इंटरनेट मानक

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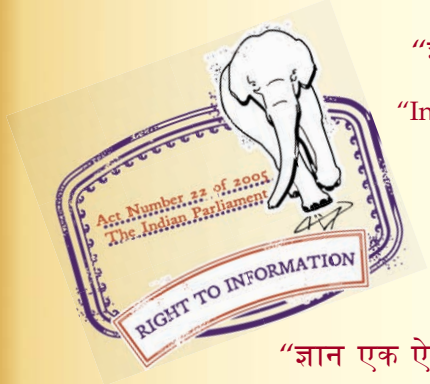
IS 7098-3 (1993): Cross-linked polyethylene insulated thermoplastic sheathed cables, Part 3: For working voltages from 66 kV upto and including 220 kV [ETD 9: Electrotechnical]



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अनुप्रस्थ जुड़े हुए पौलीइथाईलीन विद्युतरोधी ताप स्थायी ढके केबल — विशिष्टि

भाग 3 66 कि. वो. से 220 कि. वो. तक की कार्यकारी वोल्टता के लिए

Indian Standard

CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES — SPECIFICATION

PART 3 FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 220 kV

(First Reprint SEPTEMBER 1996)

UDC 621.315.221.8 : 678.073

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1993 Price Group 7

Power Cables Sectional Committee, ETD 9

FOREWORD

This Indian Standard (Part 3) was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Cables Sectional Committee had been approved by the Electrotechnical Division Council

Other two parts of this series of Indian Standards cover crosslinked polyethylene insulated thermoplastic sheathed cables of following voltage grades

Part 1 For working voltages up to and including 1 100 V

Part 2 For working voltages from 3 3 kV up to and including 33 kV

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded oft in accordance with IS 2. 1960 'Rules for rounding off numerical values (*revised*)' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

AMENDMENT NO. 1 JULY 2001
TO
IS 7098 (Part 3) : 1993 CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES
PART 3 FOR WORKING VOLTAGES FROM 66 kV UPTO AND INCLUDING 220 kV

(*Page* 1, *clause* **1.1**, l*ine* 4) — Substitute following for the existing line:

'without metallic sheath and thermoplastic'.

(*Page* 1, *clause* **6**) — Insert the following after (c):

'd) Copper woven fabric tape.'

(*Page* 2, *clause* **7.2**) — Substitute the following for the existing:

'7.2 Metallic Sheath

7.2.1 The metallic sheath shall be either lead alloy sheath or aluminium sheath.

7.2.2 Composition of lead alloy 'E' sheath shall be as per Table 3.

7.2.3 Composition of aluminium for sheathing

Aluminium for sheathing shall have minimum 99.6% by weight of aluminium.'

(*Page* 2, *Table* 3, *clause reference)* — Substrate **'7.2.2'** *for* **'7.2'.**

(*Page* 2, *Table* 3, *col* 3) — Substitute '0.35' *for* '0.34'.

(*Page* 2, *Table* 3, *col* 10 *and* 11) — Substitute the following for the existing:

'Total of other Elements	**Lead**
Max	*Min*
(10)	(11)
0.01	Remainder'

(*Page* 3, *clause* **10.1**, *line* 1) — Substitute 'shall' *for* 'may'.

Group 2

(*Page* 3, *clause* **14.3.1**) — Substitute the following for the existing clause:

'14.3.1 The metallic part of the screening shall consist of either copper wires/copper tape(s) helically applied over non-metallic screening or an extruded metallic sheath of aluminium or lead alloy. The metallic sheath applied over the non-metallic part of the insulation screen shall form the metallic part of the screening.

NOTE — For enhancing short-circuit current carrying capacity of screen, additional copper wires/tape (s) can be applied over/under Lead alloy sheath with a suitable separator.'

(*Page* 4, *clause* **14.3.3,** *Note, line* 3) — Substitute 'may' *for* 'shall'.

(*Page* 4, *clause* **15.1**) — Substitute the following for the existing clause:

'15.1 The moisture barrier shall be provided as given in **15.1.1** or **15.1.2** or **15.1.3**.

15.1.1 Water blocking tape/powder shall be suitably applied and laminate tape shall be applied longitudinally with overlap and sealed.

15.1.2 Metallic sheath of lead alloy 'E' as per **7.2** shall be applied by extrusion. thickness of sheath shall not fall below the values specified in Table 6.

