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**INDIAN RAILWAYS STANDARD SPECIFICATION
FOR
THERMOSHRINK JOINTING KIT FOR JOINTING
UNDERGROUND QUAD CABLE**

SPECIFICATION NO. IRS: TC 77-2012

Revision 3

**TELECOM DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW-226011**

DOCUMENT CONTROL SHEET

NAME	ORGANIZATION	FUNCTION	LEVEL
Director/ Telecom-III	RDSO	Member	Prepare
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DOCUMENT DATA SHEET		
Specification IRS : TC 77-12		Revision 3
Title of Document Indian Railways Standard Specification for Thermo shrink jointing kit for jointing underground quad cable		
Author Director/ Telecom-III/ RDSO		
Approved by Executive Director/ Telecom/ RDSO		
Abstract This document specifies technical specifications for Thermo shrink jointing kit for jointing underground quad cable		

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REVISIONS/ VERSION/AMENDMENTS /AMENDMENTS

Version	Chapter/ Annexure	Revision/Version/ Amendment	Effective Month/Year
IRS:TC 77-2000	-	First issue Version - 0	2000
IRS:TC 77-2006	-	Revision - 1	2006
IRS:TC 77-2006	-	Amendment - 1	Nov. 2006
IRS:TC 77-2010	-	Revision - 2	March 2010
IRS:TC 77-2012	-	Revision - 3	Nov. 2012

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0. FOREWORD:-

0.1 This Specification is issued under the fixed serial no. IRS:TC 77, followed by the year of adoption as standard or in the case of revision, the year of last revision.

Adopted - 2000

First revision - 2006

Second revision - 2010

0.2 This Specification requires reference to the following Indian Railways Standard (IRS), Telecom Engineering Centre (TEC) and Indian Standard (IS) Specification:-

IRS:TC 30-05

RDSO/SPN/TC/72/07

IRS: S-23

IS:9000

G/CJM-01/01/ JUL 92

G/CJM-15/02.Nov 97

IS: 694-1990

Underground armoured Jelly Filled Quad Cables.

1.4mm dia. Copper conductor 4/6 quad cable.

Electrical Signalling and Interlocking equipment.

Basic climate and mechanical durability test for

Electronic equipments.

Thermoshrink Jointing Kits for unpressurised cables.

Generic Requirements for Discrete Wire Connectors

PVC insulated cables for working voltages up to and including 1100 volts- specification.

0.3 In this specification, if any of the above mentioned specification is referred to by number only without mentioning the year of issue, the latest issue of that specification is implied.

0.4 The specification is intended chiefly to cover the technical provision and the provisions relating to supply of materials and does not include all the necessary provisions of contract.

1. SCOPE:-

This Specification covers the requirements of Thermoshrink Jointing Kits for Underground 4/6 Quad Jelly Filled Cables and underground 4 quad dry core cable of conductor dia 0.9 mm and for Underground 4/6 Quad Jelly Filled Cables of conductor dia 1.4 mm .

2. TERMINOLOGY:-

2.1 For the purpose of this specification the terminology given in IRS S:23 shall be applied.

2.2 The term referred to in this specification but not covered in IRS S:23 is as under:-

2.2.1 LOT- A lot is constituted by the joints of the same type manufactured in same factory during the same period using the same process and materials.

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3. KIT CONTENTS FOR QUAD CABLE JOINTS: - Tentative requirements of various materials in a Kit for Straight through/normal, condenser, Y/derivation, Loading Coil & Transformer Joints are in Cl. 3.1

3.1 The material (Kit Contents) for Universal Jointing Kit to be used for straight through joint, condenser joints, Y-(Derivation) joint, Loading Coil Joint, Transformer Joint.

S.No.	Description of Materials	For 0.9mm dia. 4/6 quad cable		For 1.4mm dia. 4/6 quad cable	
		Size	Quantity	Size	Quantity
1	Heat Shrink Sleeve (Reinforced)	Size 75/15mm – Length 850mm Dimensions as per Annexure I-	1	Size 92/25mm – Length 910mm Dimensions as per Annexure I-	1
2	Stainless Steel Channels x 2,	Length – 450mm (±5mm), Thickness 0.7mm, ±0.1mm & Underclip (Length = 35mm±1mm) & Thickness 0.2mm ±0.05mm	1	Length – 470mm (±5mm), Thickness 0.7mm, ±0.1 & Underclip (Length = 35mm±1mm) & Thickness 0.2mm ±0.05mm	1
3	Aluminium Cannister Finger Coated	Size = 75mm x length 507mm (Dimension as per Annexure-II)	1	Size = 92mm x length 507mm (Dimension as per Annexure-II)	1
4	Adhesive P.V.C.Tape	Width (25mm ±1mm)x length (10 meter/roll Minimum)x Thickness (0.1 to 0.13mm)	2	Width (25mm ±1mm)x length (10 meter/roll Minimum)x Thickness (0.1 to 0.13mm)	3
5	Adhesive Aluminium Foil	Length (400mm±4mm) x width (100mm±2mm)x thickness (0.06 ±0.01mm)	1	Length (400mm±4mm) x width (100mm±2mm)x thickness (0.06 ±0.01mm)	2
6	Cleaning Tissue (Soaked with 5ml min Iso Propyl Alcohol)	Tissue paper size- Length (190mm min.) Width- (140mm min.)	3	Tissue paper size- Length (190mm min.) Width- (140mm min.)	3
7	Emery Strip	Length (600mm±5mm)x width (25mm± 1mm)x 60 mesh)	2	(Length (600mm±5mm)x width (25mm± 1mm)x 60 mesh)	2

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8	Tinned Copper braid	(length 500mm±5mm)x width (7mm±1mm) with heat shrink tubing size 12/4mm (length 450mm±.5mm).	1	(length 500mm±5mm)x width (7mm±1mm) with heat shrink tubing size 12/4mm (length 450mm±.5mm).	1
9	Sealant Tape	Length 400mm ±10, width 35mm ±3 x thickness 3mm ±0.5	2	Length 400mm ±10, width 35mm ±3 x thickness 3mm ±0.5	3
10	Protective split Aluminium Ring	Size :- Dia 22mm -0.0mm +2mm x width 20mm ±1mm x thickness 0.9mm ±0.1mm	2	Size :- Dia 30mm -0.0mm +3mm x width 20mm ±1mm x thickness 0.9mm ±0.1mm	2
11	Spring Steel Roll	OD-21mm ±1mm Width - 16mm ±1mm, No of rolls Minimum 8, thickness of the steel sheet 0.2mm±0.02mm	4	OD-21mm ±1mm Width - 16mm ±1mm, No of rolls Minimum 8, thickness of the steel sheet 0.2mm±0.02mm	4
12	PVC Sleeves	dia - (5mm±0.5mm) x length (50mm±3mm)	30	i) dia - (7mm±0.5mm) x length (50mm±3mm) ii) dia - (10mm±0.5mm) x length (65mm±3mm)	30 Nos. 10 Nos.
13	Cleaning Cloth	Length 1 Meter (1000mm)min. x Width 0.75 meter (750mm)min.	1	Length 1 Meter (1000mm)min. x Width 0.75 meter (750mm)min.	1
14	Cotton Waste	50 gram (min.)	2 Bags	50 gram (min.)	2 Bags
15	Multi strand tinned copper conductors insulated cable (single core)	Length 2000 mm ±10 mm, Nominal Cross sectional area 4 sq. mm, for armour continuity	1	Length 2000 mm ±10 mm, Nominal Cross sectional area 4 sq. mm, for armour continuity	1
16	Transparent polythene sheet:	length (500mm Min) x width (300mmMin),	1	length (750mmMin) x width (750mm	1

		thickness (0.07 to 0.1mm)		Min), thickness (0.07 to 0.1mm)	
17	Jelly filling Compound	(300 gm. min.)	2 Pack	(300 gm. min.)	2 Pack
18	Installation Instructions		1		1
19	Kit Packing Box	size length 900mm x 140mm height x 120mm width (Tolerance + 10mm, - 5mm)	1	size length 950mm x 140mm height x 140mm width (Tolerance + 10mm, -5mm)	1
20	Packing Slip		1		1
21	Cleaning Liquid	200 gm. (min.)	1 Pack	200 gm. (min.)	1 Pack
22	Sheath Connector (1+1+1) Assembly	(1+1+1) indicates a) 2 Clips Sheath Connector, length 700mm ± 7mm b) 1 Clip Sheath Connector, length 300mm ± 3mm c) Bridge connector	1 1 1	(1+1+1) indicates a) 2 Clips Sheath Connector, length 700mm ± 7mm b) 1 Clip Sheath Connector, length 300mm ± 3mm c) Bridge connector	1 1 1
23	Branch Off Clip (Medium)	(Dimensions as per – Annexure III) For Y (Derivation) Joint & Transformer Joint	1	(Dimensions as per – Annexure III) For Y (Derivation) Joint & Transformer Joint	1
24	Cable tie	length (254mm±3mm), width (4.75mm±0.5mm), thickness (1.43mm±0.1mm)	1	length (315mm±3mm), width (4.75mm±0.5mm), thickness (1.56mm±0.1mm)	1
25	IDC type Jelly filled discreet wire connectors	IDC type jelly filled butt connector modules made of polypropylene for 3 wires (0.4mm to 0.9mm dia. conductors)	30 Numbers	Not applicable	-
26	IDC type Jelly filled discreet wire connectors	IDC type jelly filled connector modules made of polypropylene for 2 wires bridging type (0.4mm to 0.9 mm dia. conductors)	6 Numbers	Not applicable	-

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27	Parallel jaw plier	Parallel jaw plier for crimping the discrete wire connectors. The dimension of the plier shall be compatible with the crimping tool and shall be supplied by the manufacturer of the discrete wire connectors.	One plier for every 20 jointing kits for 0.9 mm quad cable or part thereof. Minimum quantity 1 No.	Not applicable	-
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- Note:-**
- The dimensions of kit contents given in the table shall be taken as final in case of any mismatch with the dimensions mentioned anywhere else in this specification.
 - Supply of either item at SN.12 or items under SN 25, 26 and 27 shall be specific to purchaser's requirement as per clause 12 of the specification. Item No. 25, 26 and 27 shall only be supplied if IDC type discreet wire connectors are required by purchaser and in that case item number 12 shall not be supplied.

4.0 DESCRIPTION OF KIT CONTENTS:-

4.1 Heat Shrink Sleeve (Reinforced) :-

4.1.1 The heat shrink sleeves shall be manufactured from cross linked, heat shrinkable, thermally stabilised polymers consisting of a reinforcing, heat shrinkable fabric contained in a matrix material. Sleeves shall be of wrap around design furnished with stainless steel channel and one under clip to make the wrap around sleeve cylindrical prior to shrinking operation.

The inside surface of the sleeve shall be coated with a hot melt adhesive which will bond at the temperature attained during the shrinking operation. Outside surface of the sleeves shall be coated with a temperature indicating paint which shall change colour when the desired temperature is attained to allow controlled heating during installation.

4.1.2 The dimensions of heat shrink sleeves (Reinforced) Size shall be as per Annexure-I.

4.2 Stainless steel channel under clip:-

4.2.1 The stainless steel channel and under clip shall be used to close the heat shrink sleeves before shrinking.

4.3 Aluminium canister – Finger coated:-

4.3.1 The aluminium canister shall comprise of two performed half shells that can be hinged and fitted around the cable splice. The aluminium canister shall provide adequate structural strength to avoid collapsing during installation.

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4.3.2 The dimensions of Aluminium Canister finger coated size shall be as per Annexure-II.

4.3.3 The fingers shall contain a protective coating of not less than 1 mm thickness for length of 30 to 40 mm at the finger end.

4.4 Adhesive PVC tape:-

4.4.1 The PVC adhesive tapes shall be used for taping the fingers of Aluminium canister. Also, it is used to cover the splice bundle.

4.4.2 The size of the tape shall be “Width (25mm \pm 1mm) x Length (10meter/roll \pm **0.1meter**) x Thickness (0.1mm to.13mm)”

4.5 Adhesive Aluminium foil:-

4.5.1 The adhesive Aluminium foil shall be used to protect the cable jacket from damage during shrinking of heat shrink sleeves.

