



**PRODUCT MANUAL FOR
CROSSLINKED POLYETHYLENE INSULATED THERMOPLASTIC
SHEATHED CABLES FOR WORKING VOLTAGES FROM 3.3 kV UPTO
AND INCLUDING 33 kV ACCORDING TO IS 7098 (PART 2):2011**

This Product Manual shall be used as reference material by all Regional/Branch Offices & licensees to ensure coherence of practice and transparency in operation of certification under Scheme-I of the Bureau of Indian Standards (Conformity Assessment) Regulations, 2018. The document may also be used by prospective applicants desirous of obtaining BIS product certification.

1.	Product Standard	:	IS 7098 (Part 2): 2011	
	Title	:	Cross-linked Polyethylene Insulated Thermoplastic Sheathed Cables for working voltages from 3.3kV up to and including 33kV	
	No. of Amendments	:	2	
2.	Sampling Guidelines:			
a)	Raw material	:	Plain copper/ aluminum wires	IS 8130
		:	Armour material	IS 3975
b)	Grouping guidelines	:	Please refer ANNEX – A	
c)	Sampling Guidelines	:	For Considering GoL / CSoL	Cu/Al wire (before stranding) – 5m Cu wire –100 g (for Cu purity test) Armour material – 5 m XLPE Cables (Cat 01) – 15 m XLPE Cables (Cat C1, C2) – 50 m
		:	For Surveillance	XLPE Cables (Cat 01) – 15 m XLPE Cables (Cat C1, C2) – 50 m
3.	List of Test Equipment	:	Please refer ANNEX – B	
4.	Scheme of Inspection and Testing	:	Please refer ANNEX – C	
5.	Possible tests in a day	:	Please refer ANNEX – D	
6	Scope of the Licecne			
	Licence is granted to use Standard Mark as per IS 7098 (Part 2): 2011 with the following scope:			

	Name of the product	:	Cross-linked Polyethylene Insulated Thermoplastic Sheathed Cables for working voltages from 3.3kV up to and including 33kV
	Type	:	Armoured / Unarmoured, Screened / Unscreened
	Conductor	:	Copper / Aluminium
	Category	:	01 / C1 / C2
	Voltage Grade	:	
	No. of Cores & Nominal Area of Conductor	:	Single Core for sizes upto and including mm ² Three Core for sizes upto and including mm ²
	Any other declaration	:	

ANNEX A**Grouping Guidelines**

1. Crosslinked Polyethylene Insulated Thermoplastic Sheathed Cables; For Working Voltages from 3.3 kV up to and including 33 kV are classified based on the following:
 - i. Material for Conductor – Aluminium, Copper
 - ii. No. of Cores (Single core, Three core)
 - iii. Screened/Unscreened
 - iv. Armoured/Unarmoured
 - v. Category of Cable [(01, C1(FR), C2(FR-LSH))]
 - vi. Cables intended for use in Mines
2. For considering GoL/CSoL, each type of cable shall be tested. However, additional variety may be considered when a particular variety of cable is tested as given below:

Variety Tested	Additional Variety that may be covered
Three Core	Single Core
Screened	Unscreened
Armoured	Unarmoured
(a) C2 (FR-LSH)	(a) C1(FR) and 01
(b) C1(FR)	(b) 01

3.1 When a cable of higher size is tested, cables of sizes upto and including that particular size may be covered.

3.2 In case the firm opts for the optional tests, firm shall declare the same and the conformity shall be ensured.

2. Firm shall declare the varieties and sizes of various cables they intend to cover in the Licence. The Scope of Licence may be restricted based on the Manufacturing and Testing capabilities of the Manufacturer. The conductor cross sectional area and rated voltage recommended for GoL/CSoL shall not be greater than that of the tested cable.
3. During the operation of the Licence, BO shall ensure that all the varieties covered in the Licence are tested in rotation to the extent possible.

