
iii)	Dissipation factor (power factor)	Maximum 0.0005
iv)	Dielectric constant or permittivity	Maximum 2.35
v)	Volume resistivity	Minimum 1 x 1015 ohm-cm.

4.4 The insulation shall be uniform and smooth, and shall be coloured as in Table – 4. The colour shall be identifiable under normal lighting conditions and shall generally conform to IS: 9938.

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

4.6 The thickness of insulation shall be reasonably uniform to enable the completed cable to meet the electrical and mechanical requirements of the specifications.

4.7 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 1 spark over per 5 Km of the insulated conductor, when assessed on a monthly basis on the insulating line. The test will be at extrusion stage.

5. TWINING/ 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 adjacent pairs. The lay of various pairs shall be so chosen as to satisfy the capacitance

unbalance tests requirements as per cl. 25.6 and cross talk requirements as per cl. 25.7 of this specification. To the extent possible the lay of any pair may be limited to 150 mm.

6. UNIT:

6.1 A number of twisted pairs laid up to form a group shall constitute the unit.

6.2 The colour scheme of pairs and wires in a unit shall be in accordance with the table no. 4 for identification.

6.3 The different colours of the binder tape shall be readily distinguishable under normal lightening conditions. The colour scheme of binder tape shall be in accordance with Table 3 for unit identification.

7. CABLE CORE/ STRANDING:

7.1 In cables having 10 pairs, 20 pairs, the twisted pairs shall be assembled to form a symmetrical core. Polythene strings of required diameter may be used as fillers if necessary for proper circular core formation.

7.2 In cables having 50 and 100 pairs, the twisted pairs shall be arranged in units of 10 pairs, and 20 pairs respectively. An open helical lapping of 0.02 mm minimum polyster/ poly-propylene/ polythene tape shall be applied over each unit. The tapes shall be coloured in accordance with Table 3 and shall have lay not exceeding 100 mm. This tape is not necessary on the 10 pairs and 20 pairs cables.

7.3 The 50 pairs cable shall have 5 units of 10 pairs and 100 pairs cable 5 units of 20 pairs. These units shall be stranded into a compact and symmetrical cable. The sequence of the units in the cable shall be same throughout the length of the cable.

7.4 4 Nos. of 50 pairs super unit shall be assembled to form a 200 pair cable.

7.5 Cable with any defective pair will not be acceptable.

8. FILLING COMPOUND (PETROLEUM JELLY):

8.1 The cable core shall be fully filled with a suitable water resistant compound like jelly which is fully compatible with the polythene insulation, binders and tapes used in the cable. It shall be of homogenous and uniformly mixed material containing an anti-oxidant. it shall not contain dirt, metallic particles or other foreign matter. The compatibility between the polythene and filling compound shall be established by the tests as per cl.17 of this specification. The compability shall be assessed for each colour of insulation in Table – 4.

9. **CORE WRAPPING**:

9.1 After application of the water resistant filling compound, a closed helical or longitudinal lapping of a non – hygroscopic and non-wicking polyester tape or tape of any other suitable material shall be laid over the cable core. The tape may be impregnated or flooded with jelly to meet the water penetration test requirements. Application of a flooding compound below and above the core wrapping tape is recommended.

10. POLY-AL LAMINATE MOISTURE BARRIER/ SCREEN:

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

10.2 The laminate shall be bonded to the inner surface of the polythene sheathing extruded over it any suitable method. The poly-Al laminate shall be mechanically and electrically continuous through out the length of the cable. For achieving/ improving the specified reduction factor, the manufacturers may use corrugated poly-Al tapes.

11. **SHEATH:**

11.1 Cable shall be sheathed with polythene grade 03C or HO3C as per BS: 6234, and containing a suitable anti-oxidant system. The material shall be virgin as per ASTM-D-883 and meet the requirement specified below:

i)	Melt flow index	Shall not be more than 1.0 g/10 minute (190°C, 2160 g load)
ii)	Density	For 03C, shall be 0.910 to 0.940 gm/cc.
iii)	Antioxidant	OIT test in a copper pan at 199°C as per the method in Annexure-A (V) and the value to be recorded; the value should be such that the requirement of cl. 20.8 of this specification is met.

11.2 The sheath shall be reasonable circular, and free from pin holes, joints and other defects. The variation between the maximum and the minimum diameter at any cross section shall conform to the following:

Specified maximum diameter over sheath (mm)	Maximum variation (mm)
Upto 40	3 . 0
Above 40	4 . 0

11.3 The thickness of the sheath shall conform to Table – 5. The minimum thickness shall not be less than 75% of the specified nominal value. The average of six measurements at each end, equally placed around the circumference, shall not be less than 85% of the specified nominal value.

11.4 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.

12 ARMOURING:

12.1 **BEDDING:** Two close helical lapping of polythene or polypropylene tape shall be applied over inner sheath to provide sufficient mechanical 5% overlap. The second tape shall cover the overlap of the first tape about evenly. The width of tape is left to the discretion of the manufacturer.

12.2 **ARMOUR:** The sheathed cable shall then 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 28% ± 10% of the width of the first tape. In any case the overlap of the second tape over the first tape shall not be less than 20% of the width of the tape. Manufacturer may increase the number of steel tapes & their thickness so as to meet the requirement of reduction factor (cl. 25.9). However, the thickness of any of the galvanised steel tapes used in two applications including zinc coating on each tape shall not be less than 0.5 mm.

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

12.4 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. If any rusty portions are noticed on the tape, the same should be painted with suitable anticorrosive paint. When joints in tapes are necessary they shall be made by brazing or welding and any irregularity shall be removed.

13. JACKET:

13.1 The physical/ mechanical test on jacket.

13.2 The armoured cable shall be tightly jacketed with polythene conforming to the requirements as specified for sheath in cl. 11.0. The nominal thickness of the jacket shall be as per Table-7. The minimum and average thickness shall be same as in cl. 11.3.

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

13.4 The jacket shall be spark tested as per Table-7. There shall be no spark-over. This is an on line test.

14. MECHANICAL TESTS ON CONDUCTOR:

14.1 Physical Tests for Conductor:

14.1.1 Dimensions: The diameter of the conductor shall be measured on a sample from the finished cable. The measurements shall be made at least three different points along the length of the sample. The value shall be in accordance with Table-1.

14.1.2 Annealing: Test: When a sample wire of 250 mm long taken from the completed cable is slowly and steadily stretched, elongation at fracture shall not be less than appropriate value given in Table-1.

15. TESTS ON FILLING COMPOUND:

15.1 Stability: When held at a temperature of $65 \pm 1°c$ 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 'A' (I).