4.5.2 The adhesive Aluminium foil shall be in a strip form with adhesive coating on one side and protected by a release film.

4.5.3 Dimension of Aluminium foil shall be “Length (400mm \pm 4mm) x Width (100mm \pm 2mm) x Thickness (0.06mm \pm 0.01mm)”

4.6 Cleaning tissue:-

4.6.1 The cleaning tissue shall be supplied in sealed pouches containing Iso Propyl Alcohol (IPA) conforming to IS: 2631. The size of the tissue paper shall be “Length 190 mm (**min.**) x Width 140 mm (min.)”

4.6.2 The quantity of IPA contained in the pouch shall be 5 ml (min.) and the material of the pouch shall be laminated Aluminum.

4.6.3 The pouch shall be marked as under:

- Name of material
- Manufacturer’s identity
- Batch No.
- Precautions regarding handling.

4.7 Emery strip:-

4.7.1 The emery strip shall be used for surface preparation of cable with PVC/Polyethylene sheath.

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- 4.7.2 The emery used shall be synthetic or natural emery.
- 4.7.3 Cloth shall be used as backing material. The cloth shall be drill weave and shall have a breaking load of not less than 400N/25mm width when tested with a speed of 50mm/minute.
- 4.7.4 The emery cloth shall be supplied in the form of strip size “Length (600mm \pm 5mm) x Width (25mm \pm 1mm) x 60 mesh.”

4.8 Sealant tape:-

- 4.8.1 The sealant tape shall be a butyl rubber based elastic plastic sealing compound, black in colour which is used for different applications in cable jointing.
- 4.8.2 The sealant tape shall be supplied in a strip form of uniform dimensions with release paper on both the side to prevent sticking.
- 4.8.3 The sealant tape shall be capable of releasing easily from the release paper and also shall not flow during storage.
- 4.8.4 The sealant tape shall have a shelf life of not less than two years when stored at room temperature.
- 4.8.5 The sealant tape shall have good adhesive to metals and PE without preheat, medium strength and very good chemical and thermals stability. It shall not cause corrosion to the metal which comes into contact with it.

4.9 Branch off clip:-

- 4.9.1 The branch-off clip shall provide high performance cable branching technique and shall be easy to install.
- 4.9.2 The branch off clip shall be made of corrosion resistant aluminium alloy conforming to IS 617 grade 4600 and coated with epoxy.
- 4.9.3 The design of the branch off clip shall conform to the details given in Annexure-III and also the dimensions mentioned therein. The branch off clip shall have three fingers, the middle one coated with hot melt adhesive identical to that on the Thermoshrink sleeve. The adhesive on the branch off clip shall however, have a different colour to that of the Thermoshrink sleeve adhesive and thus give a visual indication to the jointer of correct adhesive flow and scaling of the branch.
- 4.9.4 The branch off clip shall contain the identification of the manufacturer/supplier on the metal part.

4.9.5 Dimension of Branch off clip (Medium size) as per Annexure-III.

4.10 Tinned copper braid:-

4.10.1 Tinned copper braid shall be used for continuity between the aluminium wire screens.

4.10.2 The tinned copper braid shall be made of copper and shall be free from dirt/grease.

4.10.3 There shall not be any dark patches on its surface.

4.10.4 “ The width and cross-section area of braid shall be $7\text{mm} \pm 1\text{mm}$ and 4 sq mm (min.) respectively. The length of braid shall be $500\text{ mm} \pm 5\text{mm}$.”

4.10.5 “ No. of strand/No. of wires in the braid shall be 24/6 or 12/12 or 16/9”.

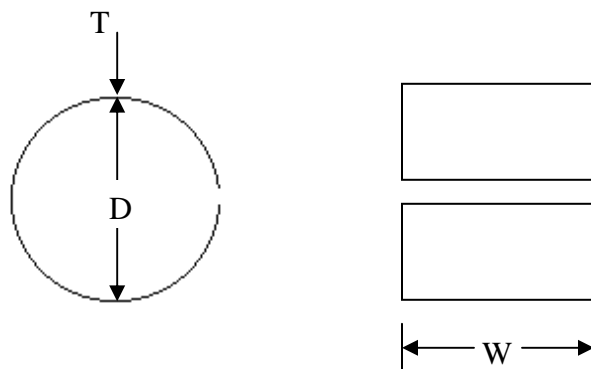
4.10.6 “ Heat Shrink tubing size $12/4\text{mm}$ – length $450\text{mm} \pm 5\text{mm}$.”

4.11 Protective Split Al ring :-

4.11.1 Protective split Aluminium ring shall be used over aluminium wire screen to prevent loosening of aluminium wire screen from the sheath.

4.11.2 Protective split ring shall be made of Aluminium and shall have no corrosion.

4.11.3 Protective split ring shall have dimensions as under :-



Type of cable	Internal Diameter D	Width W	Thickness T
For 0.9mm dia. 4/6 quad cable	22mm -0.0mm +2.0mm	20mm \pm 1mm	0.9mm \pm 0.1mm
For 1.4mm dia. 4/6 quad cable	30mm -0.0mm +2.0mm	20mm \pm 1mm	0.9mm \pm 0.1mm

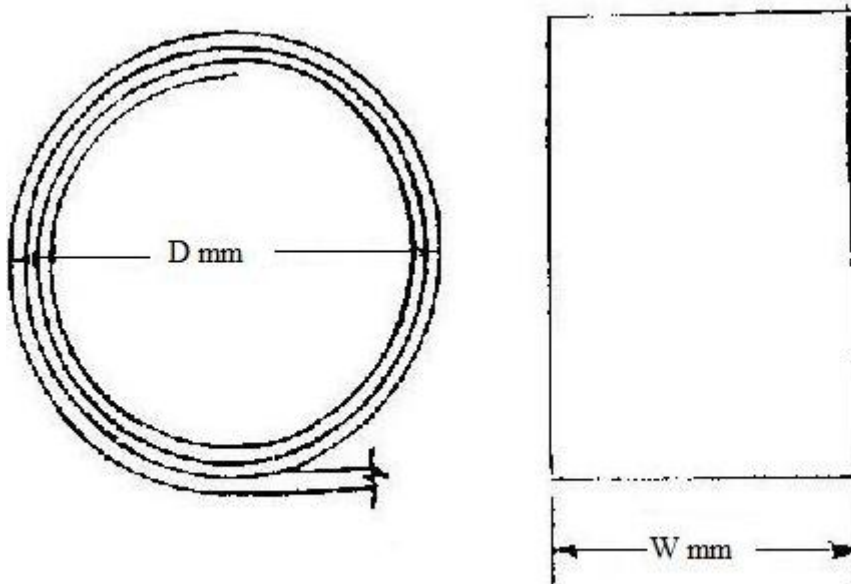
4.11.4 Protective split aluminium ring shall be supplied in polybag and with manufacturer's identity.

4.12 Stainless Steel Spring:-

4.12.1 Stainless steel spring shall be used to tighten multi strand flexible tinned copper cable over Aluminium wire screen for providing continuity of Aluminum screen. Similarly it shall be used to tighten multi strand flexible tinned copper cable over Steel armour for providing continuity of steel armour.

4.12.2 Stainless steel spring shall be made of stainless steel and its surface shall be free from oil and grease.

4.12.3 The dimensions of stainless steel spring roll shall be as under :



Outer diameter (D)	Width (W)	No of Complete rolls (minimum)	Thickness of the steel tape
21mm ± 1mm	16mm ± 1mm	Minimum 8	0.2 mm±0.02 mm

4.12.4 Stainless steel spring roll with manufacturers identity shall be supplied in polybag

4.13 PVC Sleeve :-

4.13.1 The PVC sleeve shall be used to cover ends of twisted copper conductor pairs.

4.14 Cotton waste:-

4.14.1 Cotton waste shall be used in cleaning of cable joint.

4.14.2 Cotton waste supplied with the jointing kit shall be clean and soft.

4.15 Multi strand tinned copper conductors insulated cable (single core):

4.15.1 It shall be used for providing continuity between the steel armours of the cables being joined.

4.15.2 It's length shall be 2000 mm ±10 mm and Nominal Cross sectional area shall be 4 sq. mm.

4.15.3 It shall be flexible multi strand copper conductors single core cable insulated conforming to IS 690-94

4.16 Filling Compound:-

In joints, the splice bundle shall be filled with filling compound in order to prevent insulation break down in the event of water entry into the joint.

4.17 Polythene Sheet (TPE Sheet) :-

4.17.1 For quad cable of 0.9mm dia. copper conductor:-

“ The polythene sheet for filling compound shall be provided Length (500mm ± 5mm) x Width (300mm ±3mm) with thickness (0.07mm to 0. 1 mm).”

4.17.2 For quad cable of 1.4mm dia. copper conductor:-

“ The polythene sheet for filling compound shall be provide Length (750mm ± 7mm) x Width (750± 7mm) with thickness 0.07mm to 0.1mm”

4.18 Sheath Connector Assembly:-

The sheath connector assembly consists of three items, viz an insulated stranded copper wire with connecting elements on both sides, a small wire of the same description with connecting elements on one side only and a bridge connector for jointing the two wires. The connecting element is made of phosphor bronze, backed by a non-corrosive metal back-plate strongly pressed to it and also crimped to the connecting wire. The element has an opening provided with toothed jaws into which the cable sheath can be inserted and crimped using ordinary pliers. The toothed jaws when crimped bite through the cable sheath to make a good low-resistance metallic contact with the sheath of the cable. In order to inter-connect the sheath connector wires in branch joints, the bridge wire connector is used in conjunction with the single ended connector assembly. The flexible wire shall be 14 SWG.

4.19 Cable Tie:-

Material:- UL approved Nylon-66,94 V-2

Operating Temperature:- (-)40 degree C to (+) 85 degree C

Colours available:- Natural or Black

Cable tie is an economical and versatile method of cable/wire bunching.

Cable tie has a self-locking one piece construction which ensures fast installation.

It is self-locking and releasable type.

Size	For 0.9mm dia. 4/6 quad cable	For 1.4mm dia. 4/6 quad cable
Length	254 ± 3mm	315mm ± 3mm
Width	4.75 ± 0.5mm	4.75mm ± 0.5mm
Thickness	1.43 ± 0.1mm	1.56mm ± 0.1mm
Tensile Strength Kgs (lbs)	22Kgs (50lbs) min.	22Kgs (50lbs) min.

4.20 IDC type jelly filled discreet wire connector: It shall be made of Polypropylene and as per TEC GR No. G/CJM-15/02.Nov 97.

4.20.1 IDC type jelly filled butt connector modules made of polypropylene for 3 wires (0.4mm to 0.9mm dia conductors) 30 Numbers, to be used for joining two/ three conductors of conductor diameter varying from 0.4 mm to 0.9 mm.

4.20.2 IDC type jelly filled connector modules made of polypropylene for 2 wires bridging type (0.4mm to 0.9mm dia conductors) 6 Numbers to be used for making derivation joint on a quad without cutting conductors.

4.21 Parallel Jaw plier: Parallel jaw plier for crimping the discrete wire connectors. The dimension of the plier shall be compatible with the discrete wire connector and shall be supplied by the manufacturer of the discrete wire connectors.

5.0 Tests on Complete Joint Closures:-

Following tests shall be carried out on complete heat shrink joint closures.

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5.1 Tightness Test:-

The tightness of installed closures shall be checked by pressurising to 700m bars for a period of 15 minutes while immersed in water at room temperature. A sample shall be considered tight if there is no continuous stream of air bubbles escaping from it.

One quad will be removed for tightness test (type test) at the times of cable preparation.

Pressurised air will be applied at one end of the cable & pressure will be measured at other end of the cable at the time of tightness test.

5.2 Vibration Test:-

A test specimen shall be mounted on a vibration apparatus with the cables rigidly clamped at distances of $10xD$ (Minimum 250 mm) from each end of the sleeve. D being the cable outer diameter.

In case of more than one cable, the outer diameter of the largest cable is used. Its centre point shall then be subjected to a sinusoidal vibration with a frequency of 100 vibrations per minute and amplitude of 20mm for a period of 2 hours.

5.3 Impact Test:-

Installed specimen shall be placed on a smooth, flat, horizontal surface. The rail shall be rotated by 90 degree from the point of impact.