ANNEX B**List Of Test Equipment****Major test equipment required to test as per the Indian Standard**

Sl. No.	Description Of the Test Equipment	Tests used in with Clause Reference
1	Digital Vernier Caliper	Measurement of thickness & Outer Dia. for Cl 12.2, 16.3, 17.3, 19.1(iii), 19.1(iv) & 19.1 (i) b
2	Steel Scale	Measurement of dimensions for Cl 17.3, 19.1 (iii), 19.1 (i) a & b
3	Digital Micro meter	Measurement of Wire Dia. for Cl 12.2, 16.3, 17.3, 19.1 (ii), 19.1 (iii), 19.1 (i) a & b
4	Measuring Microscope	Measurement of thickness for Cl 12.2, 16.3, 19.1(iii)
5	Graduate Magnifying Glass	Measurement of dimensions for Cl 12.2, 16.3, 19.1 (iii)
6	Tensile Testing Machine	Tensile Strength, Elongation Test & Annealing Test for Cl 17.3, 19.1 (iii), 17.6.1, 17.6.2
7	Dumb-Bell Cutting Machine with Die	Tensile Strength & Elongation Test for Cl 19.1(iii), 17.6.1, 17.6.2
8	Hot Air oven with thermostatic Temp. controller	Heat Shock, Hot Deformation & Shrinkage Test for Cl 19.1(ii), 19.1(iii)
9	Thermal Ageing Oven with Thermostatic Temperature control, Air flow Meter & Hour Meter	After Ageing Tensile Strength, Elongation Test & Loss Of Mass Test for Cl 19.1 (iii) & 19.1 (vii)
10	Water Bath with thermostatic temp. control Stirrer & Hour Meter,	Water immersion A.C. & D.C. Test, Insulation Resistance Constant & Volume Resistivity Test for Cl 19.1 (xi), 19.8
11	Million Mega ohm Meter	Insulation Resistance constant/ Volume Resistivity Test for Cl 19.1 (xi) & 19.1 (v) b
12	Heat Shock Mandrels	Heat Shock Test for Cl 19.1 (vi) f
13	Cold Bend Mandrels	Cold Bend Test for Cl 19.4 (optional requirement)
14	Cold Impact Apparatus	Cold Impact Test for Cl 19.4 (optional requirement)

15	Hot Deformation Apparatus with weight	Hot Deformation Test for Cl 19.1(vi) d
16	Physical Weighing Balance with Weight	Loss of Mass Test & Thermal Stability Test for Cl 19.1 (vi) e & g
17	Double Kelvin Bridge with galvanometer, D.C. Source & Conductivity attachment	Conductor Resistance Test for Cl 19.1 (i) d, 17.5
18	Flammability Test apparatus with burner, Gas cylinder, Scale, Stopwatch & 0.71 mm copper wire	Flammability Test for Cl 19.8
19	Conditioning chamber & De-freezer with Humidity Indicator	Tensile Strength, Elongation Test, cold bend, cold Impact & Thermal stability Test for Cl 19.1 & 19.4, 17.6.1, 17.6.2
20	AC Spark Tester	For online Spark Testing
21	D.C. High Voltage	D.C. High Voltage Test for Cl 19.1 (xiv)
22	A C. High Voltage	A.C. High Voltage Test for Cl 19.7
23	H.V. Mega Ohm Box	Insulation Resistance Test for Cl 17.5, 19.2 (g), 19.4
24	Glass Thermometer	Conductor & Insulation Resistance Test for Cl 17.5, 19.2 (g), 19.4
25	Balance Digital	Flammability Test for Cl 20.8
26	Stop Watch	Flammability Test for Cl 19.1 (iii)
27	Thermal stability test apparatus with pH paper & tubes	Thermal Stability Test for Cl 19.1 (vi) g
28	Room Thermometer	Flammability Test, Shrinkage, Annealing & Elongation Test for Cl. 19.1 (iii) b, d, e, f; 19.1 (xiv)
29	Water Absorption (Gravimetric)	Cl. 19.1 (iii) f
30	Air Conditioner	For Maintaining Room Temp.
31	Combustion boat, combustion tube, glass flowmeter, thermometer (250 to 550 degrees), furnace(500 degrees), desiccator	Carbon black content of polythene sheath Cl. 19.1 (vi) h