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

15.3 Handling: The 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.

15.4 **Volume Resistivity:** The volume resistivity measured at 100°C by the method described in ASTM-D1169 or any other approved method shall not be less than 1 x 1010 ohm-cm.

15.5 Permittivity: The permittivity at 1 MHz when tested as per ASTM D-924 shall not be greater than 2.3 at 20°C.

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

16. TESTS ON INSULATED CONDUCTORS:

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

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

16.3 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 convention type Air circulating oven for 24 hours at a temperature of 100°C ± 1°C. The total shrinkage from both ends shall be measured. A minimum of 6 or more samples shall be tested at a time. The average shrinkage of 6 samples shall not exceed 6.35 mm.

16.4 Cold Bend: 10 samples of the insulation material on the conductor shall be tested in accordance with ASTM D-1047 after conditioning at a temperature of -40°C for 1 hour with mandrel diameter equal to the diameter of the insulated conductor. There shall not be more than one failure out of 10 samples.

16.5 Thermal Stress Cracking: 10 lengths of insulated conductor of 10 cms each removed from the extruder shall be wrapped on their own diameter with a minimum of 10 contiguous turns closely wound in a length of 2 cm at 70°C ± 1°C for 14 days. After the period they shall be removed from the oven and observed for cracks with naked eye. There shall be no cracks.

16.6 The insulated conductor shall be subjected to spark test at 3KV AC (RMS) or 4.5 KV DC for all conductor sizes. There shall not be more than one spark-over per 5 Km of the insulated conductor, when assessed on a monthly basis on the insulating line. The test will be at the extrusion stage.

17. COMPATIBILITY OF INSULATION AND FILLING COMPOUND:-

17.1 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 bent, 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 70°C ± 1°C for 14 days. At the end of this period, the insulation sample shall be weighed accurately. Increase in weight shall be more than 10%.

17.2 Elongation and Tensile strength: 20 length 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 testing machine keeping 50 mm between the grips and extending these at the rate of 250 ± 50 mm 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 100 kg/cm sq. respectively.

The second set of 10 samples shall be aged in a test tube or beaker full of filling compound and maintained at 70°C ± 1°C for 14 days. after aging 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 aging shall not change by more than 30% and 15% respectively of the values before aging.

17.3 Environmental Stress Cracking: 10 lengths of insulated conductor of 150 mm each removed from the extruder, shall be immersed in filling compound for 24 hours at 70°C ± 1°C 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 70°C ± 1°C 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.

18. TESTS FOR POLY-AL LAMINATE:-

18.1 Thickness: Thickness of Aluminium tape and polythene coating shall conform to the requirements of cl.10.0.

18.2 Peel Strength: Peel strength of the polythene from the aluminium tape shall not be less than 25 gm per mm width when tested in accordance with Annexure 'A' (III).

19. TESTS ON COMPLETED CABLES:

19.1 Drip Test: When tested as in Annexure 'A'(III) there shall be no dripping of filling compound.

19.2 Oxidation Induction Test: The induction time in oxygen with a copper pan tested by the method in Annexure 'A'(V) shall not be less than 30 minutes for each colour of insulation removed from the conductor of the completed cable.

20. TEST FOR COMPOSITE SHEATH AND JACKET FROM COMPLETED CABLE:

The components removed from the cable sheath and jacket shall be capable of meeting the following requirements:

20.1 Bond Strength: 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).

20.2 For the tests in this specification, the polythene sheath shall be stripped of the laminate.

20.3 Tensile Strength and Elongation: The samples of polythene removed from the cable sheath and jacket shall meet the following requirements when tested in accordance with Appendix 'A' of BS-6234:

Tensile Strength Min. 70 Kg/cm^2

Elongation Min. 300%

20.4 Environmental Stress Creaking: Test specimen without laminate cut from the polythene sheath and jacket shall be subjected to an envirnmental stress cracking test as described in ASTM: D-1693, when tested with 105 IGEPAL solution at 50 ± 1°C for 48 hours. There shall be no failure.

20.5 Shrinkage Test: A specimen shall be cut from the cable sheath and jacket, 50 mm long measured along the axis and 12 mm wide and the same thickness as the cable sheath and placed in a convective type circulating air oven operating at a temp. of 100°C ± 1°C for a period of 24 hours. at the end of this period the shrinkage as measured in the lengthwise direction shall not exceed 5%.

20.6 Carbon Black Content: The carbon black content of sheath and jacket shall be determined as in BS: 6234, and shall be 2.5% ± 0.5% by weight.

20.7 Carbon Black Dispersion: The carbon black dispersion in sheath and jacket shall conform to BS: 6234.

20.8 Oxidation Induction Test: The induction time in oxygen when tested with copper pan as per the method in Annexure 'A' (V) shall not be less than 15 minutes.

20.9 Thickness of Sheath and Jacket: The nominal, minimum and average thickness shall be in accordance with cl. 11.0, Table-6 and Table-7 of this specification. The variation between the maximum and minimum diameter at any cross section of the sheath shall be as per cl. 11.2.

21. TEST ON RAW MATERIAL OF POLYTHENE SHEATH AND JACKET:

21.1 The tests on armouring shall be in accordance with cl. 12.3 of this specification.

22.2 The steel tapes removed from the completed cables shall meet the following requirements:

i) The steel tape thickness (including zinc coating) shall be as per cl. 12.2.
ii) The tensile strength shall be less than 250 to 450 N/ mm^2
iii) The elongation shall not be less than 10%.
iv) The steel tape shall withstand two dips of one minute each when tested in copper sulphate solution prepared as per IS: 2633.
v) The steel tape should be free from rust/ bare patches.
vi) Steel tape shall be tested for mass of zinc coating as per IS: 10810 (Part 41) – 1984 and value shall not be less than 210 gm/m^2 on each side.

22.3 The steel tape from raw material lot shall meet the following requirement of tests, conforming to IS: 3975:-

vii) The steel tape thickness (including zinc coating) shall be as per cl. 12.2.
viii) The tensile strength shall be less than 250 to 450 N/ mm^2
ix) The elongation shall not be less than 10%.
x) The steel tape shall withstand two dips of one minute each when tested in copper sulphate solution prepared as per IS: 2633.
xi) The steel tape should be free from rust/ bare patches.
xii) Steel tape shall be tested for mass of zinc coating as per IS: 10810 (Part 41) – 1984 and value shall not be less than 210 gm/m^2 on each side.

23. WATER PENETERATION TEST:

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

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

Type tests	14 days
Acceptance tests for bulk supplies	7 days.