A steel load weighing 1 Kg shall be suspended at a height of 2 meters above the centre of the test specimen. The weight shall be allowed to fall under gravity, striking the test specimen at the apex of curvature.

After the impact, the samples shall be subjected to the tightness test as described in clause 5.1.

5.4 Axial Pull Out Test:-

An axial tensile force of $D/45 \times 1000N$, with a maximum of $1000 \pm 10N$ shall be applied on each individual cable protruding from the splice, where D is the cable outside diameter in millimeters. Each cable shall be tested individually for 3 hours.

After completing the test, samples shall be subjected to the tightness test as described in clause 5.1.

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5.5 Torsion Test:-

The specimen shall be clamped rigidly. Extending cables shall be gripped at a distance of 10xD from sleeve edge. (D is the cable outside diameter). Each cable shall be tested individually.

A torsion cycle consist of each cable being subjected to a torsional stress of 50 Nm maximum or an angle of 90° maximum in one direction for a duration of .5 minutes. The cable shall be returned to its original position and the same maximum torsional stress is then applied in the opposite direction for 5 minutes. The cable shall then be returned to its neutral position. After completing two torsion cycles per cable, the sample shall be subjected to the tightness test as described in clause 5.1.

5.6 Bending Test:

The specimen shall be clamped on a smooth, flat, horizontal surface. A being force of maximum 500N shall be applied at a distance of 10xD (minimum 250mm) from the sleeve edge on each extending cable to deflect the cable to maximum angle of 45 degree (or a maximum displacement of 300 mm from the horizontal) at the point of application of the force. (D is the cable outside diameter). Each cable shall be tested individually.

A bending cycle shall consist of one excursion of the cable from the neutral position to the specified limit in one direction, back to the limit specified, maintained for 5 minutes and returned to the neutral position.

After completing two cycles per cable, samples shall be subjected to the tightness as described in clause 5.1.

5.7 Temperature Cycling Test:-

Installed samples shall be placed in a water bath and subjected to 30 cycles.

Each cycle requires 12 hours as stated below :-

2± ½ hours – Room temp. to 65⁰C±5⁰C.

6 hours at 65⁰C ± 5⁰C.

2 hours 65⁰± 5⁰C C to room temp.

2 hours at room temp. (minimum).

After completing every 10 cycles, samples shall be subjected to the tightness test as described in clause 5.1.

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5.8 Thermal Shock Test:-

Installed joint closures shall be immersed in water bath heated to $65 \pm 5^{\circ}\text{C}$ so that they are at least 5 cm below the water surface. After 15 minutes, the samples shall be suddenly transferred to ice after at $0 \pm 5^{\circ}\text{C}$ for 15 minutes.

After completing ten cycles, samples shall be subjected to the tightness test as described in clause 5.1.

5.9 Corrosion Test:-

Separate test samples shall be kept immersed in solutions of pH value 4 and 10 for 30 days. After completion of this period, the samples shall be visually inspected for corrosion of metallic parts and then subjected to the tightness test as described in clause 5.1.

5.10 Blunt Blade Test:-

The test shall be performed only on glass fibre reinforced sleeve. The installed sample shall be placed horizontally on a bed of dry sand so that the sample is supported without movement. A blunt steel blade of 6 Kg shall be allowed to fall under gravity from a height of 1 meter. The sample shall be positioned so that impact occurs at 90° from channel. After completing the impact, the sample shall be subjected to tightness test as described in clause 5.1.

5.11 Spot Heat Test:-

This test is to be conducted on reinforced sleeves.

5.11.1 Immediately after installation of a sleeve according to standard instructions, the tip of the yellow flame of length approx 330mm with blue position of around 80mm shall be allowed to impinge on area of the sleeve away from the seam, at the center of splice for 10 seconds. The sleeve shall not split and ooze out any adhesive during the application or after the withdrawal of the flame.

5.11.2. Application of Flame: The tip of the flame (minimum of 50mm) shall be allowed to impinge perpendicular to the surface and evenly on the joint so as to ensure steady contact with the sleeve surface.

5.12 REOPENING:-

One sample shall be reopened and closed five times. After completion, the sample shall be subjected to Air Tightness Test as per Clause 5.1. Also there shall be no damage to the cable and other reusable parts.

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5.13 STATIC LOAD TEST

A static load of 1000 \pm 10N shall be applied on the joint closure 90° from the seam. The load shall be applied for 5 minutes and then removed. The sample shall then be turned through 180° and the load reapplied for an additional five minutes. After completion the test, the sample shall be subjected to the tightness test as per Clause 5.1

6.0 TESTS:-

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

6.1 Type Tests on joint closure on Jelly Filled Quad Cable:-

6.1.1 Tests on completed joint closure of Quad cable.

6.1.1.1 All tests on complete closures i.e. given under clause numbers 5.1 to 5.13 shall be carried out. A minimum of 1 sample of complete joint closures of each type i.e. straight through, and condenser joint 2 samples of complete joint closures of each type i.e. loading coil joint and transformer joint shall be made and numbered as 1 to 24. Thus no. of complete joint closure for each type of cable i.e. 4 quad jelly filled and 6 quad jelly filled shall be 6 each respectively for 0.9mm dia. & 1.4mm dia 4/6 quad cables. Hence total no. of joints to be made shall be 24.

6.1.1.2(a) 0.9mm dia. 4/6 quad cable straight through joint sample no. 1(4QJ), 7(6QJ) & condenser joint sample no. 2 (4QJ), 8(6QJ) and loading coil joint sample no. 3,4(4QJ), 9,10(6QJ) and transformer joint sample no. 5,6(4QJ), 11,12 (6QJ) shall be made.

6.1.1.2(b) 1.4mm dia.4/6 quad cable straight through joint sample no. 13(4QJ), 19(6QJ) & condenser joint sample no. 14(4QJ), 20(6QJ) and loading coil joint sample no. 15,16(4QJ), 21,22(6QJ) and transformer joint sample no. 17,18(4QJ), 23,24(6QJ) shall be made.

6.1.1.3 Tightness test as per clause 5.1 shall be carried out on all the 24 samples.

6.1.1.4 Vibration test as per clause 5.2 shall be carried out on sample no. 4,16(4QJ) & 10,22(6QJ) i.e. loading coil joint.

6.1.1.5 Impact test as per clause 5.3 shall be carried out on sample no. 3,15(4QJ) & 9,21(6QJ) i.e. loading coil joint.

6.1.1.6 Axial pull out test as per clause 5.4 shall be carried out on sample no. 6,18(4QJ) & 12,24(6QJ) i.e. transformer joint.

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6.1.1.7 Torsion clause as per clause 5.5 shall be carried out on sample no. 4,16(4QJ) & 10,22(6QJ) i.e. loading coil joint.

6.1.1.8 Bending test as per clause 5.6 shall be carried out on sample no. 6,18(4QJ) & 12,24(6QJ) i.e. transformer joint.

6.1.1.9 Temperature Cycling test as per clause 5.7 shall be carried out on sample no. 5,17(4QJ) & 11,23(6QJ) i.e. transformer joint.

6.1.1.10 Thermal shock test as per clause 5.8 shall be carried out on sample no. 4,16(4QJ) & 10,22(6QJ) i.e. loading coil joint.

6.1.1.11 Corrosion test as per clause 5.9 shall be carried out on samples no. 1,2,13,,14(4QJ) & 7,8,19,20(6QJ), for pH 4 & pH10 value) i.e. straight through and condenser joints.

6.1.1.12 Blunt blade test as per clause 5.10 shall be carried out on sample no. 6,18(4QJ) & 12,24(6QJ) i.e. transformer joint.

6.1.1.13 Spot heating test as per clause 5.11 shall be carried out on sample no. 4,16(4QJ) & 10,22(6QJ) i.e. loading coil joint.

6.1.1.14 Reopening Test as per Clause 5.12 shall be carried out on sample no. 3,15(4QJ) & 9,21(6QJ) i.e. loading coil joint.

6.1.1.15 Static load test as per clause 5.13 shall be carried out sample no. 3,15(4QJ) & 9,21(6QJ) i.e. loading coil joint.

6.1.2 Tests on raw material/component of Kit Contents of Quad cable:-

6.1.2.1 One sample each of raw material/components of Kit contents shall be taken for carrying out tests as per Annexure-IV.

6.1.2.2 Test of raw material/ components shall be done at firm's premises. If the test facility for any particular test does not exist with the firm samples of raw materials for the test shall be sealed by inspecting official and shall be sent to government approved testing labs for carrying out the tests.

6.1.2.3 Vendors have to use the out sourced raw material/components of the same manufacturers for which approval was granted. In case vendor decides to change or to have additional source/ sources of raw material/components which are procured from out sourced agencies/sub vendors, the vendors have to apply to RDSO/Lucknow well in advance regarding their proposal with reasons. The competent authority in RDSO, Lucknow on the merit of the case shall decide and advice Director/Inspections to conduct tests pertaining to that particular material/components specified in the specification (Annexure-IV).For RTSF

sleeve the tests will be carried out as per clause no. 6.1 also in addition to those specified in Annexure IV.

6.1.2.4 Main manufacturers/sub vendors manufacturing identity/Trade mark shall be printed/embossed on each of the items of Kit contents which have to be ensured by inspecting agencies during test.

Note:- All tests shall be covered regardless of number of specimen samples of complete joint closures.

6.1.3 All samples shall successfully pass all the tests of the clause 6.1.1 & 6.1.2 for proving conformity to the specification. Type approval shall be accorded to the firm after samples pass the above tests.

6.2 Acceptance Tests:-

6.2.1 The following shall constitute acceptance tests :-

The items appearing in Kit contents of Quad Cable i.e. clause 3.1 shall be tested as per the sampling plan of acceptance tests given below: -

6.2.2 Sampling plan for acceptance tests for Quad cable.

SN	Tests	Sample size
1.	“Dimensions (SN 1 to 3, 5,7 to 13, 16, 19 & 22 to 24 of clause no. 3.1)”	2 for lot size 8, 3 for lot size 9-15, 5 for lot size 16-25,8 for lot size 26-50, 13 for lot size of 51 to 90, 20 for lot size 91-150, 32 for lot size 151-280, 50 for lot size 281-500, 80 for lot size 501-1200, 125 for lot size 1201-3200 and 200 for lot sizes greater than 3201.
2.	Visual Examination (Clause No. 3.1)	-do-
3.	Manufacturer’s Identity/Trademark Cl. 3.1	-do-
4.	Anchorage of PVC Tape (S.N.4 of Cl. 3.1)	One sample from the offered lot.
5.	Tensile Strength of PVC Tape (SN 4 of Cl. 3.1)	-do-
6.	Elongation of PVC Tape (SN 4 of Clause 3.1)	-do-
7.	Adhesion to Steel of PVC Tape (SN 4 of Cl. 3.1)	-do-
8.	Tensile Strength of Adhesive Aluminium Foil (SN5 of Cl.3.1)	-do-
9.	Elongation of Adhesive Aluminium Foil (SN5 of Cl.3.1)	-do-
10.	Adhesion to steel of Adhesive Aluminium Foil (SN 5 of Clause 3.1)	-do-
11.	Breaking Load of Emery Strip (SN 7 of Clause 3.1).	-do-

