



**PRODUCT MANUAL FOR  
CROSSLINKED POLYETHYLENE INSULATED  
THERMOPLASTIC SHEATHED CABLES FOR WORKING  
VOLTAGES FROM 66kV UP TO AND INCLUDING 220 kV  
ACCORDING TO IS 7098 (Pt 3): 1993**

*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.	<b>Product Standard</b>	:	IS 7098 (Pt 3): 1993
	<b>Title</b>	:	Crosslinked Polyethylene insulated Thermoplastic sheathed cables for working voltages from 66kV up to and including 220 kV
	<b>No. of Amendments</b>	:	4
2.	<b>Sampling Guidelines:</b>		
a)	<b>Raw material</b>	:	Plain copper / aluminium wires IS 8130 Armour material IS 3975
b)	<b>Grouping guidelines</b>	:	Please refer <a href="#">ANNEX – A</a>
c)	<b>Sample Size</b>	:	(i) Copper/Aluminium wire (before stranding) - 5 meters (ii) Copper wire(for Copper purity test)-100g (iii) Armour material – 5 meters (iv) Cable - 15 meters
3.	<b>List of Test Equipment</b>	:	Please refer <a href="#">ANNEX – B</a>
4.	<b>Scheme of Inspection and Testing</b>	:	Please refer <a href="#">ANNEX – C</a>
5.	<b>Possible tests in a day</b>	:	Please refer <a href="#">ANNEX - D</a>
6.	<b>Scope of the Licence :</b> Single core, Cu/ Al conductor, Crosslinked Polyethylene Insulated, with/ without metallic sheath, PVC/ Thermoplastic PE inner Sheathed, PVC/ Thermoplastic PE outer Sheathed Armoured/ Unarmoured Cables for use in 3 Phase ac earthed system for electric supply, of the following sizes and voltage grades: a) Voltage grades: b) Sizes up to and including ..... mm <sup>2</sup> .		

**ANNEXA****Grouping Guidelines**

1. Each variety of Cable shall be tested for GoL/CSoL considering the following:
  - i. Material for Conductor – Aluminium, Copper
  - ii. Inner sheath (PVC/ Thermoplastic PE)
  - iii. Unarmoured/ Armoured
  - iv. With/ without Metallic Sheath
  - v. Outer sheath (PVC/ Thermoplastic PE)
  - vi. Voltage Grade (38/66kV, 64/110kV, 76/132kV, 127/220kV)

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
Armoured	Unarmoured
With metallic sheath	Without metallic sheath
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 any Size (Nominal Cross Sectional Area of Conductor), preferably the largest 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.
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 drawal 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 Cable with Al conductor, Metallic Sheath, PVC inner and PVC outer sheath, voltage grade 127/220kV.
  - and*
  - b. Sample 2: Single Core, unarmoured Cable with Cu conductor, without Metallic Sheath, Thermoplastic PE inner and Thermoplastic PE outer sheath, voltage grade 38/66kV.