32	Partial discharge test bench (test voltage supply, coupling capacitor, HV Voltmeter, measuring impedance, variable resistance, amplifying oscilloscope and calibration pulse generator)	Partial Discharge test 19.1 (viii) & Heat cycle test 19.1 (xii)
33	Power factor measuring setup, HV Source, Current loading transformer,	Dielectric power factor test 19.1 (x)
34	Impulse generator and sphere gap, current loading transformer, barometer, hygrometer, CRO	Impulse withstand test 19.1 (xiii)
35	Apparatus for Smoke Density Test	Smoke Density Test Cl. 20.14
Additional Testing Equipment for Armour Testing (in case non ISI Strip/wire is used)		
1	Curvature Gauge	Measurement of thickness test for Cl 17.3
2	Torsion test Apparatus	For Torsion test as per Cl 19.1 (ii), 17.6.3
3	Mandrels (15 times the nom. Thickness of Strip 0.5 mm)	For Winding test as per Cl 19.1 (ii)
4	Glass Container, Copper Sulphate Solution, Distilled Water, Hot Plate, Copper Carbonate or Copper Hydroxide, Hydrometer, Suitable Glassware	For Uniformity of Zinc Coating Testing as per Cl 19.1 (ii), 17.6.5
5	Beaker (500 ml with a watch glass), Antimony Chloride, Conc. Hydrochloric Acid, Stripping Solution, Trichloroethylene, Spirit	For Mass of Zinc Coating testing as per Cl 19.1 (ii), 17.6.6
Additional Testing Equipment for Testing of Category C1(FR), C2(FR-LSH)		
1	Oxygen Index test apparatus, Oxygen & Nitrogen gas	For Oxygen Index Test and Temperature Index Testing as per Cl 20.10 & 20.15
2	Flame Retardation Test (for Single Cable) Apparatus, Ignition Fluid	For Flame Retardation Testing (for Single Cable) as per Cl 20.11

3	Flame Retardation Test (for Bunched Cable) Apparatus	For Flame Retardation Testing (for Bunched Cable) as per Cl 20.12
4	Tube Furnace, Quartz Combustion Tube, Porcelain combustion tube, Wash Bottles (03 Nos.), Glass Tubing and Silicon Rubber Stoppers, Air Flow Meter, Sodium Hydroxide Soln. (0.1 N), Nitric Acid Soln. (6 N), Silver Nitrate Soln. (0.1 N), Ammonium Thiocyanate Soln. (0.1 N), Ferric Ammonium Soln. (40 %), Potassium Hydroxide (0.1 N), Sulphuric Acid (0.1 N)	For Halogen Acid Gas Evolution Testing as per Cl 20.13
Additional Testing Equipment for Cables with Water Tight Construction		
1	Apparatus for Longitudinal water penetration test	Longitudinal Water Penetration Test Cl. 20.16

The above lists are indicative only and may not be treated as exhaustive.

ANNEX C

Scheme of Inspection and Testing

1. LABORATORY - A laboratory shall be maintained which shall be suitably equipped (as per the requirement given in column 2 of Table 1) and staffed, where different tests given in the specification shall be carried out in accordance with the methods given in the specification.

1.1 The manufacturer shall prepare a calibration plan for the test equipment.

2. TEST RECORDS – The manufacturer shall maintain test records for the tests carried out to establish conformity.

3. LABELLING AND MARKING – Crosslinked Polyethylene (XLPE) Insulated Thermoplastic Sheathed Cables for Working Voltages from 3.3 kV up to and including 33 kV shall be either intended, printed or embossed per Cl. 21 of IS 7098 (Part 2):2011. XLPE cable also shall carry the information either stenciled on the drum or contained in a label attached to it as per Cl. 22 of IS 7098 (Part 2): 2011. The Standard Mark as given in the Schedule of the licence shall be either printed or indented or embossed on the cable.

3.1 In addition to the above, the licence no. CM/L- and details of BIS website shall be marked either on the drums or on the label attached to it as follows: “For details of BIS certification please visit www.bis.gov.in”

4. CONTROL UNIT – Crosslinked Polyethylene Insulated Thermoplastic Sheathed Cables for Working Voltages from 3.3 kV up to and including 33 kV of same size and type manufactured in a day shall from same consignment of raw material shall constitute a control unit.

5. LEVELS OF CONTROL - The tests as indicated in column 1 of Table 1 and the levels of control in column 3 of Table 1, shall be carried out on the whole production of the factory which is covered by this plan and appropriate records maintained in accordance with paragraph 2 above.

6. REJECTIONS – Disposal of non-conforming product shall be done in such a way so as to ensure that there is no violation of provisions of BIS Act, 2016.