12.	Integrity of abrasive bond of Emery Strip (SN 7 of Clause 3.1)	-do-
13.	Handling test on Sealant Tape (SN 9 of Clause 3.1)	-do-
14.	Shear Strength of Sealant Tape (SN 9 of Clause 3.1)	-do-
15.	Softening Point of Sealant Tape (SN 9 of Clause 3.1)	-do-
16.	Needle Penetration of Sealant Tape (SN 9 of Clause 3.1)	-do-
17.	Colour of Sealant Tape (SN 9 of Clause 3.1)	One sample from the offered lot.
18.	Weight/Pouch of Jelly Filling Compound (SN 17 of Clause 3.1)	2 for lot size 8, 3 for lot size 9-15, 5 for lot size 16-25, 8 for lot size 26-50, 13 for lot size of 51 to 90, 20 for lot size 91-150, 32 for lot size 151-280, 50 for lot size 281-500, 80 for lot size 501-1200, 125 for lot size 1201-3200 and 200 for lot sizes greater than 3201.
19.	Cone Penetration of Jelly Filling Compound (SN 17 of Clause 3.1)	One sample from the offered lot.
20.	Homogeneity of Jelly Filling Compound (SN 17 of Clause 3.1)	-do-
21.	Air entrapment of Jelly Filling Compound (SN 17 of Clause 3.1)	-do-
22.	Wire Pull Out from connecting element of Sheath Connector Assembly (SN 22 of Clause 3.1)	
23.	Wire Pull Out from Bridge connector of Sheath Connector Assembly (SN 22 of Clause 3.1)	-do-
24.	Quantity & colour of cleaning tissue (SN 6 of Clause No. 3.1)	-do-
25.	Colour & Tensile strength of Cable Tie (SN 24 of Clause 3.1)	-do-
26.	Dimension of Adhesive PVC Tape (SN. 4 of Clause 3.1) & Cleaning Tissue (S.N.6 of Cl.3.1)	One sample from the offered lot.
27.	Peel strength of hot melt adhesive to polyethylene (SN-1 of clause 3.1)	For these tests (SN 27 to SN 31):- One sample of RTSF sleeve from every 100 quantity or part there of shall be taken and tests shall be performed on appropriate size of pieces of this sample. (Example: For quantity less than or upto 100, the sample size will be one and for quantity from 101 to 200
28.	Softening point of hot melt adhesive (SN-1 of clause 3.1)	
29.	Colour change of temperature indicating point of RTSF sleeve (SN-1 of clause 3.1)	
30.	Resistance to split propagation of RTSF sleeve (SN-1 of clause 3.1)	

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31.	Bursting strength of RTSF sleeve. (SN-1 of clause 3.1)	the sample size will be two and so on).
32.	Test for longitudinal sealing of RTSF sleeve. (SN-1 of clause 3.1)	For the tests (SN 32 to SN 33):- One sample of RTSF sleeve from every 100 quantity or part there of shall be taken and tests shall be performed on this sample. (Example: For quantity less than upto 100, the sample size will be one and for quantity from 101 to 200 the sample size will be two and so on).
33.	Longitudinal shrinkage of RTSF sleeve. (SN-1 of clause 3.1)	
34	Visual inspection of the Discrete wire connectors (SN 25 and 26 of clause 3.1)	5 samples for each from offered lot
35	Manufacturer's marking on Discrete wire connector (SN 25 and 26 of clause 3.1)	5 samples for each from offered lot
35	Filling compound quantity in Discrete wire connectors (SN 25 and 26 of clause 3.1)	5 samples for each from offered lot
36	Wire pull out on Discrete wire connectors (SN 25 and 26 of clause 3.1)	One sample from offered lot
37	Contact resistance of Discrete wire connectors (SN 25 and 26 of clause 3.1)	One sample from offered lot
38	Parallel Jaw plier marking and manufacturing identity, model number etc. (To be supplied one for every 10 jointing kits or part thereof)	One sample from offered lot
39	Resistance of 2000 mm Multi strand copper conductor single core insulated cable (SN 15 of clause 3.1)	One sample from offered lot
40	Number of strand in 2000 mm Multi strand copper conductor single core insulated cable. (SN 15 of clause 3.1)	One sample from offered lot
41	Length of Multi strand copper conductor single core insulated cable. (SN 15 of clause 3.1)	One sample from offered lot
42	Marking on Multistrand copper conductor IS Marking (SN 15 of clause 3.1)	One sample from offered lot
43	Marking on the complete jointing kit as per clause 7.2	One sample from offered lot
44	Installation instructions whether in Hindi and English and in good quality. They are as per approved instructions or not.	One sample from offered lot.

6.2.3 Any other tests as required by the inspecting authority to ensure that equipment is in conformity with the requirement of specification.

6.2.4 Any failure in the acceptance tests mentioned in clause 6.2.1 shall lead to rejection of the lot.

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6.3 Routine Tests:-

6.3.1 The following shall constitute routine tests:

6.3.1 All tests given under clause 6.2 acceptance test and any other test as required by manufacturer shall constitute routine tests.

6.3.2 The manufacturer shall certify that routine test have been successfully carried out all the jointing kits offered for inspection. He shall produce the test results at the time of inspection.

7.0 MARKING:-

7.1 **“ Following marking to the extent applicable as per marking requirement of the raw material test under Annexure – IV shall be legibly and indelibly printed/ engraved on the item of the kit.”**

- a) Manufacturer’s name and identification mark.
- b) Year/ month of manufacture.
- c) Specification No.
- d) Serial No.
- e) Dimensions
- f) Batch No.
- g) Marking “ For 0.9mm/1.4mm conductor Quad Cable” on RTSF sleeve.

7.2 **Following shall be legibly and indelibly marked on the kit packing box :-**

- a) “Thermoshrink jointing kit for U/G 4/6Q JF cable and 4Q Dry cable of conductor dia.0.9mm .” or “ Thermoshrink jointing kit for U/G 4/6 quad jelly filled cable of conductor dia. of 1.4 mm” as applicable
- b) Expiry Date

Note: The shelf life of all the components of the kit shall be at least 2 years at the time of Acceptance Testing except for the following components ,the performance of which may deteriorate by not more than 10% after one year. However these components shall be perfectly usable till expiry date of the kit. These components are - Adhesive PVC Tape, Adhesive Aluminium Foil, Sealant Tape, Jelly Filling Compound & Cleaning tissue.

8.0 INSPECTION:-

8.1 The inspection and test shall be carried out to the satisfaction of the purchaser or his nominee.

8.2 The purchaser or his nominee shall have the right to be present during all stages of manufacture and shall be accorded all reasonable/complete facilities to satisfy himself that the thermoshrink jointing kit contents are being manufactured in accordance with the terms and conditions of the specification. The purchaser or

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his nominee shall have the right to reject any material that fails to conform to the specification.

- 8.3 When inspection is carried out during manufacture, the manufacturer shall supply the material and samples required for testing free of charge and shall at his own cost prepare and furnish the necessary test pieces and appliances for such testing as may be carried out at his premises in accordance with the specification. If facilities are not available at his own works for conducting the prescribed tests, manufacturer shall bear the cost of carrying out the tests at an approved test Laboratory.

9.0 INSTALLATION INSTRUCTIONS:

- 9.1 Installation instructions shall be supplied with each Thermoshrink Jointing Kits. The installation instructions shall be given both in Hindi and in English with clear sketches of stage-wise jointing procedure.

10.0 EXECUTION OF THERMOSHRINK JOINTING AT SITE:

- 10.1 Cable jointing shall be carried out at site as per the detailed procedure suggested by the manufacturer only by competent cable jointer having competency certificate issued by authorized agencies viz IRISSET/Secunderabad, zonal training schools, RDSO approved manufacturers of thermoshrink jointing kit. This is necessary to ensure quality control over the joints.

- 10.2 The above clause should be suitably reflected in the tender and payment conditions.

11.0 PACKING:

- 11.1 The kit content shall be packed so as to permit convenient handling and protect against loss or damage during transit and storage.

12.0 INFORMATION TO BE GIVEN BY THE PURCHASER.

The purchaser shall clearly specify the conductor dia. of 4/6 quad cable for which the joints are required. While placing orders for Thermoshrink Jointing Kits, the purchaser shall quote following description:-

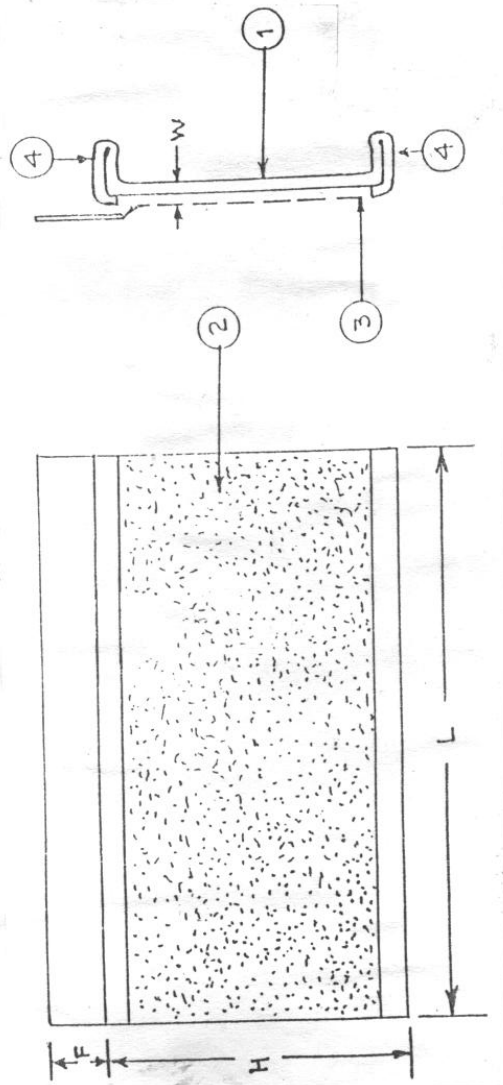
- A. “Thermoshrink jointing kits for jointing underground 0.9mm dia. conductor 4/6 quad cable as per specification IRS: TC 77-2012 Rev.3 or latest.”

Or

“Thermoshrink jointing kits for jointing underground 0.9 mm dia. conductor 4/6 quad cable as per specification IRS: TC 77-2012 Rev.3 or latest with IDC type jelly filled discreet wire connector”

- B. “Thermoshrink jointing kits for jointing underground 1.4 mm dia. conductor 4/6 quad cable as per specification IRS: TC 77-2012 Rev.3 or latest.”

ANNEXURE-I
Clause No. 3.1(S.No.1)



Material:-

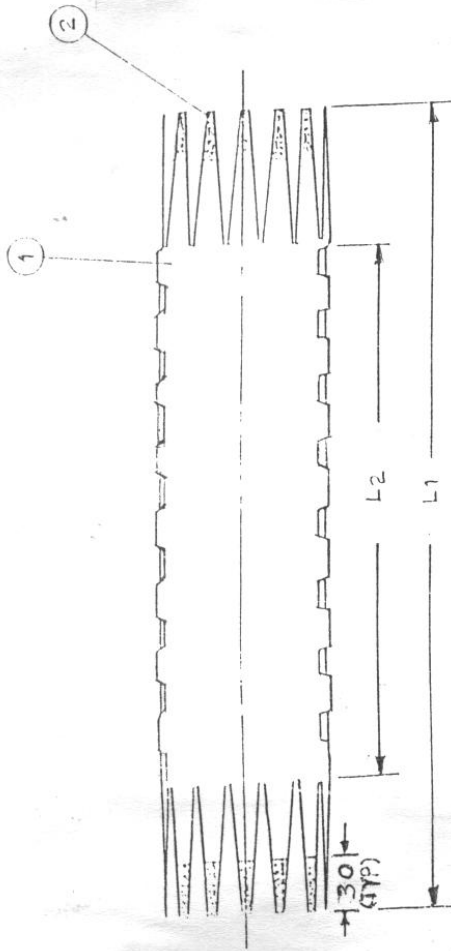
1. Reinforced heat – shrinkable material.
2. Temperature – indicating paint.
3. Hot – melt adhesive.
4. White paint.

Type of joints	L	H	F	W
Straight through joint, condenser joint, loading joint, transformer (Derivation) joint (75/15) for 0.9mm dia 4/6 quad cable	850 (+30 -0)	275 (+15 -5)	18 (Min.)	1.5 (Min.)
Straight through joint, condenser joint, loading joint, transformer (Derivation) joint (92/25) for 1.4mm dia 4/6 quad cable	910 (+30 -0)	355 (+20 -5)	30 (Min.)	1.5 (Min.)

R. D. S. O.
HEAT SHRINK SLEEVE (REINFORCED)

NOTE: All dimensions in mm.