15.1.3 Alternative to above, moisture barriers shall be provided by Aluminium sheath either smooth or corrugated.'

(*Page* 4, *clause* **15.2.1**) — Substitute the following for the existing clause:

15.2.1 Metallic sheath shall consist of either extruded lead alloy 'E' Sheath as per **7.2.2** or Aluminium Sheath smooth or corrugated as per **7.2.3**.'

(*Page* 4, *clause* **15.2.2**) — Substitute the following for the existing clause:

'15.2.2 Thickness of lead alloy sheath shall not fall below the value specified in Table 6A. Thickness of aluminium sheath shall not fall below the value specified in Table 6B.

NOTE — Aluminium sheath can be either smooth or corrugated. From flexibility and thermal expansion point of view corrugated aluminium sheath is recommended. Smooth aluminium sheath is not recommended for cables of calculated diameter under metallic sheath exceeding 50 mm.'

(*Page* 4, *Table* 6A, *col* 2, *row* 3) — Substitute '50' *for* '45'.

(*Page* 4, Table 6, *Title*) — Substitute the following for tbe existing title: 'Table 6A Thickness of Lead Alloy Sheath'.

(*Page* 4, *Table* 6) — Insert the following new Table 6B after Table 6:

Table 6B Thickness of Aluminium Sheath

Calculated Diameter under Metallic Sheath mm		**Minimum Thickness of Metallic Sheath mm**	
Over	Up to and including	Smooth	Corrugated
(1)	(2)	(3)	(4)
—	40	1.9	0.6
40	45	2.2	0.6
45	50	2.4	0.6
50	55	—	0 6
55	65	—	0.8
65	80	—	0.8
80	105	—	0 9
105	120	—	1 0

(*Page* 4, *clause* **17.2**, *line* 1) — Substitute 'nominal diameter' *for* 'dimensions'.

(*Page* 4, *Table* 8, *Title*) — Substitute 'Diameter' *for* 'Dimensions'.

[*Page* 5, *clause* **18.1**(a)] — Substitute the following for the existing:

'a) over the moisture barrier or metallic screen for unarmoured cables, and'

(*Page* 5, *clause* **18.4**) — Substitute the following for the existing clause:

'18.4 The outer sheath shall be coated with a suitable conducting material when required.'

[*Page* 5, *clause* **19.1**(b)(i), *col* 2] — Substitute 'Table 5 and 20.16' *for* 'Tables5, 19, 16'.

[*Page* 6, *clause* **19.1**(f)(i), col 1] — Substitute 'Diameter of armour wire' *for* 'Dimensions'.

[*Page* 6, *clause* **19.**1(g)(3) (i), (ii) *and* (iii)] — Substitute the following for the existing:

'3)	PE sheath	Nominal value	Part 32
I)	Carbon black content	2 5 ± 0.5%	
II)	Tensile strength	8 3	Part 7
III)	Elongation at break		
	Before ageing	8 3	Part 7
	After ageing	8 3	Part 7
IV)	Hot deformation	8 3	Part 15'

[*Page 6, clause* **19.1** (j)] — Substitute the following for the existing:

???	Water tightness test		
I)	Longitudinal water lightness test	20 8 1 and 20 8 3	Annex D
II)	Radial water lightness test	Under consideration	Under consideration'

[*Page* 6, *clause* **19.1**(k)(ii), *col* 2]— Substitute '20 9.1' *for* 'Table 2 and IS 5831 : 1984'.

(*Page* 6, *clause* **19.1**(k) (iii), *col* 2] — Substitute '20.9.1 and Annex C' *for* '20.2'.

[Page 6, *clause* **19.1**(k) (iii), *col* 3] — Substitute '20.2.2 and Annex C' *for* '20.2'.

(*Page* 6, *clause* **19.1**, *Note* 1) — Substitute 'm to r' *for* 'n to q'.

(*Page* 6, *clause* **19.1**, *Note* 2, *line* 1) — Substitute 'm to r' *for* 'n to r'.

(*Page* 7, *clause* **19.1.1**, *line* 1) — Substitute 'm to r' *for* 'n to r.'

(*Page* 7, *clause* **19.1 2**, *line* 1) — Substitute 'n and q' *for* 'p and q.'