24. CABLE BEND TEST:

24.1 This test shall be carried out with the armouring removed in case of armoured cable or an unarmoured cable sample.

24.2 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 to sheath.

25. ELECTRICAL REQUIREMENTS:

25.1 Continuity Test:

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

25.2 Conductor Resistance:

25.2.1 The resistance of conductors and the tolerance of individual values shall meet the requirements of Table-1. The temperature correction factor is indicated in Table-2. The temperature corrections for resistance shall be made using the following equation:

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

25.3 RESISTANCE UNBALANCE:

25.3.1 The conductor resistance unbalance (RU) shall not exceed the values indicated below:

Conductor Size	Percentage Unbalance	
	Maximum Average	Individual Maximum
0.50 mm	1	2.5
0.63 mm	1	2.0
0.90 mm	1	2.0

25.3.2 The percentage RU of any individual pair tested shall be calculated as followings:

$$\% \text{ Resistance Unbalance} = \frac{R_1 - R_2}{R_1 + R_2} \times 100$$

Where R_1 & R_2 are the resistance of individual conductors of the pair under test & R_1 is higher than R_2.

25.4 **POLY-AL TAPE:** The poly-al tape shall be tested for continuity, and its resistance value noted.

25.5 **MANUAL CAPACITANCE:**

25.5.1 The average mutual capacitance of the pairs in the cable when measured at 800 to 1000Hz shall be 52 ± 4.5 nF/km.

25.6 CAPACITANCE UNBALANCE:

25.6.1 The pair to pair capacitance unbalance measured at 800Hz to 1000Hz for all combinations of pairs in each unit/ super unit in cable shall not exceed the following limits:

Average	50 pf/km
Individual combination	200 pf/km.

25.6.2 The pair to ground capacitance unbalance (at 800 Hz – 1000 Hz) shall not exceed the following values:

Average	750 pf/km
Individual	3,000 pf/km.

25.6.3 The measurement shall be corrected as follows:

i) Capacitance unbalance pair to pair measured value shall be divided by

$$\tfrac{1}{2}\left(L/1000 + \sqrt{L/1000}\right)$$

Where, L is the length of the cable tested in metres.

ii) Capacitance unbalance pair to ground - The measured value shall be divided by 1000 where L is length of the cable under test in metres.

25.6.4 Length less than 100 metres shall be assumed as 100 metres.

25.7 **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 25.7.1 and 25.7.2 respectively. The measurement will be made on all combinations of pairs in cable as indicated in cl. 25.6.1.

25.7.1 **ELFEXT:** The individual and RMS value shall be better than 55 dB/Km and 67.8 dB/km respectively.

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.

25.7.1.1 For lengths other than one km, the measured value shall be corrected by 10 log 10/ L100, L being the cable length tested in metres.

25.7.2 **NEXT:** The individual values between pairs shall be better than 55 dB, when corrected to unit length of 1 km.

25.7.2. **1NEXT CORRECTION:** No correction is necessary if cable length of 300 metres or more are tested. For other lengths the NEXT value shall be corrected with the following:

Nx = No – 10 log10 [(1-e-4.a.1x) / (1-e-4.a.1o)]

where, a = Average attenuation in Naperies per km
Nx = Next in dB corrected to a unit length of 1 lm.
No = Measured value for length (10) in dB.
1x = 1 km
1o = Length of cable tested in km
e = 2.71828

25.7.2.2 Lengths less than 150 meters shall not be tested for these parameters.

25.8 **ATTENUATION**: The average attenuation of the pairs at 150 KHz shall not exceed the value listed below at 20°C:-

0.5 mm	8.25 dB/km
0.63 mm	6.3 dB/km
0.90 mm	4.4 dB/km.

Temperature correction for attenuation will be done as:
Attenuation 20°C = [Attenuation at T°C] / [1+0.0018 (T – 20)]

25.9 Reduction Factor: The intrinsic reduction factor for cable sizes 10 pair to 200 pair, when measured in accordance with cl. 507 of VDE Specification No. 0472/ 6.65 shall not be higher than 0.5 in the field intensity range of 50 to 450V/km. This shall be conducted on armoured cable only.

25.10 HIGH VOLTAGE TEST (EIELECTRIC STRENGTH) :-

25.10.1 The insulation between conductors shall be capable of withstanding for three seconds, a DC potential of 2.4 kv for 0.5 mm and 3.5 kv for 0.63 mm and 0.9 mm dia conductor.

25.10.2 The insulation between the shield and the conductors in the core shall withstand for 3 second a DC potential of 5kv for 0.5mm and 10kv for 063 and 0.9 mm dia conductor.

25.11 INSULATION RESISTANCE:

25.11.1 The insulation resistance measurements shall be made with DC voltage of magnitude not less than 500v after steady electrification for one minute. The insulation resistance between each conductor in the cable and the other conductors connected together with the aluminium foil and earthed shall not be less than 5000 Mega ohms – km (cable length in km x observed insulation in Mega ohms) at room temperature.

26. INSPECTION AND TESTING:

26.1 Unless otherwise specified, all tests shall be carried out under ambient atmosphere condition.

26.2 Type Tests: The following shall constitute type tests and shall carried out once in three years or earlier at the discretion of the inspecting authority. At least two cable drums each of different conductor dia. and different pairs comprising of one of size 10 pairs of 50 pairs and another of size 20 pairs or 100 pairs shall be taken for type test from the lot consisting of two drums each of two different sizes. There shall not be any failure in both the drums selected for prototype evaluation.

26.2.1 Test on raw materials:

26.2.1.1 Polythene for conductor insualtion (cl. 4.0)

a) Density (cl.4.3,i)
b) M.F.I. (cl.4.3,ii)
c) Dissipation factor (cl.4.3,iii)
d) Dielectric constant or permittivity (cl.4.3,iv)

26.2.1.2 Filling compound (Petroleum Jelly) (cl. 15.0)

a) Stability (cl. 15.1)
b) Colour (cl. 15.2)
c) Handling (cl. 15.3)
d) Volume resistivity (cl. 15.4)
e) Permittivity (cl. 15.5)
f) Flash point (cl. 15.6)

26.2.1.3 Poly-Al tape (Screen) (cl. 18.0)

a) Thickness (cl. 18.1)
b) Peel Strength (cl. 18.2)

26.2.1.4 Polythene for sheath and jacket (cl. 11.0)

a) Melt Flow Index (cl. 11.0)
b) Density (cl. 11.0)
c) Antioxidant (cl. 11.0)

