



**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 Bureau of Indian Standards (Conformity Assessment) Regulations, 2018 for various products. The document may also be used by prospective applicants desirous of obtaining BIS certification licence/certificate.

1.	Product Standard	:	IS 7098 (Pt 2): 2011
	Title	:	Cross-linked Polyethylene Insulated Thermoplastic Sheathed Cables for working voltages from 3.3kV up to and including 33kV
	No. of Amendments	:	1
2.	Sampling Guidelines:		
a)	Raw material	:	Plain copper/ aluminum wires IS 8130 Armour material IS 3975
b)	Grouping guidelines	:	Please refer ANNEX – A
c)	Sample Size	:	(i) Copper/Aluminium wire (before stranding) - 5 meters (ii) Cu wire –100 g (for Cu purity test) (iii) Armour material – 5 meters (iv) XLPE insulated Thermoplastic sheathed Cable - 15 meters (01 category), 50mtrs (C1 & C2)
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 Licence: Cross-linked Polyethylene Insulated, PVC/Polyethylene Sheathed Cables for Single Phase or Three Phase (earthed and unearthed) systems for electricity supply purposes, Armoured/Unarmored, Screened/Unscreened, with Aluminium/Copper Conductor, Category 01/C1/C2, except/suitable for use in mines, excluding/including Low Temperature Applications, for working voltages up to and including kV for the following sizes a) Single core for Sizes up to and including mm ² . b) Three-core for Sizes up to and including mm ² .		

BUREAU OF INDIAN STANDARDS

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ANNEX A

Grouping Guidelines

1. Each variety of Cable shall be tested for GoL/CSoL considering the following:
 - i. Material for Conductor – Aluminium, Copper
 - ii. No. of Cores (Single core, Three core)
 - iii. Screened/Unscreened
 - iii. Armoured/Unarmoured
 - iv. Type of Outer Sheath (PVC -Type ST 2/ Polyethylene)
 - v. Category of Cable [(01, C1(FR), C2(FR-LSH)]
 - vi. Voltage grade
 - vii. Cables intended for use in Mines
 - viii. Low Temperature Application

2. The following relaxation may be given when a variety is tested for all the requirements and the manufacturing process remains the same:

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
Particular Voltage Grade Uo/U	Grades up to and including Voltage Grade Uo/U

3. Firm shall declare the varieties and sizes of various cables they intend to cover in the Licence. Cable with the largest size (Nominal cross sectional area of conductor), intended to be covered in the Licence may be drawn for testing. The Scope of Licence may be restricted based on the Manufacturing and Testing capabilities of the Manufacturer. The conductor cross sectional area recommended for GoL/CSoL shall not be larger than that of the tested cable.

4. 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.

5. A typical example for drawl of samples to cover the entire varieties under the Scope of the Licence is given below for the purpose of general guidance:
- a. Sample 1: Single Core, Armoured, Unscreened Cable with Copper Conductor, PVC Outer Sheath, Category C2, suitable for use in Mines.

and

- b. Sample 2: Three Core, Armoured, Screened Cable with Aluminium Conductor, Polyethylene Outer Sheath, Category 01, including Low Temperature Applications.

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)
7	Dumb-Bell Cutting Machine with Die	Tensile Strength & Elongation Test for Cl 19.1(iii)
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 CI 19.1(vi) d
16	Physical Weighing Balance with Weight	Loss of Mass Test & Thermal Stability Test for CI 19.1 (vi) e & g
17	Double Kelvin Bridge with galvanometer, D.C. Source & Conductivity attachment	Conductor Resistance Test for CI 19.1 (i) d, 17.5
18	Flammability Test apparatus with burner, Gas cylinder, Scale, Stopwatch & 0.71 mm copper wire	Flammability Test for CI 19.8
19	Conditioning chamber & De-freezer with Humidity Indicator	Tensile Strength, Elongation Test, cold bend, cold Impact & Thermal stability Test for CI 19.1 & 19.4
20	AC Spark Tester	For online Spark Testing
21	D.C. High Voltage	D.C. High Voltage Test for CI 19.1 (xiv)
22	A C. High Voltage	A.C. High Voltage Test for CI 19.7
23	H.V. Mega Ohm Box	Insulation Resistance Test for CI 17.5, 19.2 (g), 19.4
24	Glass Thermometer	Conductor & Insulation Resistance Test for CI 17.5, 19.2 (g), 19.4
25	Balance Digital	Flammability Test for CI 20.8
26	Stop Watch	Flammability Test for CI 19.1 (iii)
27	Thermal stability test apparatus with pH paper & tubes	Thermal Stability Test for CI 19.1 (vi) g
28	Room Thermometer	Flammability Test, Shrinkage, Annealing & Elongation Test for CI. 19.1 (iii) b, d, e, f; 19.1 (xiv)
29	Water Absorption (Gravimetric)	CI. 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 CI. 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)
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)
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)
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)
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 CI 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 CI 20.13

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 – As per the requirements of IS 7098 (Pt 2).