(*Page* 7, *clause* **19.4**) — Substitute the following for the existing clause:

'19.4 Optional Test

a) Cold Impact Test

b) Voltage Test (spark test on outer sheath without semi-conducting coating)

A spark test shall be carried out by earthing the metallic sheath or concentric wires or tapes for an ac test and connecting them to the negative pole in the case of a dc supply. The voltage shall be 6 kV ac per millimeter nominal thickness or 9 kV dc per millimeter nominal thickness of the extruded oversheath subject to maximum values of 15 kV and 25 kV respectively. The dwell time of the cable in the region of test shall have sufficient duration to detect any defect.'

(*Page* 7, *clause* **19.5**, *para* 3, *line* 6) — Substitute 'same' *for* 'ssme'.

(*Page* 7, *clause* **19.5**) — Insert the following Note at the end of the clause:

'NOTE — The declared nominal value of the insulation thickness in context with 19.5 shall mean the value declared by the manufacturer to the purchaser.'

(*Page* 7, *clause* **20.1.1**, *para* 4, *line 5*) — Substitute '1.27 mm' *for* '0.127 mm'.

[*Page* 7, *clause* **20.1.1**, *para* 6, *Sl No.*(i), (ii) and (iii)] — Substitute '50 µm' *for* '5 µm'.

(*Page* 7, *clause* **20.1.2**) — Delete this clause.

(*Page* 8, *clause* **20.4**, *Note, line* 2) — Substitute '0.017 86' *for* '0.178 6'.

(*Page* 8, *clause* **20.5**, *last line*) — Substitute 'either in Table 6A or Table 6B' *for* 'in Table 6'.

(*Page* 8, *clause* **20.6**) — Substitute the following for the existing clause:

'20.6 Diameter of Armour

The diameter of non-magnetic armour wires shall not be less than the specified nominal values given in Table 8.'

(*Page* 8, *clasue* **20.8.1**, *heading*) — Substitute the following title for the existing:

'*Water Tightness Test (Not Applicable for corrugated Aluminium Sheathed Cables*)'.

(*Page* 8, *clause* **20.9.1**, *para* 2, line 2) — Substitute 'Annex C' *for* 'Annex B'.

(*Page* 8, *clause* **20.10**, *para* 2, *lines 2 and* 4) — Substitute '*Uo*' *for* 'the rated voltage'.

[*page* 9, *clause* **20.11**,(i)] — Substitute 'metallic sheath' *for* 'lead sheath' and 'laminated tape' for 'metal foil'.

(*Page* 9, *clause* **20.12**, *lines* 2 *and* 4) — Substitute *'Uo' for* 'rated voltage'.

(Page 9, *clause* **20.13**, *para* 2, *line* 2) — Substitute *'Uo' for* 'rated voltage'.

(*Page* 9, *clause* **20.15**) — Insert the following at the end of the clause:

'The impulse wave form shall have a virtual front time between 1 µs and 5 µs and a nominal time to half the peak value between 40 µs and 60 µs. In other respects, the impulse pulse shall be in accordance with IS 2071.'

(*Page* 10, *clause* **20.17**, *lines* 3 *and* 6) — Substitute *'Uo' for* 'rated voltage'.

(*Page* 11, *Table* 10, *col* 4, row 6) — Substitute '50.5' *for* '50.3'.

(*Page* 11, *clause* **B-3.4**, *Note, line* 2 *)* — Substitute '**B-3.3** and **B-3.4'** *for* '**A-3.3** and **A-3.4**'.

(*Page* 11, *clause* **B-3.5**) — Substitute *'Dsc' for 'Sec'*.

(Page 13, *clause* **D-3**, *line* 4) — Insert '3' before the words 'heating cycles'.

(Page 13, *clause* **D-3**, l*ine* 5) — Substitute '16 h' *for* '15 h'.

(Page 13, *clause* **D-3**, *line* 11) — Substitute 'last' *for* 'first'.

(*Page* 13*, Fig*. 2) — Insert the following above the caption of the figure:

'The minimum inner diameter of the water tube shall be 10 mm'.

(ETD 9)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 FEBRUARY 2007
TO
IS 7098 (PART 3) : 1993 CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES — SPECIFICATION

PART 3 FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 220 kV

(*Page* 1, *clause* **4.1**) — Substitute the following for the existing clause:

'The conductor shall be composed of plain copper or aluminium wires complying with IS 8130 : 1984 '

(*Page* 9, *clause* **20.16.2**) — Substitute '10%' *for* '15%' in the last line.