ANNEXURE-II
Clause No. 3.1(S.No.3)



Material:-

1. Aluminium – 95% as per IS 737 or equivalent.
2. Heat – resistant dipping.

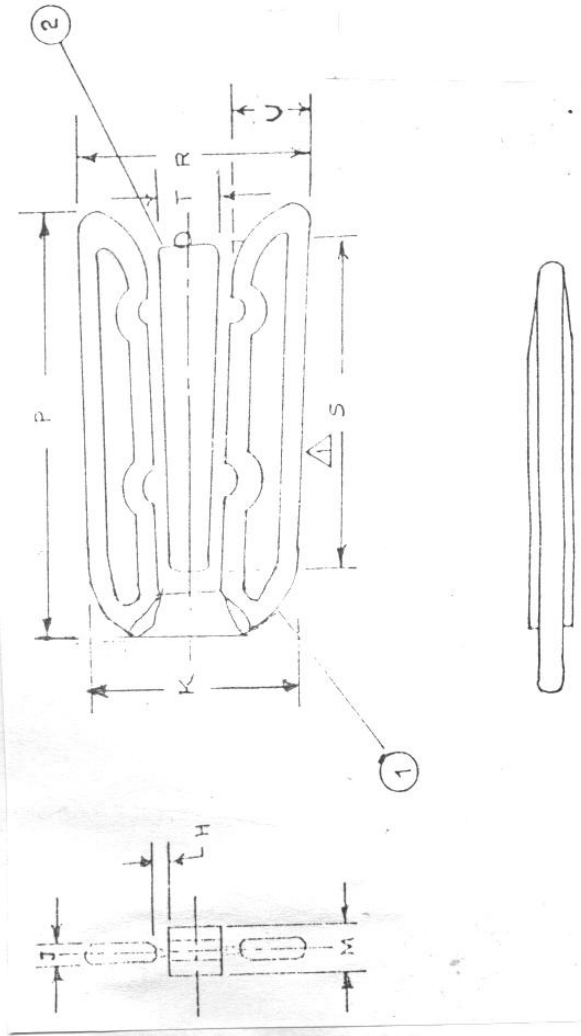
Type of joints	L ₁ (±3)	L ₂ (±3)	D (±2)	T (±0.08)
Straight through joint, condenser joint, loading joint, transformer (Derivation) joint (75/15) for 0.9mm dia 4/6 quad cable	507	355	75	1.0
Straight through joint, condenser joint, loading joint, transformer (Derivation) joint (92/25) for 1.4mm dia 4/6 quad cable	507	355	92	1.0

R.	D.	S.	O.
ALUMINIUM CANNISTER FINGER COATED			

NOTE: All dimensions in mm.

ANNEXURE-III

Clause No. 3.1(S.No.23)



Material:-

1. Corrosion protected moulding of Aluminium Alloy conforming to IS:617 grade 4600 or equivalent coated with EXPOXY.
2. Hot – Melt adhesive.

R. D. S. O.
BRANCH OFFCLIP (MINIMUM)

TYPE OF JOINT	P (±2)	K (±2)	S (±2)	R (±1)	T (±1)	U (±0.5)	M (±1)	J (±0.5)	H (±0.5)
Transformer joint/Derivation main/Derivation PIJF	110	54	85	60	15.5	18.5	12	6	3

NOTE: All dimensions in mm.

ANNEXURE – IV

**RAW MATEIAL TEST OF THERMOSHRINK JOINTING KITS FOR
JOINTING UNDERGROUND QUAD CABLE TO SPECIFICATION
NO. IRS:TC 77-2012**

SN	TESTS	PAGE NO.
1.	Thermoshrink Sleeve (Reinforced) and Hot Melt Adhesive.	24 - 35
2.	Thermoshrink Sleeve (Reinforced) Closure Channel and under clip	36
3.	Branch off Clip	37 - 38
4.	Aluminium Cannister	39
5.	Sheath Connector Assembly	40 - 42
6.	Splice Filling Compound	43 - 46
7.	Cable Cleaning Liquid	47 - 50
8.	Adhesive PVC Tape	51
9.	Sealant Tape	52 - 53
10.	Emery Strip	54 - 55
11.	Cleaning Tissue	56
12.	Adhesive Aluminium Foil	57
13.	Cable Tie	58
14	Discrete wire connector	
15	Multi strand tinned copper conductor flexible insulated cable (single core)	

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Note: *Either ISO or ASTM or IS test standards are indicated for testing various properties. Testing by equivalent standards shall be acceptable, (e.g. if a particular ISO standard is mentioned, then equivalent IS or ASTM standard shall be acceptable and so on.) provided the value of parameters is same in the equivalent standard as is indicated in this specification. However, in case of change in parameter value in the equivalent standard, prior approval of RDSO shall be obtained before initializing process of testing with equivalent standard.*

THERMOSHRINK SLEEVE (REINFORCED) AND HOT MELT ADHESIVE

1. GENERAL

- 1.1 The heat shrinkable sleeves shall be manufactured from cross-linked, heat shrinkable, thermally stabilised polymers, or a composite laminate, consisting of a reinforcing, heat shrinkable fabric contained in a matrix material. The sleeve shall be of wrap around design furnished with stainless steel channels and one retaining clip to make the wrap-around sleeve cylindrical prior to the shrinkage operation.
- 1.2 The inside surface of the sleeve shall be coated with a hot melt adhesive which will bond at the temperature attained during the shrinkage operation. The inner adhesive surface of the sleeve shall be protected by a polythene release paper. The outside surface of the sleeve shall be coated with a temperature indicating paint which changes colour when the desired temperature is attained to allow a controlled heating during installation. The heat shrinkable sleeve and adhesive shall meet the requirements given in section 2.1, 2.2 and 3 of this specification respectively when tested in accordance with the associated test methods and test procedures.

2. HEAT SHRINKABLE MATERIAL REQUIREMENTS

2.1 Heat shrink sleeve manufactured from reinforced heat shrinkable thermally stabilised materials

Unless otherwise specified, test shall be done on unrecovered, cross linked uncoated material.

Parameters for full recovery shall be $200 \pm 2^{\circ}\text{C}$ for 5 minutes in an air circulating oven.

Where test temperature is not indicated, the test shall be carried out at room temperature.

Section	Properties	Test methods & conditions	Reference	Requirements
2.1.1	Bursting strength	Unrecovered material.	ISO 3303 Method A	Min. 1500 N.
2.1.2	a) Thermal ageing b) Bursting strength after thermal aging	Fresh sleeve aged for 168 hrs. at $150^{\circ}\text{C} \pm 2^{\circ}\text{C}$.	ISO 188	Min. 1600 N.
2.1.3	Dielectric strength	Electrodes : 6 mm dia brass rods Upper electrode weight: 50 ± 2 gm Test medium : transformer oil Voltage application : 2 KV steps at 20 seconds intervals	ASTM D 149	Min.12KV/mm
2.1.4	a) Chemical resistance b) Bursting Strength after the chemical resistance test	Immersion in the following liquids, one liquid per sample group. Na_2SO_4 0. IN for 24 hrs. NaCl 0. IN for 24 hrs. H_2SO_4 0. IN for 24 hrs. NaOH 0. IN for 24 hrs. Fuel oil ASTM 396 No.1 for 24 hrs. Petroleum Jelly 168 hrs. $70 \pm 2^{\circ}\text{C}$	ISO 175 ISO 3303 Method A	Min. 1200 N.
2.1.5	Environmental Stress Cracking	Stress Crack initiator 10% Igepal CO 630 solution. Immersion time : 48 hrs. Test Temp : $50 \pm 2^{\circ}\text{C}$	ASTM – D 1693	No cracking
2.1.6	Corrosion effect	Copper mirror test Test Temp : $120 \pm 2^{\circ}\text{C}$ Test time : 16 hours.	ASTM – D 2671 Clause 97.	No corrosion
2.1.7	Colour change of temperature indicating paint.	Suitable length of sleeve containing the paint. a) Condition at $260^{\circ} \pm 2^{\circ}\text{C}$ for 5 minutes. b) Condition at $150^{\circ} \pm 2^{\circ}\text{C}$ for 30 minutes.		Total colour change No colour change.

Section	Properties	Test methods & conditions	Reference	Requirements
2.1.8	Carbon content	Heating rate : 20°C per min. Inert Gas : Nitrogen Oxidation Gas : Oxygen	ISO : 11358	Min. 2.5%
2.1.9	Fungus Resistance	Inoculation : 30°C 85% RH for 28 days	ASTM – G 21	Rating of 1 or better.
2.1.10	Water absorption	48 hours Immersion	Section 2.2.3 & ASTM – D 570	0.1% Max.
2.1.11	Resistance to split propagation	15 min. at 200 ± 2°C	Sec. 2.2.1	No split propagation.
2.1.12	Longitudinal shrinkage	Installed on substrate of min. dia	Sec. 2.2.2	< 5% shrinkage
2.1.13	Test for longitudinal sealing	Recover the sleeve on a mandrel with OD equal to max. dia		Two white lines. Should appear below the SS channel.
2.1.14	Defects	Visual		Shall be free from defects.
2.1.15	Dimensions	Measurement	As per Ann.-I & Sl. No. 1 of Cl. 3.1	Shall conform.
2.1.16	Marking	Visual	-	Manufacturer's name and identification mark, Batch No., Year of manufacture, Dimensions (as per SN .1 of Cl.No. 3.1), Spec. No. , “For 4/6 quad cable of 0.9/1.4 mm dia. conductor”

2.2 TEST PROCEDURE :-

2.2.1 RESISTANCE TO SPLIT PROPAGATION TEST PROCEDURE

The test shall be performed only on fibre glass reinforced sleeve

A rectangular specimen 50 mm long (in the shrink direction) shall be cut from material in the unrecovered condition as delivered (preferably uncoated). An indelible line (unaffected by the recovery process) shall be drawn parallel to and 5 mm from the long edge. A perpendicular cut shall be made approximately half way along the same edge to just touch the line. The sample shall be clamped at both ends and held rigidly so that no shrinking may occur during testing. The test assembly shall be placed in an air-circulation oven at $200 \pm 2^{\circ}\text{C}$ for 15 minutes. After removal from the oven and cooling to room temperature, the sample shall be examined for cut propagation.

2.2.2 LONGITUDINAL SHRINKAGE TEST PROCEDURE

The test shall be performed only on fibre glass reinforced sleeves.

The minimum length of the sleeve sample as delivered shall be determined to the nearest millimeter. The sleeve shall then be shrunk onto an aluminium tube with an outside dia. equivalent to the minimum applicable dia. of the sleeve. The wall thickness of the aluminium tube shall not exceed 3 mm and its outside surface shall be treated with a release agent. The minimum length of the sleeve shall be determined after the sample has cooled to room temperature.

The percentage longitudinal shrinkage shall be calculated as follows –

$$\frac{\text{Min. length as delivered} - \text{min. length after shrinking}}{\text{Min. Length as delivered}} \times 100$$

2.2.3 WATER ABSORPTION

The test shall be done as per ASTM D.570. However, to prevent entry of water into the sample, the edges of the sample shall be sealed with Microcrystalline wax.

3.0 HOT MELT ADHESIVE

3.1 REQUIREMENT

Whenever test temperature is not indicated, the test shall be carried out at room temperature.

Section	Properties	Test methods & conditions	Ref.	Requirements
3.1.1	Peel Strength	- Polyethylene - Lead	Sec. 3.2	Min. 100N/25m Min. 100N/25m
3.1.2	Environmental	Stress crack initiator :	ASTM D	No cracking

	stress cracking	10% Igepal CO 630 solution Immersion time : 48 hrs. Test temp : $50 \pm 2^{\circ}\text{C}$	1693	
3.1.3	Corrosive effect	Copper mirror test Test temp. $120 \pm 2^{\circ}\text{C}$ Test time : 16 hrs.	ASTM D 2671 Clause 97	No corrosion
3.1.4	(a)Chemical Resistance	Immersion in the following liquids, one liquid per sample group Na ₂ SO ₄ 0. IN for 24 hrs. NaCl 0. IN for 24 hrs. H ₂ SO ₄ 0. IN for 24 hrs. NaOH 0. IN for 24 hrs. Fuel oil ASTM D 396 No.: 1 for 24 hrs. Petroleum Jelly 168 hrs. $70 \pm 2^{\circ}\text{C}$	ISO 175	
	(b)Peel Strength after chemical resistance test.	- Polyethylene - Lead	Sec. 3.2	Min. 80N/25m Min. 80N/25m
3.1.5	Shear strength	Test Speed : 50 mm / min.	Sec. 3.3	Min. 1300 N
3.1.6	Fungus Resistance	Inoculation : 30°C 85 RH% for 28 days	ASTM G21	Rating of 1 or better
3.1.7	Softening point	Ring & Ball method	ASTM E-28	$100 \pm 10^{\circ}\text{C}$
3.18	Water absorption	48 hours immersion at RT	ASTM D570	0.5% max.
3.1.9	Colour	Visual		Amber

3.2 TEST PROCEDURE FOR PEEL STRENGTH

3.2.1 PROCEDURE

The adhesive peel strength shall be determined by the rolling drum peel test method. The test samples shall consist of uncoated heat shrinkable tubing or

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equivalent sleeves of appropriate size and a sheet of adhesive under test, installed on straight cylindrical substrates in the form of polyethylene cable jackets. The sheet of adhesive shall be approximately 1 mm thick.