4. CONTROL UNIT – Cables of each size and type manufactured in a day 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.

(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	Each drum of finished cable	These are in addition to the production line checks at wire drawing stage. Until requirements after stranding are specified, annealing test may be confined to one sample out of ten units or part thereof received before stranding.
b)	Tensile test (for Al)	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	One	For each consignment	No further testing is required if accompanied with Test Certificate or ISI marked.
19.1(ii)	Test for armouring wires/ formed wires	Cl 8, 17.3 Table 6	IS 7098(Pt.2)	36-42	R	One	Each drum of finished cable of each size & type manufactured from the same consignment of armour/ formed wires.	No testing of armouring wires/ formed wires is required if it is 'ISI' marked. Records to this effect to be maintained.
19.3(d)	Resistance test for armour (for mining cables)	17.5	IS 7098(Pt.2)	42	R	One	Each drum of finished cable	---
4 to 9	Materials	4 to 9	IS 7098(Pt.2)	-	R	One	Each drum of conductors/ finished cable	---
10	Construction of conductor	10	IS 7098(Pt.2)	-	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(Pt.2)	7	R	One	Cable of each size & type manufactured in a month from each consignment of XLPE compound	---
b)	Ageing in Air oven	-do-	IS 7098(Pt.2)	11	R			
c)	Hot set test	-do-	IS 7098(Pt.2)	30	R			
d)	Shrinkage test	-do-	IS 7098(Pt.2)	12	R			
e)	Water absorption (gravimetric)	-do-	IS 7098(Pt.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(Pt.2)	6	R	One	Each drum of finished cable	---
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(Pt.2)	-	R	One	Cable of each size & type manufactured in a month	---
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(Pt.2) or IS 5831	7	R	One	Cable of each size & type manufactured in a month from each consignment of outer sheath compound	---
b)	Ageing in air oven	Table 3		11	R	One		

c)	Shrinkage test	-do-	IS 7098(Pt.2) or IS 5831	12	R	One	Cables manufactured in a month from each 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	-do-		32	S	One		
19.1(vii)	Thermal ageing test for complete cable	20.9	IS 7098 (Pt.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(Pt.2)	46	R	One	Each length of finished cable	---
19.3 (c)	High voltage test	20.7.2	IS 7098(Pt.2)	45	R			

19.1(ix)	Bending test	20.3	IS 7098 (Pt.2)	50	R	One	Cable of each size & type manufactured in a fortnight	---
19.1(x)	Dielectric power factor test i) as a function of voltage ii) as a function of temperature	20.4	IS 7098(Pt.2)	48	R	One		
19.1 (xi)	Insulation resistance test	Table 1	IS 7098 (Pt.2)	43	R			
19.1(xii)	Heating cycle test	20.5	IS 7098 (Pt.2)	49	R			
19.1(xiii)	Impulse withstand test	20.6	IS 7098 (Pt.2)	47	R			
19.1(xiv)	High voltage test (Type test)	20.7.1	IS 7098 (Pt.2)	45	R			
19.1(xv)	Flammability test for PVC sheathed cables	20.8	IS 7098 (Pt.2)	53	R			
19.4	Cold impact test for outer sheath(optional test)	Table 2	IS 5831	21	S	Cables manufactured every 3 months from each consignment of outer sheath compound		

19.1.3	Additional type tests for cables with Improved Fire Performance							
	Oxygen Index test	20.10	IS 7098 (Pt.2)	58	S	One	Cables manufactured every 3 months from each consignment of outer sheath compound	For category C1 and C2 sample to be taken from outer sheath, as applicable, and prepared in the manner given in the relevant test method
	Flame Retardance Test on single cable	20.11	IS 7098 (Pt.2)	61				
	Flame Retardance Test on bunched cable	20.12	IS 7098 (Pt.2)	62				
	Temperature Index	20.15	IS 7098 (Pt.2)	64				
	Smoke density test (on sheathing material)	20.14	IS 7098 (Pt.2)	Under Preparation				
	Test for halogen acid gas evolution	20.13	IS 7098 (Pt.2)	59				

Note-1: Sub-contracting is permitted to a laboratory recognized by the Bureau or Government laboratories empanelled by the Bureau.

Note-2: Levels of control given in column 3 are only recommendatory in nature. The manufacturer may define the control unit/batch/lot and submit his own levels of control in column 3 with proper justification for approval by BO Head.

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