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

<b>Sl. No.</b>	<b>Description Of the Test Equipment</b>	<b>Tests used in with Clause Reference</b>
1	Digital Vernier Calliper	Measurement of thickness & Outer Dia. for Cl 19.1(b)(I), Table 5,19.1(e),19.1(f),20.6,19.1(g),Table 9,20.5,Table 6
2	Steel Scale	Measurement of dimensions for Cl 19.1(f),20.6
3	Digital Micro meter	Measurement of Wire Dia. For Cl 9.2, 12.3, 13.3, 13.6(b), 15.1(d),15.2(a) & (b)
4	Measuring Microscope	Measurement of thickness for Cl 19.1(b)(I), Table 5,19.1(e),19.1(g),Table 9,20.5,Table 6
5	Graduate Magnifying Glass	Measurement of dimensions for Cl 19.1(b)(I), Table 5,19.1(e),19.1(g),Table 9,20.5,Table 6
6	Tensile Testing Machine	Tensile Strength, Elongation Test & Annealing Test for Cl 19.1(a)(i),19.1(b)(ii),19.1(f)(ii),19.1(g)2(i), 19.1(g)3(ii), 8.3, 19.1(k)(ii),Table 2
7	Dumb-Bell Cutting Machine with Die size 75mm	Tensile Strength & Elongation Test for Cl 19.1(b)(ii), 19.1(f)(ii),19.1(g)2(i),19.1(g)3(ii), 8.3, 19.1(k)(ii),Table 2
8	Hot Air oven with thermostatic Temp. controller	Heat Shock, Hot Deformation & Shrinkage Test for Clause 19.1(b)(v),19.1(g)2(iv, v & vi),19.1(g)3(iii), 20.2
9	Thermal Ageing Oven with cell/tube(Dia 100mm, Length 300mm), Thermostatic Temperature control, Air flow Meter & Hour Meter	After Ageing Tensile Strength, Elongation Test & Loss Of Mass Test for Cl 19.1(g)2(iii),19.1(b)(ii),19.1(f)(ii), 19.1(g)2(i),19.1(g)3(ii)
10	Impulse Test System	Impulse Withstand Test for Cl 19.1 (r), 20.15
11	Digital Capacitance Meter	Capacitance Measurement Test for Cl 20.18
12	Heat Shock Mandrels	Heat Shock Test for Cl 19.1 (g)(iv)
13	Tan Delta Test System	Dielectric Power Factor and Capacitance Measurement for Cl 19.1(n),20.12,20.13,20.18
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(g)2(v)
16	Physical Weighing Balance with Weight	Loss of Mass Test & Thermal Stability Test for Cl 19.1(g)2(iii, vii)
17	Double Kelvin Bridge with galvanometer, D.C. Source & Conductivity attachment/ Digital Micro Ohm Meter / Digital Ohm Meter	Conductor Resistance Test for Cl 19.1 (a)(ii)
18	Flammability Test apparatus with burner, Gas cylinder, Scale, Stopwatch & 0.71 mm copper wire	Flammability Test for Cl 20.7
19	Conditioning chamber & Refrigerator with Humidity. Indicator	Tensile Strength, Elongation Test, Cold Impact & Thermal stability Test for Cl 19.1 and 19.4
20	AC Spark Tester	For Spark Testing ( optional requirement)
21	Partial Discharge Test System	Partial Discharge Test for Cl 20.10
22	High Voltage ac Resonant System	A.C. High Voltage Test for Cl 20.17
23	Heating Cycle Test System	Load Cycle Test for Cl 19.1(q),20.14
24	Glass Thermometer	Conductor & Insulation Resistance Test for Cl 13.5.2, 15.1 (a)
25	Digital Balance	Flammability Test for Cl 20.7
26	Stop Watch	Flammability Test for Cl 20.7
27	Thermal stability test apparatus with pH paper(Range 1 to 10) & glass tubes (OD 5mm, Length 110mm)	Thermal Stability Test for Cl 19.1 (g)2(vii)
28	Room Thermometer	Flammability Test, Shrinkage, Annealing & Elongation Test for Cl 19.1, Cl.20.7
29	Hot set oven with sample hanging arrangement, hour meter, thermostatic temp controller, air flow meter and digital laser height gauge	Hot Set Test for Cl 19.1(b)(iv),19.2.1(d)
30	Air Conditioner	For Maintain Room Temp.

<b>Additional Testing Equipment</b>		
1	Water Penetration / Tightness Test System	Water Tightness Test for Cl 19.1(j),20.8
2	Carbon Black Content Test System with airflow meter, desiccator and Trichloroethylene	Carbon black content test for Cl 19.1 (g)3(i),8.3(d)
3	Bending Mandrels /Cylindrical Barrel and other various Mandrels(8mm,10mm)	Bending Test for Cl 19.1 (m),20.11 Heat Shock Test for Cl 19.1(g)2(iv)
4	Chemical Test arrangement	For determining composition of lead alloy sheath as per Cl 7.2,Table 3
5	Set of weights(Brass/Steel)- 1g,2g,5g,10g,20g,50g,100g	For Hot Set & Hot Deformation Tests as per Cl 19.1 (b)(iv),19.1(g)2(v), 19.1(g)3(iii),19.2.1(d)
<b>Additional Testing Equipment-Miscellaneous</b>		
1	Slicing Machine	For making slice of insulation for Tensile Strength and Elongation Testing
2	Conductor Pulling Machine	For removing conductor from insulated core for making sample for testing