The specimen shall remain at room temperature for one day before cutting the samples into 25 mm wide. Exposure to any specified medium shall be done at this stage.

The specimen shall be placed in a tensile testing machine, with the specimen around the positioning mandrel and the free end of the specimen inserted into the tensile testing machine jaw. The holding fixture shall be constructed so that the yoke is free to rotate during testing. Testing shall be with a jaw separation speed of 50 mm per minute. Readings of peel strength shall be taken at every 12.5 mm of jaw separation after an initial separation of 25 mm. The average of five readings shall define peel strength.

3.2.2 **SAMPLE PREPARATION**

The mandrel specimen shall be 450 mm (approximate) length of lead or polyethylene sheath telephone cable. The diameter of the cable shall be approximately twice that of the free recovered equivalent diameter of the heat shrinkable product and shall be at least 30 mm.

Polyethylene

Clean cable mandrel with cleaning tissue.

Lightly abrade the cable mandrel with 60 mesh emery strip.

Wipe particles from abrasion off the cable mandrel with a clean, dry cloth.

Flame brush the cable mandrel for 15 seconds by passing a yellow flame lightly over the entire specimen (not to a glossy finish)

Assemble the adhesive and then tube or sleeve over the cable mandrel.

Completely recover the tube or sleeve over the cable mandrel.

Post-heat the specimen assembly for 30 seconds after complete recovery.

Metal

The sample preparation shall be as described for polyethylene, except for the flame brushing which shall be replaced by a preheating of the mandrel to approximately 60°C and the abrasion which must remove all oxide from the metal surface. It is preferable to use a flat file to remove the oxide coating.

3.3 **TEST PROCEDURE FOR SHEAR STRENGTH**

3.3.1 **TEST METHOD**

The method shall be in accordance with ISO 4587.

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The adhesive bonds shall be pulled in a suitable tensile testing machine at a jaw separation rate of 50 mm per minute. The initial jaw separation shall be between 100 mm and 150 mm. The mean of five breaking loads shall be recorded as the shear strength, which shall be reported in Newton.

3.3.2 **SAMPLE PREPARATION**

Adhesive bonds shall be prepared using test pieces of 25 ± 1 mm wide and 1.0 ± 0.1 mm thick aluminium alloy sheeth approximately 100 mm long. They shall be free of burrs and the surfaces shall not be scratched or roughened.

To prepare the etching solution, dissolve 25 gms. of sodium metasilicate ($\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$) in 1000 ml of distilled water. Add 2.5 gms. of non ionic detergent (e.g. 10% IGEPAL C0 630 solution). Heat the solution to 70°C .

At least a 25 mm length of each test piece shall be etched in the metasilicate solution for 5 minutes. The aluminium shall then be washed well with distilled water and air-dried. Test joints shall be formed not more than three hours after the etching process.

The adhesive under test shall be applied to one treated surface of each test piece so that an even, continuous film is formed. Test surfaces assembled to form joints shall overlap by 12.5 ± 0.5 mm. The joints shall be placed under a pressure of 1 Kg. in an oven at 180°C for 10 minutes; subsequently they shall be held at room temperature for one day before testing.

THERMOSHRINK SLEEVE (REINFORCE) CLOSURE CHANNEL AND UNDER CLIP

1.0 GENERAL

- 1.1 The thermoshrink sleeve closure channel and under clip are required in close the thermoshrink sleeve before shrinking.
- 1.2 The closure channel and clip are same for RTSF sleeves.
- 1.3 The dimensions of closure channel and under clip shall be as per drawings as per clauses 3.1 Serial No. 2 of this specification.
- 1.4 The under clip is positioned under the closure channels for reinforced sleeve.

2.0 REQUIREMENT

Sr. No.	Property	Requirement	Test Method
2.1	Material	Stainless steel conforming to IS – 6911 04 Cr 18 Ni 10 or AISI-304 or equivalent	Chemical analysis
2.2	Dimensions: Closure Channel Under clip	As per SN 2 of Cl. 3.1	Measurement
2.3	Visual	Absence of burrs and sharp edges and any other defect.	Visual
2.4	Fittings	Correct fitting over the rail portion should neither be too tight not too loose. Should not cause scratches over the thermoshrink sleeve. Sleeve should not pull out while shrinking.	Installation.
2.5	Marking	Manufacturer's identity	Visual

BRANCH OFF CLIP

1. **GENERAL**

The branch –off clip shall provide high performance cable branching technique, easy to install.

2. **MATERIAL**

The branch off clips shall be manufactured from corrosion resistant aluminium alloy conforming to IS 617 grade 4600 and coated with epoxy.

3. **DESIGN**

The design of the branch off clip shall conform to the details given in Annexure – III and also have dimensions mentioned therein. The branch off clip shall have three fingers, the middle one coated with hot melt adhesive identical to that on the thermoshrink sleeve. The adhesive on the branch off clip shall, however, have a different colour to that of the thermo shrink sleeve adhesive and thus give a visual indication to the jointer of correct adhesive flow and sealing of the branch.

There shall be two types of Branch off clips, small, medium. Each type of Branch of clip shall be used for particular size of Thermo shrink sleeves as specified Annexure – III as per clauses no. 3.1 serial no. 23 of this specification.

4. **COMPATIBILITY**

The branch -off clip shall be compatible with the jointing system and should show no failure at the branch when tested for tightness on a complete joint.

5. **CORROSION RESISTANCE**

The clip shall show no traces of corrosion when subjected to salt spray test as per ASTM D 117 for 72 hours.

6. **MARKING**

The branch off clip shall contain the identification of the manufacturer / supplier on the metal part in order to identify the source of supply of the item when required.

7. **REQUIREMENT**

Sr. No.	Property	Test Method	Requirement
7.1	Appearance	Visual	Shall be free from burrs, sharp edges, holes, cracks, and shall be finished smooth shall be given black epoxy coating.
7.2	Dimensions	Measurement	As per Annexure – III
7.3	Material conformity	Chemical analysis	Aluminium alloy conforming to IS:617 Grade - 4600
7.4	Corrosion resistance	Salt spray as per ASTM D117 for 72 hrs.	No corrosion
7.5	Thickness of corrosion resistance epoxy coating	As per IS : 101	80 microns, min.
7.6	Marking	Visual	Manufacturer's identity on metal part
7.7	Compatibility with sleeve	Visual	Sample joints made using the BOC's shall meet the installed product requirements.
7.8	Softening point of adhesive	Ring & ball method (ASTM E 28)	100 ±10°C

ALUMINIUM CANNISTER

1.0 GENERAL

The aluminium Canister shall comprise of two performed half shells that can be hinged and fitted around a cable splice. Finger –like formation shall be provided at the ends of the Canister such that, when bent, it will give a smooth transition over the cable. The Aluminium canister shall provide adequate structural strength to avoid collapse during installation. The aluminium cannister shall conform to the dimensions given as per Annexure – II of Clauses 3.1 serial no. 3 of this specification and satisfy the requirements given in Section 2. The fingers of Cannisters supplied in kits containing reinforced sleeves shall contain a protective coating of not less than 1.0 mm thickness for length of 30 to 40 mm at the finger end.

2.0 REQUIREMENT

Sr. No.	Property	Requirement	Test Method
2.1	Material	As per IS – 737 of grade 40800 or its equivalent	I.S. 504 I.S. 1816 I.S. 737
2.2	Dimensions	As per Annexure – II	Measurement
2.3	Visual	Absence of burrs and sharp edges and any other defect.	Visual
2.4	Cleanliness	Free from oil, dust dirt, (Degreasing by chemical treatment desirable)	Visual
2.5	Marking	Manufacturer's identity	Visual
2.6	Packing	Shall be enclosed in a poly bag of correct size. The fingers shall be protected from damage during transit.	Visual
2.7	Tensile Strength	8 Kgf / Sq. mm minimum	Measurement
2.8	Bend Test	No cracks	IS : 737 & IS : 1599

SHEATH CONNECTOR ASSEMBLY

1.0 **GENERAL**

The sheath connector assembly consists of three items, viz. an insulated stranded copper wire with connecting elements on both sides, a small wire of the same description with connecting element on one side only and a bridge connector for jointing the two wires. The connecting element is made of phosphor bronze, hacked by a non-corrosive metal back-plate strongly pressed to it and also crimped to the connecting wire. The element has an opening provided with toothed jaws into which the cable sheath can be inserted and crimped using ordinary pliers. The toothed jaws when crimped, bite through the cable sheath to make a good low-resistance metallic contact with the sheath of the cable. In order to inter-connect the sheath connector wires in branch joints, the bridge wire connector is used in conjunction with the single ended connector assembly. The flexible wire shall be 14 SWG.

2.0 **REQUIREMENTS**

The sheath connector assembly shall conform to the following requirements when tested as per details given in section-3 of this specification.

Sr. No.	Property	Requirements	Test Method
2.1	Connection resistance	Less than 3 milli ohms	Sec. 3.1
2.2	Vibration at 100 vibrations/min. for 2 hrs. at an amplitude of ± 10 mm	Change in CR less than 1 milli ohm	Sec. 3.2
2.3	Wire pull out of connecting element (sheath wire connector)	More than 150 N	Sec. 3.3
2.4	Wire pull out of Bridge wire connector	More than 75 N	Sec. 3.4
2.5	Salt fog Exposure	No corrosion. Change in CR not more than 1 milli ohm	Sec. 3.5
2.6	Marking	Manufacturer's Identity	Visual
2.7	Material conformity	Copper wire (Grade Cu-FRHC) as per IS-191 & clip elements (Grade 1) as per IS-7814.	Chemical analysis

3 TESTING PROCEDURE FOR SHEATH CONNECTORS

3.1 MEASUREMENT OF CONNECTION RESISTANCE

Cut a length of 300 mm of any size of cable with aluminium moisture barrier. Mark at 75 mm from the ends and remove the sheath at both ends up to mark. Clean the polyethylene coating over the aluminium moisture barrier using a knife. Measure the D.C. resistance of this piece (R.1) making connections at the flaps using a sensitive measuring instrument.

Similarly, measure the resistance of the sheath connector assembly (R.2) using the same instrument.

Cut the sheath connector wire approximately in the middle and expose the wire for about 20 mm for making connection. Install the sheath connector halves on the already prepared flaps of the samples. Measure the resistance of the sample at the connector ends (R.3)

The contact resistance is calculated by using the formula:

$$\frac{R3 - (R1 + R2)}{2}$$

This value should not be more than 3 milliohms.

3.2 VIBRATION TEST

The test sample is prepared as described in Sec. 3.1 and is rigidly mounted on a vibration table. The sample is vibrated at 100 vibrations per minute with an amplitude of ± 10 mm for 2 hrs. During this process the sheath connector wires are connected in series to an electrical circuit and continuity is monitored. There should be no discontinuity during the vibration test. On completion of the test the contact resistance variation is measured which should not be more than 1 milli ohm.

3.3 WIRE PULL OUT TEST ON SHEATH WIRE CONNECTOR

Cut the sheath connector wire in the middle. From the cut end remove insulation for about 100 mm. Hold the connector element on the jig and place the assembly in a tensile machine. Measure the pull out strength at a speed of 50 mm jaw separation per minute. The pull out strength should not be less than 150 N.

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3.4 **WIRE PULL OUT TEST ON BRIDGE WIRE CONNECTOR**

Join two connector wires together using a bridge wire connector. Connect wires to the upper and lower jaws of the tensile testing machine and measure the pull out strength at a speed of 50 mm per minute. The value obtained should not be less than 75 N.