26.2.1.5 Galvanised Steel Tape (cl. 22.3)

a) Thickness (cl. 22.3)
b) Tensile strength (cl. 22.3)
c) Elongation (cl. 22.3)
d) Dip test (cl. 22.3)
e) Mass of zinc coating (cl. 22.3)

26.2.2 Test on Insulated Conductor (cl. 16.0): The sample for these tests shall be taken from bobbins of the extruded insulated conductors, used for manufacturing cable for type test. These tests shall be carried out for each colour of insulation.

a) Resistance to compression (cl. 16.1)
b) Retraction of insulation (cl. 16.2)
c) Shrink back of insulation (cl. 16.3)
d) Cold bend (cl. 16.4)
e) Thermal stress cracking (cl. 16.5)
f) Absorption of filling compound (cl. 17.1)
g) Elongation and Tensile strength (cl. 17.2)
h) Environmental stress cracking (cl. 17.3)

26.2.3 Tests on conductor (cl. 3.0): The samples for these test shall be taken from the bobbins of insulated conductors.

a) Conductivity of copper (cl.3.1)
b) Resistance of joints in conductor (cl.3.2.1)
c) Tensile strength of joints in conductor (cl.3.2.2)

26.2.4 Test on completed cable:

i) COPPER CONDUCTOR

a) Dimensions (cl. 14.1.1)
b) Annealling (cl. 14.1.2)

ii) POLY-AL-TAPE:

a) Overlap of poly-al tape (cl. 10.1)
b) Thickness of composite tape (cl. 10.1)
c) Bond strength between
i) Poly-al at overlap (cl. 20.1)
ii) Poly-al & sheath (cl. 20.1)

iii) **POLYTHENE SHEATH & JACKET:** The following tests shall be conducted on the samples taken from sheath and jacket both from finished cable.

a) Tensile strength & % elongation at break (cl. 20.3)
b) Environmental stress cracking resistance (cl. 20.4)
c) Shrinkage (cl. 20.5)
d) Carbon black content (cl. 20.6)
e) Carbon black dispersion (cl. 20.7)
f) Oxidation Induction Test (cl. 20.8)
g) Thickness of sheath (cl. 11.3)
h) Diameter over sheath (Table-5)
i) Variation between the maximum and minimum diameter over sheath at any cross section (cl. 11.2)
j) Thickness of jacket (Table-7 & cl. 13.2)
k) Diameter over jacket (Table-5)

1v) **BEDDING TAPE:**

a) Width (cl. 12.1)
b) Overlap (cl. 12.1)

v) GALVANISED STEEL TAPE:

a) Gap in application of first tape (cl. 12.2)
b) Overlap of second tape over first one on either side (cl. 12.2)
c) Thickness (cl. 22.3 i)
d) Tensile strength (cl. 22.3 ii)
e) Elongation at break (cl. 22.3 iii)
f) Dip test (cl. 22.3 iv)
g) Mass of zinc coating (cl. 22.3 vi)

vi) COMPLETED CABLE:

a)	Drip test	(cl. 19.1)
b)	Cable bend test	(cl. 24.0)
c)	Water penetration test	(cl. 23.0)

vii) ELECTRICAL TEST:

A) **LOW FREQUENCY (AUDIO FREQUENCY RANGE TESTS):**

a	Continuity of conductors, absence of crossed pairs and contacts with poly-al tape.	(cl.25.1)
b)	Conductor Resistance	(cl.25.2)
c)	Resistance unbalance	(cl.25.3)
d)	Continuity of poly-al tape i.e. resistance	(cl.25.4)
e)	Mutual capacitance (Pair/average)	(cl.25.5)
f)	acitance unbalance (Pair to pair)	(cl.25.6.1)
g)	Capacitance unbalance (pair to ground)	(cl.25.6.2)
h)	Dielectric strength (High voltage) between conductors.	(cl.25.10.1)
i)	Dielectric strength between all conductors and shield.	(cl.25.10.2)
j)	Insulation resistance.	(cl.25.11)

B) **HIGH FREQUENCY (150 KHz FREQUENCY RANGE) TESTS:**

a)	Equal level far end cross-talk (ELFEXT)	(cl.25.7.1)
b)	Near end cross talk	(cl.25.7.2)
c)	Attenuation	(cl.25.8)

C) **REDUCTION FACTOR TEST AT 50 Hz** (cl.25.9)

27. ACCEPTANCE TEST:-

27.1 Acceptance test shall comprise the following:

a)	Visual examination	(cl.29)
b)	Test for conductor	(cl.14.0)
c)	Test on polythene insulation/ insulated conductor	(cl.16.3)
d)	Test on Poly-al tape	(cl.10.1)
e)	Test on polythene sheath & jacket	(cl. 20.0) except (cl.20.1)
f)	Test on bedding tape	(cl.10.1)
g)	Test on galvanised steel tape	(cl. 26.2.4,v)
h)	Test on completed cable	(cl. 26.2.4, vi b & vi c)
i)	Electrical test	(cl.25.0)

27.1.1 Any other test as required by the inspecting authority to ensure that offer is in conformity with the requirement of the specification.

28. ROUTINE TESTS:-

28.1 The following shall constitute the routine tests. The manufacturer shall have the system to undertake the following routine tests during in process as well as completed cable stages. As far as possible, the test results of these tests shall be well documented and shown to the inspecting authority as and when asked by the inspecting authority.

a) Visual inspection (cl.29.0) = 100%
b) Dimensional check (cl.10..1, 11.2,11.3, 12.2, 12.3, 13.2, 20.9) = 100%
c) Spark test (cl.11.4, 13.4, & 16.6) = 100% to be carried out for entire lot of material offered for inspection in the form of flow chart in such a way that link up/ back trace history of each drum shall be identified from insulation stage to the final jacketing stage.
d) Electrical test (cl. 25.except cl.25.2) = 20%
(cl.25.2) = 100%
e) Reduction factor (cl.25.9) = 20%
f) Water penetration (cl.23.0) = 100%
g) Bend test (cl. 24.0) = 20%

29. VISUAL EXAMINATION:-

29.1 The physical condition of the cable shall be visually examined by transferring it to another drum. The cable shall be reasonably circular throughout its length and shall be free from any physical defects.

29.2 The cable shall be visually examined to meet the requirement as specified under cl.33 i.e. marking over the cable jacket of unarmoured cable.

30. PACKING:-

30.1 The direction of rotation of the colour scheme of the units in the cable shall be indicated by bends of red colour in the clockwise direction. Suitable self adhesive tapes may be used for the purpose.

30.2 The cable drums shall have cables of lengths 500M ± 10% unless single longer lengths are specified by individual purchaser for specific application.