*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** – In addition to requirements of IS 7098 (Pt 3): 1993, Identification in code or otherwise shall be either stencilled on reel/drum, packages of individual coil or contained in the label attached to the coil, in order that the date of manufacture and control unit can be traced back to factory records.

**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.

**TABLE 1**

(1)				(2)	(3)		
Test Details				Test equipment requirement R: required (or) S: Sub-contracting permitted	Levels of Control		
Cl.	Requirement	Test			No. of Sample	Frequency	
		Cl	Ref	Test Methods Part Ref of IS 10810			
19.1(a)	<b>Tests on Conductor</b>						
i	Annealing test ( <i>for copper</i> )	7.1.2	IS 8130	1	R	one	Each length of finished cable. For annealing, every 10 spools of wire drawn or received (before stranding)
ii	Conductor resistance	7.3, Table 1,2		5	R	one	
	Purity test(for Cu)	Table 4	IS 191	-	S	For each consignment	No further testing is required if accompanied with Test Certificate or ISI marked.
19.1(f)	Test for armouring material i. Dia of armour wire ii. Tensile strength and elongation at break iii. Wrapping test iv. Resistivity test	20.6  Under consideration	IS 7098 (Pt 3)	36 37 3 42	R	one	Each length of finished cable from same consignment of armour wires received. No further testing is required if accompanied with TC or ISI marked.
4 to 10	Materials	4 to 10	IS 7098 (Pt 3)	-	S	one	Each consignment of material received. No further testing is required if accompanied with Test Certificate or ISI marked
11	Construction of conductor	11	IS 7098 (Pt 3)	-	R	one	Each length of conductor /finished cable
12	Conductor Screening	12	IS 7098 (Pt 3)	-	R	one	
13	Insulation	13	IS 7098 (Pt 3)	-	R	one	
14	Insulation Screening	14	IS 7098 (Pt 3)	-	R	one	
15	Moisture Barrier	15	IS 7098 (Pt 3)	-	R	one	
17	Armouring	17.1, 17.2, 17.3 & 17.4	IS 7098 (Pt 3)	-	R	one	

18	Outer Sheath	18	IS 7098 (Pt 3)	-	R	one	
19.1(b)	<b>Physical tests on insulation</b>						
i	Thickness & dimension of insulation	Table 5, 20.15	IS 7098 (Pt 3)	6	R	one	Each length of finished cable.
ii	Tensile strength and elongation at break	Table 2	IS 7098 (Pt 3)	7	R	one	Cable of each size & type manufactured in a month from each consignment of XLPE compound
iii	Aging in air oven	Table 2	IS 7098 (Pt 3)	11	R	one	-do-
iv	Hot Set test	Table 2	IS 7098 (Pt 3)	30	R	one	Cable of each size & type manufactured in a fortnight from each consignment of XLPE compound
v	Shrinkage test	Table 2	IS 7098 (Pt 3)	12	R	one	Cable manufactured in a month from each consignment of XLPE compound
19.1(c)	Resistivity test for semi-conducting layers	20.1	IS 7098 (Pt 3)	-	S	one	Cable of each size & type manufactured in a month from each consignment of XLPE compound
19.1(d)	Test for concentric metallic screen: i. Test for concentric Cu wire ii. Test for concentric Cu tape	20.2 20.3	IS 7098 (Pt 3)	-	S	one	Cable of each size & type manufactured in a month from each consignment of XLPE compound
19.1(e)	Thickness of metallic sheath	20.4	IS 7098 (Pt 3)	34	R	one	Each length of finished cable.
19.1(g)	<b>Physical tests on outer sheath</b>						
1	Thickness of sheath	Table 9	IS 7098 (Pt 3)	6	R	one	Each length of finished cable.
2	<i>PVC Sheath</i>						
i	Tensile strength and elongation at break	Table 2	IS 5831	7	R	one	Cable of each size & type