3.5 **SALT FOG EXPOSURE TEST (ASTM D 117-73/79)**

Prepare the test sample as described in Section 3.1. Expose the sample to salt fog as per ASTM D 117-73/79 for 72 hours. The sheath connectors are checked for corrosion after the test. There shall be no corrosion. Measure the variation in connector resistance. The variation shall not be more than 1 milli ohm.

SPLICE FILLING COMPOUND

1.0 **GENERAL**

- 1.1 The splice filling compound shall be used for RTSF joints.
- 1.2 The splice bundle is filled with splice filling compound in order to prevent insulation break down in the event of water entry into the joint.

2.0 **REQUIREMENT**

The splice filling compound shall conform to the following requirements when tested as detailed in Section 3 of this specification.

Sr. No.	Parameter	Requirement	Test Method
2.1	Water Penetration	No dripping of water or oil	Section 3.1
2.2	Homogeneity	No un dissolved particles	Section 3.2
2.3	Air Entrapment	No bubble formation	Section 3.3
2.4	Dry heat aging	No crack of drying after over ageing at 70±2°C for 7 days	Section 3.4
2.5	Stability	No separation of the constituents of filling compound after 120 hrs. at 65±2°C	Section 3.5
2.6	Cone Penetration	200 to 300	Section 3.6
2.7	Volume resistivity	Not less than 10 ¹⁰ ohm cm.	Section 3.7
2.8	Water absorption	The volume resistivity shall not be less than 10 ¹⁰ ohm cm.	Section 3.8
2.9	PE Stress cracking	No cracks after ageing for 7 days at 70±2°C	Section 3.9
2.10	Connector stress cracking	No cracking after ageing in filling compound at 70±2°C for 7 days	Section 3.10
2.11	Copper corrosion	No pitting or blackening of bare copper conductors after 7 days ageing at 70±2°C in filling compound.	Section 3.11

2.12	Colour	The compound shall not obscure the identification of colours of the insulation after ageing in filling compound for 7 days at $70\pm 2^{\circ}\text{C}$	Section 3.9
2.13	Handling	The splice filling compound shall be free from unpleasant odor and shall have no toxic or dermatitis hazard.	The supplier shall produce a certificate from a recognized Laboratory to this effect.
2.14	Packing	300 gm. in sealed PE pouches (transparent)	Measurement
2.15	Marking	Identity of the manufacturer, Batch No., Month and Year of manufacture.	Visual

3.0 TEST PROCEDURE FOR SPLICE FILLING COMPOUND

3.1 WATER PENETRATION

A joint is made using cleaned jelly filled cable and filled with adequate quantity of filling compound and wrapped tightly with 2 layers of PVC tape. One end of the cable is connected to a water column of one meter for 14 days. The cable on either side of the joint should be restricted to 150 to 200 mm. Dripping of oil or water shall be construed as a failure.

3.2 HOMOGENEITY

Place a small sample of splice filling compound between two glass slides and squeeze together to form a thin film. There shall be no undissolved particles / lumps, when observed visually.

3.3 AIR ENTRAPMENT

Fill a glass beaker evenly with filling compound. Place the beaker in an oven at $65\pm 2^{\circ}\text{C}$ for two hours. Remove the beaker from the oven and observe. There shall be no bubble formation on the surface of the filling compound.

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3.4 **DRY HEAT AGEING**

Fill three plastic cups 37.5 mm. In dia, and 25 mm deep with splice filling compound such that no air pockets are formed. Scrape off the excess material place the cups in an oven at $70\pm 2^{\circ}\text{C}$ for 7 days. The compound shall show no signs of cracking or drying.

3.5 **STABILITY**

About 5 grams of splice filling compound is filled in a glass container with both ends open and held with the axis of the container in a horizontal place. 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 a test tube so that it hangs freely. The temperature of the compound is measured by a thermometer. The test tube is now placed in a constant temperature bath maintained at $65\pm 2^{\circ}\text{C}$ for 5 days. There shall be no dripping of the filling compound and consequent disintegration of its constituents.

3.6 **CONE PENETRATION**

Place an empty grease worker cup and an appropriate amount of the sample of splice filling compound in a metal container in water or air bath maintained at 25°C for sufficient time to bring the temperature of the sample and the worker cup to $25\pm 2^{\circ}\text{C}$. Transfer the sample, preferably in one lump, to overfill the cup of the grease worker. Shake the cup to drive out trapped air and pack the grease with a stapula with as little manipulation as possible to obtain a cupful without air pockets. Scrape off the excess compound extending above the using a stapula. Place the cup on the penetrometer table and set the mechanism to hold the cone in zero position, adjusting the apparatus so that the tip of the cone just touches the surface of the sample. Release the cone shaft rapidly and allow it to drop for 5 seconds. Gently depress the indicator shaft until stopped by the cone shaft and read the penetration from the indicator. The reading obtained shall not be less than 200 and not more than 300.

3.7 **VOLUME RESISTIVITY**

Prepare electrode assembly using two plates of 1 cm^2 cross section. Place the assembly into the filling compound. The other ends of the wires shall be connected to a mega ohm meter set to 500 volts. Measure the insulation resistance. The value obtained should not be less than 10^{10} ohms cm.

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3.8 **WATER ABSORPTION**

A container is formed by solvent welding a polycarbonate pipe of I.D. 25 mm into a polycarbonate plate of 6 mm thick. Two copper electrodes O.D. 2 mm approximately are installed through the bottom plate spaced 12.5 mm apart to a height of 1 cm. The compound to be tested encapsulate the two electrodes upto a height of approximately 2.5 mm above the top of electrodes. Measure the volume resistivity. A 25 mm water is then applied over the compound surface. After 48 hours, the insulation resistance is measured again using a mega ohm meter. The reading obtained shall not be less than 10^{10} ohm cm. and there shall be no change between the initial and final readings.

3.9 **POLYETHYLENE STRESS CRACKING**

Prepare 150 mm long PE insulated conductors of all colours at the rate of 5 samples for each colour and immerse them in the splice filling compound. Condition it in an oven for 24 hours at 70°C. Remove the conductors and wipe them clean. Wrap the conductors around its own diameter for a minimum of ten continuous turns over a length of 2 cms. of insulated conductor. Then suspend them in an air circulating oven maintained at 70±2°C for 7 days. At the ends of the period, remove the samples from the oven and observe for cracks. There shall be no cracks. Also there shall be no change of colours.

3.10 **CONNECTOR STRESS CRACKING**

Fill a 250 ml beaker with the splice filling compound immerse approved wire connectors completely in the compound and place in an air circulating oven at 70±2°C for 7 days. Wipe off the connectors with a tissue, and inspect for sign of cracking. There shall be no cracking.

3.11 **COPPER CORROSION**

Remove bare copper conductors from cables, wipe them clean using a solvent and cotton wool and immerse them in a beaker containing the splice filling compound. Place the container in an oven maintained at 70±2°C for 7 days. The condition the sample for 4 hours at R.T. Remove the conductors from the filling compound and thoroughly clean them using a solvent and wipe them clean using cotton wool, examine the copper conductors carefully. The samples should show no pitting or blackening.

CABLE CLEANING LIQUID

1.0 GENERAL

- 1.1 The cleaning liquid shall effectively dissolve and remove the different cable filling compounds used in the manufacture of Quad cable.
- 1.2 The cleaning liquid shall be non-flammable at room temperature.
- 1.3 The cleaning liquid shall be safe to handle and shall not cause any dermatic hazard or toxic effect or respiratory problems. (The manufacturer / supplier shall produce a test certificate to this effect from a recognized laboratory).
- 1.4 The cleaning liquid shall be compatible with the insulation of cable conductors and shall not cause corrosion to the metal parts of the conductors and sheath of the cable with which it is likely to come into contact.
- 1.5 The cleaning liquid shall have a shelf life of not less than two years and during this period the properties of cleaning liquid shall not change under normal storage conditions.
- 1.6 The cleaning liquid shall be packed in water-tight containers so that the loss of the liquid shall be negligible.

2.0 REQUIREMENT

The cleaning liquid shall comply with the following requirements when tested in accordance with the test method shown against each.

Sr. No.	Property	Requirement	Test Method
2.1	Cleaning of cable jelly from conductors	Good cleaning to be ensured. There shall be no discoloring of conductor insulation.	As per Section 4
2.2	Flash Point	> 50°C	ASTM D 92
2.3	Boiling Point	Not less than 100°C	Measurement
2.4	Corrosion	No Corrosion	Immerse copper conductors & an Al. strip into the cleaning liquid for 24 hrs. wipe & age at 65±2°C for 7 days.

Sr. No.	Property	Requirement	Test Method
2.5	Connector stress crack	No crack should be observed when viewed through an optical device.	Immerse connectors of various makes into the cleaning liquid for 24 hours & age in an oven at $65\pm 2^{\circ}\text{C}$ for 7 days.
2.6	Compatibility with PE Insulation	No crack or colour fading. The retention of average tensile strength shall not be less than 85% elongation shall not be less than 70% of the reference sample.	Section 3
2.7	Storage Stability	Weight loss shall not exceed 2%	Sealed container with cleaning liquid shall be aged at $65\pm 2^{\circ}\text{C}$ for 7 days.
2.8	ESCR test	No failure when tested on cable sheath grade P.E.	As per ASTM D 1693 @ $50^{\circ}\pm 2^{\circ}\text{C}$ in 10% Igepal Co-630 after conditioning in the cleaning liquid for one hour. Test duration 48 hours.
2.9	Marking	Manufacturer's Identity, Batch No., Month & Year of manufacture, caution level.	Visual

3.0 **TEST METHOD FOR DETERMINING COMPATIBILITY OF THE CLEANING LIQUID WITH PE INSULATION**

- 3.1 Immerse 100 to 250 mm length of insulated conductors, 5 samples per color, into the cable cleaning liquid for 24 hours. Then remove them and wipe them clean and allow them to dry. Twist the wires over their own diameters 10 close turns continuously. Suspend the samples in an air circulating oven at $70\pm 2^{\circ}\text{C}$ for 14 days. After this period remove them and condition at RT for 6 hours. Visually

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examine the samples for cracks or colour fading. There shall be no cracks or fading of the colours.

3.2 Elongation and Tensile Strength:-

10 long lengths of insulation shall be carefully removed from the conductors and made into 2 sets of 10 half lengths. The tensile strength and elongation of the 1st set (reference samples) shall be measured and their average value shall be noted. The 2nd set shall be immersed into the cleaning liquid for 24 hours and then wiped clean and dry. Then they will be aged at $70 \pm 2^{\circ}\text{C}$ for 14 days and conditioned at RT for 6 hours. The tensile and elongation of the aged samples shall be measured and their average value shall be calculated. The tensile strength of the aged samples should not be less than 85% of the reference samples and the elongation shall not be less than 70% of the reference samples.

4.0 **CLEANING PROCEDURE**

This procedure is applicable only in locations, where the free ends of the cables are available. (Wherever cleaning is required on a through cable joint, soak cotton waste in the cleaning liquid and then clean the conductors of the through cable with the cotton waste.

- 4.1 Open the sheath of the cable up to one and half times the recommended splice opening.
- 4.2 Separate the units and complete the unit binder ties.
- 4.3 Tie the free end of the cable core with a wire.
- 4.4 Pour the entire quantity of cleaning liquid into the pouch supplied in the Kit.
- 4.5 Insert the cable core into the pouch such that the end is about 50 mm above the liquid level.
- 4.6 Starting from the free end squeeze the pouch and remove the entrapped air inside the pouch. Tie the pouch over the sheath tightly close to the sheath opening.
- 4.7 Work the pouch by hand for 15 minutes for cables up to 200 pairs and 10 mts. For cables of larger sizes so that the cleaning liquid comes into contact with all conductors.
- 4.8 Leave the end free for about 5 minutes so that the cleaning liquid drains to the bottom at the pouch.

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- 4.9 Release the pouch with the liquid carefully by untying the PVC tape over the sheath.
- 4.10 Repeat the procedure for Quad cable in the joint.
- 4.11 Now the cable is cleaned and ready for commencing the jointing work.
- 4.12 Bury the used up material and containers at site and do not reuse them for any other purpose.