Table 1

(1)					(2)	(3)		
TEST DETAILS					Test equipment requirement R: required (or) S: Sub-contracting permitted	LEVELS OF CONTROL		
Clause	Requirements	TEST METHODS				No. of Sample	Lot Size/ Frequency	Remarks
		Clause	Reference	Part no. of IS 10810				
19.1 (i)	Tests on Conductor							
a)	Annealing test (for Cu)	7.1.2	IS 8130	1	R	One	For each consignment	No further testing is required if accompanied with Test Certificate or ISI marked.
b)	Tensile test (for Al) (not applicable for compacted or shaped conductor)	7.2.1	IS 8130	2	R			
c)	Wrapping test (for Al)	7.2.2	IS 8130	3	R			
d) & 19.3 (a)	Resistance test	7.3	IS 8130	5	R			
	Purity test (for Cu)	Table 4	IS 191	-	S			
19.1(ii)	Test for armouring wires/ formed wires	Cl 8, 17.3 Table 6	IS 7098 (Part 2)	36-42	R	Firm to have adequate in-process controls to check compliance of this parameter as per the tolerances given in the Indian Standard. However, appropriate records shall be maintained by the manufacturer for evidence of conformity.		
19.3(d)	Resistance test for armour (for mining cables)	17.5		42	R			
4 to 9	Materials	4 to 9		-	R			
10	Construction of conductor	10		-	R			
11	Conductor screening	11			R			
12.5	Application of insulation	12.5			R			
13	Insulation screening	13			R			
14	Core identification	14			R			
15	Laying up of cores	15			R			
16	Inner sheath	16			R			
17	Armouring	17	R					
18	Outer sheath	18	R					

19.1 (iii)	Physical tests for insulation							
a)	Tensile Strength and elongation at break	Table 1	IS 7098 (Part 2)	7	R	One	Cable of each size & type manufactured in a month from same consignment of XLPE compound	
b)	Ageing in Air oven	-do-	IS 7098 (Part 2)	11	R			
c)	Hot set test	-do-	IS 7098 (Part 2)	30	R			
d)	Shrinkage test	-do-	IS 7098 (Part 2)	12	R			
e)	Water absorption (gravimetric)	-do-	IS 7098 (Part 2)	33	S			
19.1(iv)	Thickness of insulation & sheath, eccentricity of insulation	Cl 12.2, 12.3, 12.4,16.3 & 18.3; Table 4, Table 5; & Annex-A	IS 7098 (Part 2)	6	R	Firm to have adequate in-process controls to check compliance of this parameter as per the tolerances given in the Indian Standard. However, appropriate records shall be maintained by the manufacturer for evidence of conformity.		
19.1(v)	Test on extruded semi-conducting screens							
a)	Test for strippability of semiconducting strippable insulation screen (wherever applicable)	Table 2 & Annex B	IS 7098 (Part 2)	-	R	Firm to have adequate in-process controls to check compliance of this parameter as per the tolerances given in the Indian Standard. However, appropriate records shall be maintained by the manufacturer for evidence of conformity.		
b)	Volume resistivity	Table 2 & Annex E			R			
19.1 (vi)	Physical test for outer sheath							
a)	Tensile strength and elongation at break	Table 3	IS 7098 (Part 2) or IS 5831	7	R	One	Cable of each size & type manufactured in a month from same consignment of outer sheath compound	---
b)	Ageing in air oven	Table 3		11	R	One		

c)	Shrinkage test	-do-	IS 7098 (Part 2) or IS 5831	12	R	One	Cables manufactured in a month from same consignment of outer sheath compound	
d)	Hot deformation	-do-		15	R	One		
e)	Loss of mass in air oven	-do-		10	R	One		
f)	Heat shock	-do-		14	R	One		
g)	Thermal stability	-do-		60	R	One		
h)	Carbon black content of polythene sheath (applicable for Black PE sheath only)	-do-		32	S	One		
19.1(vii)	Thermal ageing test for complete cable	20.9	IS 7098 (Part 2)	-	S	One	Cables of each size and type manufactured in 3 months	---
19.1(viii)	Partial discharge test (for screened cables)	20.2	IS 7098 (Part 2)	46	R	Firm to have adequate in-process controls to check compliance of this parameter as per the tolerances given in the Indian Standard. However, appropriate records shall be maintained by the manufacturer for evidence of conformity.		
19.3 (c)	High voltage test	20.7.2	IS 7098 (Part 2)	45	R			

Note 1: Levels of control given in table above are only recommendatory in nature.

Note 2: The manufacturer may define the control unit/batch/lot and submit his own levels of control with proper justification. (see Clause 1.2 of SIT)

Note 3: To facilitate the implementation of Standards by the MSMEs, the test facilities categorised as 'R' can also be subcontracted to NABL accredited laboratories.

ANNEX D

Possible tests in a day

- i. Dimensions
- ii. Annealing Test (for Copper wires)
- iii. Tensile Test (for Al wires)
- iv. Wrapping test (for Al wires)
- v. Conductor Resistance
- vi. Tensile Test (before ageing) on Insulation and Sheath
- vii. Shrinkage Test
- viii. Hot Deformation
- ix. Heat Shock Test
- x. Insulation Resistance Test
- xi. HV Test (at Room Temperature)
- xii. Flammability Test