ii	Aging in air oven	Table 2	IS 5831	11	R	one	manufactured in a month from each consignment of PVC compound
iii	Loss of mass in air oven	Table 2	IS 5831	10	R	one	Cable manufactured in a month from each consignment of PVC compound
iv	Heat shock test	Table 2	IS 5831	14	R	one	
v	Hot deformation test	Table 2	IS 5831	15	R	one	
vi	Shrinkage test	Table 2	IS 5831	12	R	one	
vii	Thermal stability test	Table 2	IS 5831	60	R	one	
3	<i>PE Sheath</i>						
i	Carbon Black Content	19.1.g(3)(i)	IS 7098 (Pt 3)	32	R	one	Cable manufactured in a month from each consignment of PE compound
ii	Tensile strength	8.3	IS 7098 (Pt 3)	7	R	one	
iii	elongation at break before and after ageing	8.3	IS 7098 (Pt 3)	7	R	one	
iv	Hot deformation	8.3	IS 7098 (Pt 3)	15	R	one	
19.1(h)	Flammability test(for PVC outer sheathed cable only)	20.6	IS 7098 (Pt 3)	53	R	one	Cable manufactured from each consignment of PVC compound
19.1(j)	Water Tightness test Longitudinal Radial	20.7.1, 20.7.3 Under consideration	IS 7098 (Pt 3)	-	S	one	Cables of each size and type manufactured in a month
19.1(k)(i)	Thermal ageing on complete cable sample	20.8,20.8.1	IS 7098 (Pt 3)	-	S	one	Cables of each size and type manufactured in 3 months
19.1(k)(ii)	Tensile strength and elongation at break for insulation and outer sheath	20.8.1	IS 7098 (Pt 3)	-	S	one	Cables of each size and type manufactured in 3 months
19.1(k)(iii)	Resistivity test for semiconducting layers	20.8.1& Annex C	IS 7098 (Pt 3)	-	S	one	Cables of each size and type manufactured in 3 months
19.1 (m)	Bending test followed by P D test	20.10	IS 7098 (Pt 3)	-	R	one	Cables of each size and type manufactured in a fortnight

19.1(n)	Dielectric power factor & Measurement of capacitance at ambient temperature	20.11, 20.17	IS 7098 (Pt 3)	48	R	one	Cables of each size and type manufactured in a day
19.1(p)	Dielectric power factor measurement at elevated temperature	20.12	IS 7098 (Pt 3)	-	R	one	Cables of each size and type manufactured in a fortnight
19.1(q)	Load cycle test followed by P D measurement	20.13	IS 7098 (Pt 3)	-	R	one	Cables of each size and type manufactured in a fortnight
19.1(r)	Impulse withstand test followed by HV test	20.14	IS 7098 (Pt 3)	-	R	one	Cables of each size and type manufactured in a fortnight
19.3.1(b)	Partial Discharge Test	20.9	IS 7098 (Pt 3)	46	R	one	Each length of finished cable
19.3.1(c)	High voltage test	20.16	IS 7098 (Pt 3)	-	R	one	Each length of finished cable.
19.4(a)	Cold impact test(optional test)	19.4(a)	IS 5831				
19.4(b)	Voltage test(spark test on outer sheath without semiconductor coating)(Optional test)	19.4(b)	IS 7098 (Pt 3)	-	As per agreement between manufacturer and supplier		

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. Conductor Resistance
- iv. Tensile Test (before ageing) on Insulation and Sheath
- v. Shrinkage Test
- vi. Hot Deformation
- vii. Heat Shock Test
- viii. HV Test
- ix. Flammability Test