30.3 Short length upto 55 of the ordered quantity subject to any single short length not less than 150 meter shall be permissible unless otherwise specified by the purchaser.

30.4 The lagging shall be further strengthened by steel straps bound circumferencially over the drum. The tolerance of ± 10% on the nominal drum length for all sizes shall be permitted.

30.5 Cable shall be wound on strong wooden drums conforming to TEC Spec. No. G/CBD-01/02. Nov94 of suitable fungicide. Nails used in the drums shall be properly clinched.

30.6 The drum shall be fitted with spindle plate of minimum thickness 3 mm to take 75 mm round steel spindle.

30.7 The dia. of the yoke of the drums used shall not be less than 20 times the overall dia. of the cable.

30.8 Both ends of the cable shall be kept inside the drums and shall be located to enable easy access for the test. The battons on the drum to gain access to the cable ends shall be painted red.

30.9 Cable ends shall be fastened and secured that the cable turns do not unravel, get loose or displaced.

30.10 The drum shall be effectively lagged with stout and closely fitted battens after cable tests so as to prevent any damage to the cable during transit or storage.

31. SEALING OF ENDS:-

31.1 Immediately after completion of the electrical tests, the ends of the cable shall be sealed by enclosing them in rubber or PVC caps of wall thickness not less than 1.8 mm. The caps shall be robust construction and tight fit. The caps 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. Alternatively, thermoshrinkable capes of adequate wall thickness may be used to seal the ends.

31.2 After the cable is passed & inspected by RDSO, the ends of the cable may be sealed as above, and hot stamping with RDSO stamp at the ends shall be done.

32 SAMPLING:

32.1 All cable drums having cable of same conductor dia. same number of pairs and similar construction shall constitute a lot.

32.2 Drums shall be chosen at random from the lot for taking samples. The samples will be cut from these cable drums. The length of samples required for various tests shall be according to the requirements laid down in various tests clause.

32.3 The number of drums and samples from which test pieces will be taken for various tests shall be as per Table – 7.

33 MARKING:-

33.1 Manufacturer's Identification & Sequential Length Marking :
To enable proper identification of the cable, the following marking shall be embossed, engraved or printed on the polythene jacket in case of armoured cable, and on the sheath for unarmoured cable. All the marking shall be in white or yellow colour.

a) Name/ Trade mark of the manufacturer,
b) Year of manufacture (Calebder year)
c) No. of pairs/ conductor size (Ex.100 prs/0.63 mm)
d) Length (sequential marking)
e) IRS Specification No. IRS: TC 41.
f) Cable drum No.

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

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

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

33.5 The following information shall be stenciled on the drums.

a) Manufacturer's name, brand name of trade mark,
b) IRS Specification No. IRS: TC 41-97,
c) Type of table,
d) No. of pairs and dia. of conductor,
e) Length of cable on the drum,
f) Direction of rotation of the drum (by means of an arrow),
g) Approximate gross weight,
h) Country and year of manufacture,
i) Drum No.

TABLE - 1

CONDUCTOR DIAMETER, RESISTANCE AND ELONGATION

Nominal conductor diameter (mm)	Resistance per km of cable conductor at 20°C (ohms)	Tolerance on resistance (ohms/km)	Minimum % elongation of conductor samples taken from completed cable.
0.50 mm	86	± 6	15
0.63 mm	58	± 4	18
0.90 mm	28	± 2	18

TABLE - 2

CORRECTION FACTOR FOR CONDUCTOR RESISTANCE

Temp. in °C at which conductor resistance is measured	Multiplier constant for conversion to 20°C	Temp. in °C at which conductor resistance is measured	Multiplier constant for conversion to 20°C
10	1.0409	31	0.9586
11	1.0367	32	0.9550
12	1.0367	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 - 3

COLOUR CODE FOR TAPE OR BINDER FOR UNIT IDENTIFICATION

Unit Number	Colour of biner
1	Blue
2	Orange
3	Green
4	Brown
5	Grey

TABLE - 4

COLOUR CODE 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

NOTES:

a) In 10 pair units, cables colours code specified for pairs, 1 to 10 shall be used.

b) In 20 pair units, colour code specified for pair 1 to 20 shall be used.

c) The number of pairs with respect to the colour scheme is only for the purpose of identification of pairs, the actual numerical sequence of the pairs may not be insisted upon.

TABLE - 5

DIAMETER OVER SHEATH AND JACKET

No. of pairs in cable		Maximum Diameter (mm)					
		0.5 mm		0.63 mm		0.9 mm	
Nominal	Actual	Sheath (mm)	Jacket (mm)	Sheath (mm)	Jacket (mm)	Sheath (mm)	Jacket (mm)
10	10	12.7	19.0	15.3	21.5	17.5	23.6
20	20	17.0	24.0	19.0	26.0	25.0	32.0
50	50	22.0	29.0	25.5	32.5	35.0	42.5
100	100	28.0	36.0	34.0	42.0	47.0	55.5
200	200	37.5	45.5	46.0	54.0	65.0	73.0

NOTE:

The above values are tentative and meant for the manufacturer's guidance. These values are subject to modifications after further feed back is received from the manufacturers and users.

TABLE - 6

POLYTHENE SHEATH THICKNESS AND SPARK TEST VOLTAGE

Specified diameter of cable over sheath (mm)		Nominal sheath thickness (mm) (excluding Poly-Al laminate)	Spark test voltage KV	
Above	Upto		RMS AC	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

TABLE - 7

NOMINAL THICKNESS OF JACKET AND SPARK TEST VOLTAGE

Specified diameter of cable over polythene jacket		Nominal thickness of polythene jacket	Spark test voltage KV	
Above	Upto		RMS AC	DC
- mm	46 mm	1.4 mm	8	12
46 mm	64 mm	1.8 mm	10	15
64 mm	- mm	2.2 mm	11	17