(*Page* 10, *clause* **20.18**) — Insert the following new section after clause **20.18**

SECTION 5 IDENTIFICATION, PACKING AND MARKING

21 IDENTIFICATION

21.1 Manufacturer's Identification — The manufacturer shall be identified throughout the *length* of cable by manufacturer's name or trade-mark and the voltage grade and year of manufacture indented, printed or embossed or by means of a tape bearing this information. The indentation, printing or embossing shall be done only on the outer sheath.

For manufacturer's name, if none of these methods is employed or if the purchaser so desires, colour identification threads in accordance with a scheme to be approved by the Bureau of Indian Standards shall be employed.

21.2 Cable Code — The following code shall be used for designating the cable:

Sl No	*Constituent*	*Code Letter*
i)	Aluminium conductor	A
ii)	XLPE insulation	2 x
iii)	Copper screen	C
iv)	Non-magnetic round wire armour	Wa
v)	Lead alloy sheath	Ly
vi)	Aluminium sheath	A
vii)	PVC outer sheath	Y
viii)	Polyethylene outer sheath	2Y

NOTE — No code letter for conductor is required when the conductor material is copper

22 PACKING AND MARKING

22.1 The cable shall be wound on a drum (*see* IS 10418 1982[1)]) and packed. The ends of the cable shall be sealed by means of non-hygroscopic sealing material

22.2 The cable shall carry the following information either stenciled on the drum or contained in a label attached to it

a) Reference to this Indian Standard, for example, *see* IS 7098 (Part 3),
b) Manufacturer's name or trade-mark,
c) Type of cable and voltage grade,
d) Number of cores,
e) Nominal cross-sectional area of conductor,
f) Cable code,
g) Length of cable on the drum,
h) Number of lengths on the drum (if more than one);
j) Direction of rotation of drum (by means of an arrow),
k) Gross mass;
m) Country of manufacture, and
n) Year of manufacture.

1) Specification for drums for electric cables

22.2.1 The cable (drum or label) may also be marked with BIS Standard Mark

NOTE — The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

(ET 9)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 SEPTEMBER 2007
TO
IS 7098 (PART 3) : 1993 CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES — SPECIFICATION

PART 3 FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 220 kV

[*Page* 3, *clause* **14.3.1,** *second line (see also Amendment No* 1)] — Delete the words 'an extruded'

[*Page* 4, *clause* **15.1.2,** *first line (see also Amendment No* 1)] — Delete the words 'by extrusion'

[*Page* 4, *clause* **15.2.1,** *first line (see also Amendment No* 1)] — Delete the words 'extruded'.

(ET 09)

Reprography Unit, BIS, New Delhi, India

Indian Standard

CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES — SPECIFICATION

PART 3 FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 220 kV

SECTION 1 GENERAL

1 SCOPE

1.1 This standard (Part 3) covers the requirements of single core, cross-linked polyethylene insulated, unarmoured or armoured (with or without lead alloy sheath) and thermoplastic outer sheathed cables for 3 phase ac earthed system for electric supply for the voltage grades given in Table 1

Table 1 Voltage Grades

System Voltage U (kV)	Rated Voltage Uo/U (kV)	Highest System Voltage Um(kV)
(1)	(2)	(3)
66	38/66	72 5
110	64/110	123
132	76/132	145
220	127/220	245

1.2 Cables covered under this standard are suitable for use where the combined ambient temperature and temperature rise due to load result in conductor temperature not exceeding 90°C under normal operation and 250°C under short circuit operation

2 REFERENCES

2.1 Indian Standards listed in Annex A are necessary adjuncts to this standard

3 TERMINOLOGY

3.0 For the purpose of this standard the following definitions in addition to those given in IS 1885 (Part 32) 1971 shall apply

3.1 Routine Test

Tests carried out by the manufacturer on all finished cable lengths to demonstrate integrity of the cable

3.2 Type Tests

Tests required to be made before supply on a type of cable on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE — These tests are of such a nature that after they have been made, they need not be repeated unless changes are made in the cable materials on design which might change the performance characteristics

3.3 Acceptance Tests

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

3.4 Optional Tests

Special tests to be carried out, when required, by agreement between the purchaser and the supplier

3.5 Earthed System

An electrical system in which the neutral point or a mid-point connection is earthed in such a manner that even under fault conditions, the maximum voltage that can occur between any conductor and earth does not exceed 80 percent of nominal system voltage.