ADHESIVE PVC TAPE

1.0 GENERAL

1.1 PVC Tapes are required for taping the splice bundle and the fingers of the aluminium Cannister in case of RTSF joints.

2.0 REQUIREMENT

The PVC adhesive tape shall bear the ISI mark or shall be from TEC approved source and meet the following requirements when tested in accordance with the test methods shown against each.

Sr. No.	Property	Requirement	Test Method
2.1	Length / Roll	10meter/roll \pm 0.1meter.	Measurement
2.2	Width	25 mm \pm 1mm	Measurement
2.3	Thickness	0.1 mm to 0.13 mm	Measurement
2.4	Breaking Strength	> 5 Kgf / 25 mm width	IS - 3676
2.5	Elongation	> 100%	IS - 3676
2.6	Adhesion to Steel	> 400 gm. / 25 mm width	IS - 3676
2.7	Durability test at 65 \pm 2°C for 7 days, 80% RH followed by adhesion	> 350 gm. / 25 mm width	IS - 3676
2.8	Anchorage	No transfer of adhesive	IS - 8402
2.9	Water immersion followed by adhesion	No decrease in adhesion	IS - 3676
2.10	Marking	Manufacturer's identity. Batch No., Mfg. date.	Visual

SEALANT TAPE

1.0 GENERAL

- 1.1 The sealed tape shall be butyl rubber based elastic-plastic sealing compound, black in colour which is used for different applications in cable jointing.
- 1.2 The sealant shall be supplied in strip form of uniform dimensions as indicated in the specifications of respective jointing kits protected on both sides by release papers to prevent sticking. It will not cause swelling of the release paper.
- 1.3 The sealant tape shall be capable of releasing easily from the release paper and also shall not flow during storage.
- 1.4 The sealant shall not phase separate during storage or drastically change its properties.
- 1.5 The sealant shall have a shelf life of not less than two years when stored at room temperature.
- 1.6 The sealant shall have good adhesion to metals and PE without preheat, medium strength and very good chemical and thermal stability and shall not puddle on bottom of the sleeve. It shall not also cause corrosion to the metals which come into contact with it.
- 1.7 The sealant shall be compatible with the cable and other jointing materials and shall not cause deterioration to the electrical properties of the cable.
- 1.8 The sealant shall be safe to handle and shall be free from biological attack.

2.0 REQUIREMENT

The sealant tape shall conform to the following requirements, when tested in accordance with the methods, shown against each.

Sr. No.	Property	Requirement	Test Method
2.1	Water absorption	Less than 0.5%	Immersion at RT for 24 hours.
2.2	Corrosion	No corrosion	ASTM D 2671 24 hours at 120°C method B
2.3	Fungus & Bacteria resistance	Rating of 1 or better	ASTM G 21
2.4	Solvent resistance	Weight change not more than 1%	ASTM D 543

2.5	Volume resistivity	More than 10^{10} ohms cm.	Section 3.1
2.6	Shear Strength	2 N / cm ² (min.)	Section 3.2
2.7	Softening Point	Not less than 100°C	ASTM E 28 Ring & Ball method
2.8	Brittleness Temp.	Less than (-) 30°C	ASTM 2137
2.9	Heat Ageing	No flow, stratification or cracks after 120 \pm 2°C for 7 days	ISO 188
2.10	Needle Penetration	70 to 130 units per 10 seconds	ASTM D 5
2.11	Colour	Black	Visual
2.12	Marking	Manufacturer's identity, Batch No. Mfg. date.	Visual
2.13	Dimensions	Length : 400 \pm 10 mm Width : 35 \pm 3 mm Thickness : 3 \pm 0.5 mm	Measurement

3.0 **TEST METHOD**

3.1 **PROCEDURE FOR TESTING VOLUME RESISTIVITY**

The test sample is sandwiched between two copper (disc) electrodes and placed centrally inside a guard ring (1) of copper. The outer electrode (2) is connected to one terminal of the million ohm meter. The guard ring and the outer electrode (2) are strapped together and the inner electrode connected to the other terminal of the meter. The resistance is recorded and the volume resistivity arrived as follows

Volume Resistivity in ohms cm = $R_x \times A/H$

R_x = Volume Resistance in ohms.

A = Effective area of inner electrode in cm²

H = Average thickness of the test specimen in cm.

3.2 **PROCEDURE FOR TESTING SHEAR STRENGTH**

Take two metal strips 100 mm x 50 mm x 2 mm. Clean the surface for 50 mm x 50 mm at one end of both the plates. Cut a piece of 25 mm length of sealant tape and sandwich the same between the cleaned surfaces of the metal plates. Keep a weight of 1 Kg. for about one minute over the plates to press the sealant between them. Release the weight and carefully fix the plates in a tensile machine such that the plates are lullled in opposite direction at a speed of 50 mm / min. Calculate the shear strength per square cm. of area.

EMERY STRIP FOR CABLE JOINTS

1.0 GENERAL

The Emery strip covered under this specification shall be used for surface preparation of cables with lead or polyethylene sheath.

2.0 MATERIAL REQUIREMENTS

2.1 EMERY

The emery used shall be synthetic or natural emery and shall not have less than 55% aluminium oxide and also shall not have less than 15% or more than 35% combined oxide by mass. Other properties shall be as follows:

Specific gravity	3.6 minimum
Hardness	8.0 on mhos. Scale

2.2 ADHESIVE

Adhesive used shall be of good quality glue or any other adhesive suitable for the purpose and shall satisfy the requirements given in Sec. 6.0. The adhesive shall be properly treated to resist attack by fungi or micro organism.

2.3 BACKING

Cloth shall be used as backing material. The cloth shall be of drill weave and shall have a breaking load of not less than 400 N / 25 mm width when tested with a speed of 50 mm / minute.

3.0 WORKMANSHIP

Finished product shall be free from any imperfection that may affect the serviceability.

4.0 FORM AND DIMENSIONS

The emery cloth shall be supplied in the form of strips conforming to dimensions given in the respective Kit content chart.

5.0 COATING

The material shall be supplied in CLOSED COAT, in which the abrasive grains completely cover the surface of backing.

6.0 **ADHESIVE STRENGTH OF ABRASIVE**

The strip shall be tested by rubbing abrasive side against the abrasive side of the sheet with the same grit in a to and fro motion. The criterion of acceptability shall be that the grains shall not disintegrate from the base in 20 strokes when tested in accordance with IS 715 Part – I.

7.0 **MARKING**

Each strip shall be marked with the following:

- A) Grill number
- B) Manufacturer's name and trade mark
- C) Batch number or manufacturing code

8.0 **PACKING**

The emery strips shall be packed in PE pouches.

9.0 **REQUIREMENT**

The emery strip shall conform to the following requirements when tested in accordance with the methods.

Sr. No.	Property	Requirement	Test Method
9.1	Defects	No burrs / sharp edges free from defects, moisture and fungus, abrasive intact.	Visual
9.2	Marking	Manufacturer's identity, Batch No., Grit size (60 mesh)	Visual
9.3	Packing	Should be enclosed in a PE pouch / sheet.	Visual
9.4	Integrity of abrasive bond	No disintegration of abrasive material	Rub test, IS - 715
9.5	Breaking Load	Not less than 400 N / 25 mm width	Tensile test
9.6	Dimension	Length (600mm \pm 5mm) x Width (25mm \pm 1mm) x 60 mesh.	Measurement

CLEANING TISSUE

1.0 GENERAL

The cleaning tissue shall be supplied in sealed pouches containing IPA conforming to IS 2631. The supplier shall produce a certificate to this effect from a recognized laboratory. The size of the tissue paper shall be Length (190 mm min.) x Width (140mm min.).

2.0 PACKING

The quantity of IPA contained in the pouch shall be 5 ml (min.). and the material of the pouch shall be laminated aluminium.

3.0 INTEGRITY OF SEALING

The sealed pouches shall be kept in an air-circulating oven at $50 \pm 2^{\circ}\text{C}$ for seven days and the weight loss is calculated. The weight loss shall not exceed 2%.

4.0 MARKING

Name of material
Manufacturers identify
Batch No.
Precautions regarding handling

5.0 REQUIREMENT

The cleaning tissue shall conform the following requirements:

Sr. No.	Property	Requirement	Test Method
5.1	Packing	No breakage, leakage or spilling	Visual
5.2	Marking	Manufacturer's identity, Caution level, Batch No.	Visual
5.3	Tissue / cloth	The tissue / non-woven cloth should not get softened or dissolved in the solvent due to reaction with the solvent. It shall be intact and useable.	Visual
5.4	Quantity of IPA	5 ml (min.) conforming to IS-2631.	Measurement
5.5	Colour	Clear or colourless	Visual
5.6	Integrity of sealing	The weight loss shall not exceed 2%.	Air-circulating oven at $50^{\circ} \pm 2^{\circ}\text{C}$ for 7 days.
5.7	Dimension of Tissue paper	Length: 190 mm (min.) Width: 140mm (min.)	Visual

ADHESIVE ALUMINIUM FOIL

1.0 GENERAL

The adhesive aluminium is used to protect the cable jacket from damage during shrinkage of thermo-shrink sleeve.

2.0 REQUIREMENT

The adhesive aluminium foil shall be in a strip form with adhesive coating on one side and protected by a release film.

Sr. No.	Property	Requirement	Test Method
2.1	Dimension	(400mm \pm 4mm) x (100mm \pm 2mm) x (0.06mm \pm 0.01mm)	Measurement
2.2	Tensile Strength	> 7.5 Kgf / 25 mm (width)	IS – 7809 Part - II
2.3	Elongation	> 4%	IS – 7809 Part - II
2.4	Peel Strength	> 400 gms. / 25 mm (width)	IS – 7809 Part - II
2.5	Marking	Manufacturer's identity, Batch No.	Visual

CABLE TIE

1.0 **GENERAL**

The Cable Tie is used to bunch cable / wires.

2.0 **REQUIREMENTS**

The Cable Tie shall conform to the following requirements.

Sr. No.	Property	Requirement	Test Method
1	Colour	Natural or Black	Visual
2	Dimensions	For 0.9mm dia.4/6 quad cable:- Length: 254mm \pm 3mm Width: 4.75mm \pm 0.5mm, Thickness: 1.43mm \pm 0.1mm. For 1.4mm dia.4/6 quad cable: Length: 315mm \pm 3mm Width: 4.75mm \pm 0.5mm Thickness: 1.56mm \pm 0.1mm.	Measurement
3	Tensile Strength	22Kgs (50lbs) min.	Tensile Machine
4	Marking	Manufacturer's identity.	Visual

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Discrete Wire Connectors

1.0 GENERAL

Discrete wire connectors shall be used to join individual conductors while making straight joint or derivation joints of 0.9 mm dia. conductor quad cable.

2.0 REQUIREMENTS

The discrete wire connector shall be made of Polypropylene plastic material and shall be filled with Moisture resistant compound. The Discrete wire connectors shall conform to the TEC GR No. G/CJM-15/02. Nov 97.

- 2.1 The following two types of Discrete wire joint shall be part of the jointing kit content for 0.9 mm dia. conductor quad cable.
 - 2.1.1 IDC type jelly filled butt connector modules made of polypropylene for 3 wires (0.4mm to 0.9mm dia. conductors) 30 Numbers
 - 2.1.2 IDC type jelly filled connector modules made of polypropylene for 2 wires bridging type (0.4mm to 0.9mm dia. conductors) 6 Numbers
- 2.2 All the tests as required under clause 6.1 of the TEC GR shall be carried out for type approval.

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Multi strand tinned copper conductor flexible insulated cable (single core)

- 1.0 **General:** The single core insulated cable conforming to IS: 694:1990 shall consist of multi strands of flexible tinned annealed copper conductors
- 2.0 **Requirements:**
- 2.1 The nominal Cross sectional area of the single core shall be 4 mm²
- 2.2 The nominal thickness of the insulation shall be 0.8 mm
- 2.3 The minimum number of strands shall be 53.
- 2.3 It shall be supplied in nominal length of 2000 mm
- 2.4 The resistance of 2000 mm long wire shall be 9.9 milliohms (maximum) at 20°C.