TABLE - 8

SAMPLING PLAN FOR ACCEPTANCE TESTS

S. No.	Inspection item & clause No.	Sample size (No. of drum)	No. of test pieces to be taken from each drum.
1.	Dimensions (cl. 10.1, 11.2, 11.3, 12.1, 12.2, 13.2, 20.9)	10% subject to minimum of 1 drum	10 Pairs
2.	Visual examination (cl.29.0)	One drum (min.)	One drum of each size of conductor dia.
3.	Annealing of copper conductors (cl. 14.1.2)	5% subject to min. of 1 drum	10 Pairs
4.	Tensile strength & % elongation of sheath & jacket (cl. 20.3)	- Do -	2 specimen each of sheath & jacket from each size of conductor dia.
5.	Tensile strength & % elongation at break of galvanised steel tape (cl.22.2 except vi)	- Do -	2 specimen each of inner and outer steel tape of the cable for T.S. elongation at break & dip test.
6.	ESCR of sheath & jacket (cl. 20.4)	1 drum (min.)	2 specimen each of sheath & jacket from each size of conductor dia.
7.	Shrinkage of sheath & jacket (cl. 20.5)	1 drum (min)	- Do -
8.	Carbon black content & carbon black dispersion (cl. 20.6 & 20.7)	1 drum (min.)	1 specimen each of sheath & jacket from any drum of the lot.
9.	Shrinkage back of insulation (cl.16.3)	1 drum (min.)	6 test specimen from each colour of insualtion and each size of conductor dia.
10.	Conductor resistance (cl. 25.2)	20% subject to minimum of 2 drum	100%
11.	Resistance unbalance (cl. 25.3)	20% subject to minimum of 2 drum	100%
12.	Mutual capacitance (cl. 25.5)	10% subject to min. of 2 samples.	100%
13.	Capacitance unbalance (cl. 25.6)	10% subject to min. of 2 samples.	100%

S. No.	Inspection item & clause No.	Sample size (No. of drum)	No. of test pieces to be taken from each drum.
14.	Dielectric strength (cl. 25.10)	20% subject to min. of 2 samples.	All pairs (Bunch method)
15.	Insulation resistance (cl.25.11)	20% subject to min. of 2 samples.	All pairs (Bunch method)
16.	Reduction factor (cl.25.9)	5% subject to minimum 1 sample.	2 conductors from different binder & pairs
17.	Water penetration (cl.23)	10%	One specimen from each drum
18.	Cable Bend test (cl. 24)	5% subject to minimum of one sample.	One specimen from each drum
19.	Cross talk (cl. 25.7)	10% subject to minimum of 2 samples	100%
20.	Attenuation (cl. 25.8)	10% subject to minimum of 2 samples.	100%

TABLE - 9
SAMPLEING PLAN FOR TYPE TEST

I. RAW MATERIAL:

S.No	Raw Material	Cl. No. of spec.	Test	Sampling
1.	Polythene for conductor insulation	4	a) Density b) Melt Flow Index c) Dissipation factor (power factor)	1 sample from the bag used for manufacturing cable for type test - Do - - Do -
2.	Filling Compound	15.1 15.3 15.4 15.5 15.6	Stability Toxic/ dermatic hazards Volume Resistivity Permittivity Flash point	- Do - Compound suppliers test certificate to be furnished 1 sample from the Barrel used for manufacturing cable for type test. - Do - - Do -

S.No	Raw Material	Cl. No. of spec.	Test	Sampling
3.	Poly-al tape screen	18.1 18.2	Thickness Peel strength	5 samples from the coil used for manufacturing cable for type test. - Do -
4.	Polythene for sheath and jacket	11	a) Melt Flow Index b) Density	1 sample from the bag used for manufacturing cable for type test. - Do -
5.	Galvanised steel tape	22.3	i) Thickness ii) Tensile strength iii) Elongation iv) Dip test	5 samples from coil used for manufacturing cable for type test. - Do - - Do - - Do -

II. INSULATED CONDUCTORS (EACH COLOUR TO BE TESTED)

S. No.	Cl. No.	Test	Sampling
1.	16.1	Resistance to compression	No. of sets such that at least one conductor for each colour is tested.
2.	16.2	Retraction of insulation	One sample from one bobbine of each colour.
3.	16.3	Shrinkage back of insulation	A minimum of 6 samples of each colour.
4.	16.4	Cold bend	10 samples of each colour
5.	16.5	Thermal stress cracking	10 samples of each colour
6.	17.1	Absorption of filling compound	One set (approx. 20 samples) per colour.
7.	17.2	Elongation and tensile strength	10 samples of each colour
8.	17.3	Environmental stress cracking	lour

III. IN-PROCESS TESTS:

S. No.	Cl. No.	Test	Sampling
1.	3.2.1, 3.2.2	Joints in conductors for resistance & tensile strength	1 joint of each colour of insulated conductor to be tested
2.	16.6	Spark test on insulated conductor	Factory records to be checked up
3.	11.4	Spark test on sheath	- Do -
4.	13.4	Spark test in jacket	- Do -

IV. TESTS ON COMPLETED CABLES:

S. No.	**Cl. No.**	**Test**	**Sampling**
1.	7.2	Colour, thickness & lay of unit binder tape	1 cable drum
2.	10.1	Overlap of poly-al tape	- Do -
3.	19.1	Drip test	2 samples (one from each end) from offered cable drums
4.	19.2	Oxidation/ induction test	1 sample each of each colour of insulation from any one drum
5.	20.1	Bond Strength between Poly-al at over lap ii) Poly-al & sheath	5 samples each each size of conductor dia. - Do -
6.	20	Polythene sheath	
	20.3	Tensile strength	- Do -
	20.3	Elongation at break	- Do -
	20.4	Environmental stress cracking (ESCR)	2 samples each from sheath & jacket of each size of conductor dia
	20.5	Shrinking	- Do -
	20.6	Carbon black content	1 sample from any one drum
	20.7	Carbon black dispersion	- Do -
	20.8	Oxidation induction test	- Do -
7.	12.1	Bedding Tape	Tapes from each size of conductor dia.
		Width	- Do -
		Over lap	- Do -
8.	26.2.4(v)	Galvanised steel tape	- Do -
		a) Gap in the appli-cation of the first tape	- Do -
		b) Overlap of 2nd tape over the first one on either side	- Do -

S. No.	Cl. No.	Test	Sampling
		c) Thickness	- Do -
		d) Tensile strength	2 samples each from inner & outer steel tape of each size of conductor dia.
		e) Elongation at break	- Do -
		f) Dip test	- Do -
		g) Mass of zinc coating	- Do -
9.	20	Polythene jacket	
	20.3	Tensile strength	2 samples each from jacket of each size of conductor dia.
	20.3	Elongation at break	- Do -
	20.4	Environmental stress cracking (ESCR)	- Do -
	20.5	Shrinkage	- Do -
	20.6	Carbon black content	1 sample from any one cable drum
	20.7	Carbon black dispersion	- Do -
	20.8	Oxidation induction test	- Do -
10.	20.9	Thickness of sheath	To be tested for each size of conductor dia.
11.	Table-5	Diameter over sheath	- Do -
	11.2	Variation between the maximum and minimum diameter over sheath at any cross-section	- Do -
12.	20.9	Thickness of jacket	- Do -
13.	Table-5	Diameter over jacket	- Do -
14.	25.4	Resistance of poly-al tape	- Do -
15.	14.1.2	Annealing of copper	10 pairs of each size of conductor dia.
16.	25.10.1	Dielectric strength between conductors.	All conductors of offered drums for type test (Bunch method)
17.	25.10.2	Dielectric strength between all conductors and shield.	- Do -
18.	25.7.1	ELFEXT	100%
19.	25.7.2	NEXT	- Do -
20.	25.8	Attenuation	100%
21.	25.11	Insulation resistance	Bunch method
22.	24	Cable bend test	To be tested for each size of conductor dia.
23.	25.1	Continuity test	- Do -
24.	25.2	Conductor resistance	100% (all drums offered for type test).
S. No.	**Cl. No.**	**Test**	**Sampling**

25.	25.3	Resistance unbalance	- Do -
26.	25.5	Mutual capacitance	- Do -
27.	25.6.2	Capacitance unbalance (pair to pair)	- Do -
28.	25.6.2	Capacitance unbalance (pair to ground)	- Do -
29.	25.9	Reduction factor	One specimen from each drum of two different sizes/ conductor dia with two conductors from different binders and pairs.
30.	23	Water penetration test	Two specimens from each drum from top end and bottom end for two different sizes/ conductor dia.
31.	29	Visual examination	1 drum each of each size of conductor dia.

I. STABILITY TEST METHOD:

Experimental set up is as indicated in fig. 1. About 5 gms filling compound is filled in a glass 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 sports.

This container is suspended vertically in (accurately weighted) test tube so that it hangs freely. The temperature of the jelly is mentioned by a thermometer. The test tube is now placed in a constant temperature bath maintained at 65°C ± 1°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 if 30 cm 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 a approximately 45° angle. The same shall then be suspended in air oven with a glass disc placed directly below the flared and of the cable. The oven temperature shall be set at 65°C ± 1°C for a period of 24 hours. At the end of the test the glass disc shall be examined for the presence of filling compound which might have dripped. There shall be no dripping of filling compound.

III. PEEL STRENGTH FOR LAMINATE AND COMPOSITE SHEATH:

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

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).

Test pieces taken for testing the strength of the bond between the interface of the aluminium tape at the seal shall include only the overlap of the tape.

2. a) For testing peel strength of laminate only, separate the aluminium and polythene tape at one end. Insert the aluminium in the fixed 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 the poly-al –poolythene sheath (other edge) in the grip. For cl. 4.0 a, b & c, the grip can be brought closer upto 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. Initial separation of the laminate or laminated 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 for about 30 seconds.

4. 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 40 gms/mm (minimum) and 60 gm/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 meter length shall be cut from the end of the cable. The inner one meter length as indicated in the fig. 3 shall then be cut for test ensuring minimum disturbance to the cable core during the cutting process. This inner 1 meter sample shall be subjected to the water penetration test. The outer 2 meter shall not be used for this test. However, for acceptance test, piece of only one meter length shall be taken from the end of the cable drum for tests without discarding two meter length.

Testing Arrangement: This arrangement is shown in fig. 2 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 water tight gland to a water pipe containing 1 meter 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 meter 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 ensuring that the head of water is one meter 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:

1. 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 68°C ± 1°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 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 clean and dry.

2. Instrument Test Procedure:

2.1 **Cell Cleaning:** Hold cell at approximately 400°C for 10 minutes in nitrogen. Cell should be cleaned after standing overnight and between testing of different formulations.

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

Engineering Notes:

Dupont 990 with DSC Cell: With instrument in isothermal mode, Calibrate Stating Temperature dial may be set to a reading which results in a corrected thermocouple read-out of 199°C.

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 5°C per minute. Plot melting temperature and interpolate to find the correct set point for 199°C. Repeat calibration required only adjustment for the indium melt temperature.

2.3 **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.

2.4 **Sample Preparation**: Remove the insulation from the conductor. Flatten the resin to about 15 mils thickness (not critical), Clip samples to approximate roundness, about 2mm in diameter.

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

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

2.6 **Oxidation Test:** Rapidly increase sample temperature 20°C/min. or greater) from 100°C or lower initial temperature, to 199°C ± 1°C. 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.

2.7 **Induction Period:** his 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 draw. The time from time zero to this intersection point/ induction time. The insulation over the copper conduction shall be capable of providing a minimum oxidation, Induction Time of thirty minutes.

For this purpose one sample of each colour of any size/ gauge of the cable should be taken as a specimen for testing for type approval.

APPENDIX - A

Information to be furnished by the purchaser:

The purchaser shall specify the following:

1. IRS/RDSO specification number.
2. Conductor size (cl. 2.1).
3. Size of the cable i.e number of pairs (cl.2.1)
4. Quantity.
5. Special length of the cable required in a drum, if any (cl. 30.2)

NOTE:

As an example the purchaser should mention in the indent/ purchase order like:

1. 50 pair, 0.5 mm conductor dia. armoured, PIJF U/G telephone cable as per IRS: Specification No. IRS: TC 41-97. The quantity is to be written separately in the quantity column.

2. 10 pairs, 0.63 mm conductor dia. unarmoured, PIJF telephone cable as per IRS: Specification No. IRS: TC 41-97.

APPENDIX - B

The information to be supplied and instruction to be followed by the manufacturer.

The manufacturer should submit the following to the inspecting authority when the material is ready for inspection:

1. Copy of all the test results of the routine tests as specified in cl. 28.0 of the specification.

2. Type of polythene used for conductor insulation, cable sheath and jacket, Galvanised steel tape, Poly-Al tape etc.

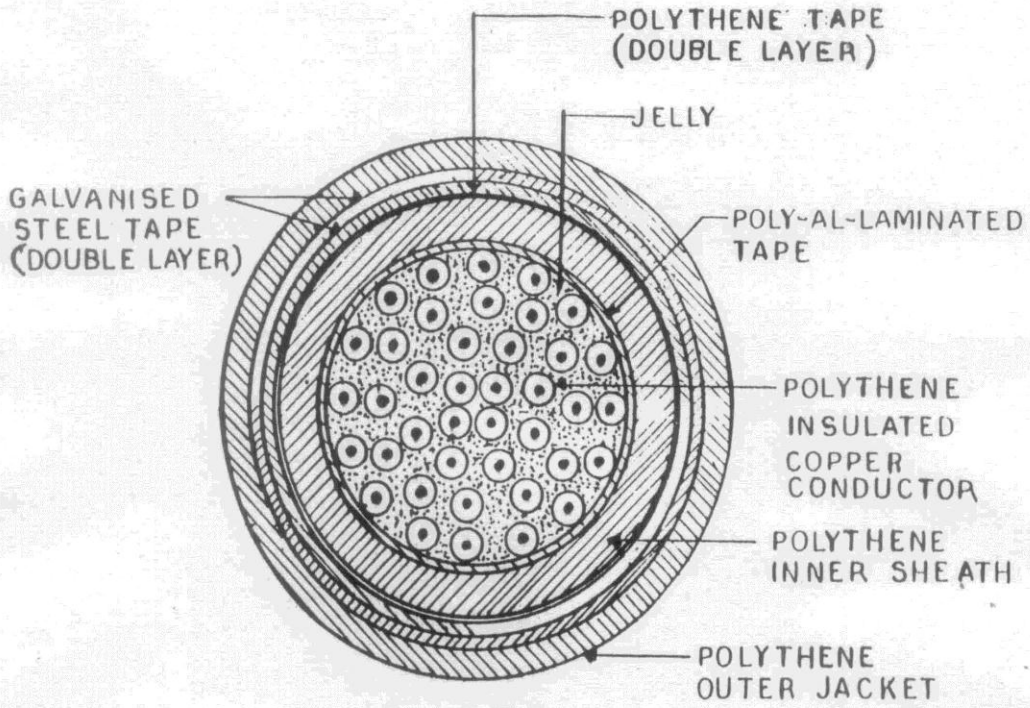
3. Type of jelly used as filling compound.

4. Validity of type approval granted by RDSO/Lucknow.

NOTES:

i) All reasonable/ complete facility considered necessary by the inspecting authorities for the inspection of the cables shall be supplied by the manufacturers free of cost.

ii) In case the inspecting authority observed as a result of the test carried out by him that the recorded test results supplied to him are not reasonably accurate for the lot offered for the inspection, he may reject the complete lot at his discretion and call upon the manufacturer to have the cable type tested before any further supplies are inspected or accepted.



TYPICAL CROSS SECTION OF 20 PAIR

PIJF CABLE

FIG. 1.

ANNEXURE-A-I

STABILITY TESTING METHOD

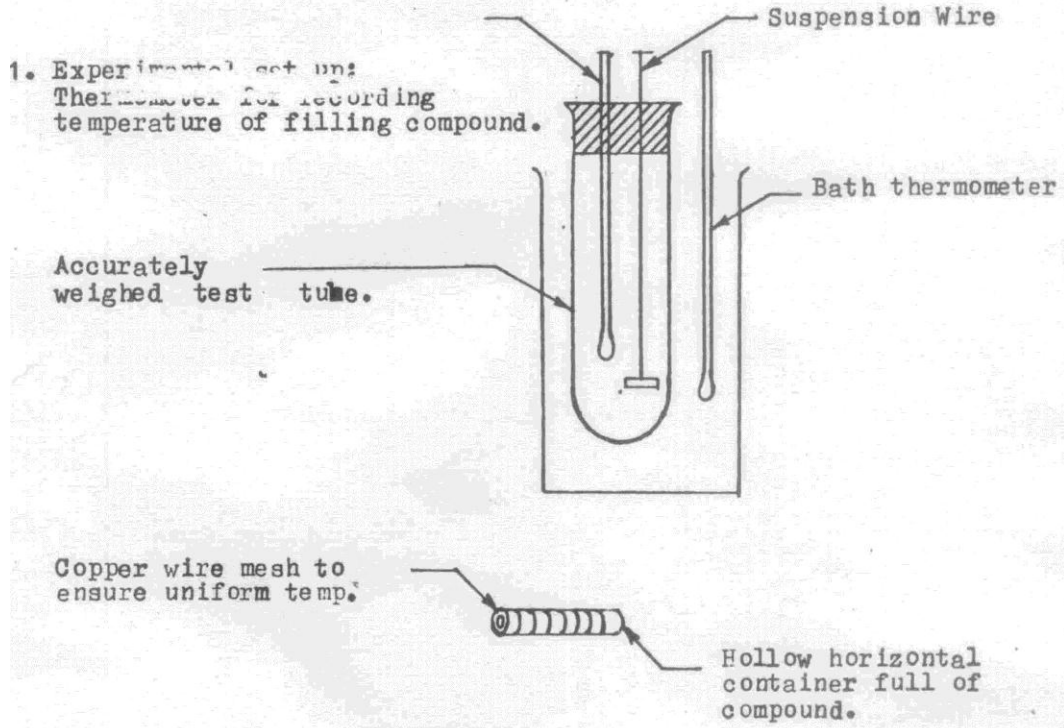


Fig. 2.

ANNEXURE-A-IV

WATER PENETRATION TEST

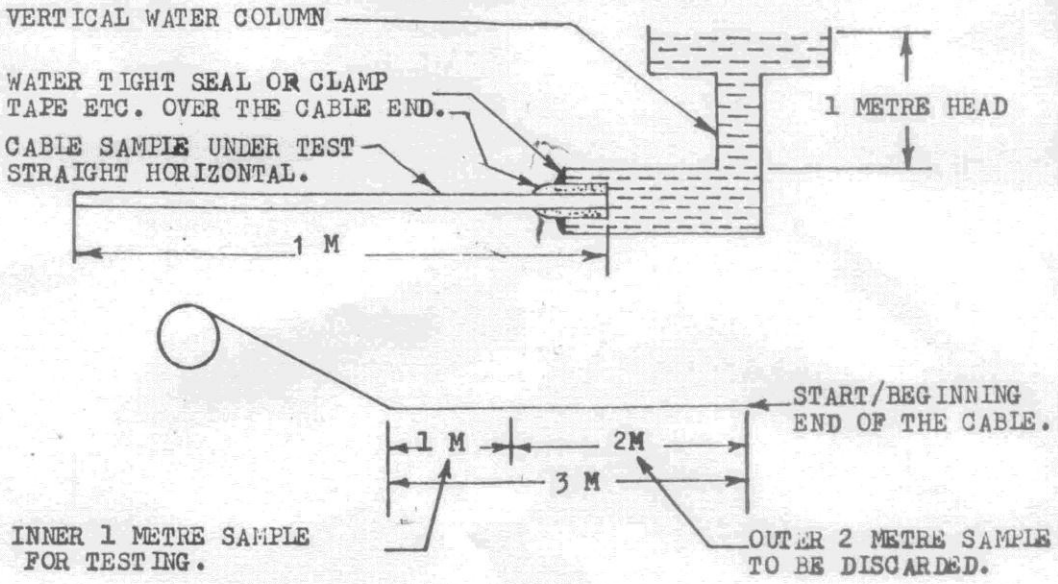


Fig. 3.