3.6 Longitudinally Watertight Cables

Cables to meet the requirements to prevent the propagation of water along the length of cable.

3.7 Radially Watertight Cable

Cables to meet the requirements to prevent the radial propagation of water

SECTION 2 MATERIALS

4 CONDUCTOR

4.1 The conductors shall be composed of plain copper wires complying with IS 8130 : 1984

5 INSULATION

The insulation shall be of cross-linked polyethylene conforming to the requirements of Table 2

6 SCREENING

The screening shall consist of one or more of the following:

a) Non-metallic semi-conducting tape;

b) Non-metallic semi-conducting compound, and

c) Non-magnetic metallic tape, wire, strip or sheath.

NOTE — The semi-conducting tape and the semi-conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material

Table 2 Properties of XLPE Insulation

(*Clause* 5)

Sl No.	Property	Requirement
i)	Tens le strength before ageing	12 5 N/sq mm (*Min*)
ii)	Elongation at break before ageing	200% (*Min*)
iii)	Ageing in air oven	
	a) Treatment Temperature	135 ± 3°C
	Duration	168 h
	b) Variation from corresponding values before agcing	
	Tensile strength	±25% (*Max*)
	Elongation at break	±25% (*Max*)
iv)	*Hot* set	
	a) Treatment temperture	200 ± 3°C
	Time under load	15 Minutes
	Mechanical stress	20 N cm^2
	b) Elongation under load	175% (*Max*)
	c) Permanent elengation after cooling	15% (*Max*)
v)	Shrinkage	
	a) Treatment Temperature	130 ± 3°C
	Duration	6 h
	b) Shrinkage	4% (*Max*)

7 MOISTURE BARRIER

7.1 Laminated Tape

This shall be a plastic coaled non-ferrous metal tape longitudinally applied and suitably sealed.

7.2 Lead Alloy Sheath

The metallic sheath shall be of Lead Alloy E conforming to requirements given in Table 3

NOTF — For special applications other lead alloys may be used as agreed to between the purchaser and the manufacturer

7.3 Water Blocking Tape/Powder

This shall be synthetic non-woven tape/synthetic powder with suitable water swellable absorbent. The tape/powder can be either non-conducting or semi-conducting

8 INNER SHEATH

8.1 The inner sheath shall be of PVC compound or thermoplastic polyethylene compound

8.2 The PVC compound shall conform to Type ST2 of IS 5851 1984

Table 3 Composition of Lead Alloy E Sheath

(*Clause* 7 2)

Antimony		Tin		Tellurium	Silver	Copper	Bismuth	Zinc	Total Lead Other Elements	
Min	*Max*	*Min*	*Max*	*Max*	*Max*	*Max*	*Max*	*Max*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0 15	0.25	0 34	0 45	000 5	0 005	0 06	0 05	0 002	0 01	Remainder

NOTES

1 Values are in percentage by weight

2 Description of material — 0 4 percent Tin, 0 2 percent Antimony.

8.3 The thermoplastic polyethylene compound shall conform to following properties.

a) Tensile strength before ageing (*Min*)	12 5 N/mm^2
b) Elongation at break (*Min*)	
— before ageing	300%
— After ageing in air oven at 110 ± 2°C for 14 days	300%
c) Hot-deformation test — 115 ± 2°C for 6 hours	
— *Max* depth of indentation	50%
d) Carbon black content	2 5 ± 0 5%

9 ARMOUR

9.1 The armour shall be of non-magnetic metallic wires

9.2 The requirements of non-magnetic material shall be as agreed to between the purchaser and the supplier

10 OUTER SHEATH

10.1 The outer sheath may be of PVC compound or thermoplastic polyethylene compound

10.2 The PVC compound shall conform to Type ST2 of IS 5831 . 1984

10.3 The thermoplastic polyethylene compound shall conform to **8.3**

SECTION 3 CONSTRUCTION

11 CONDUCTOR

11.1 The conductor shall be of stranded circular compacted construction complying with the requirements of Class 2 of IS 8130 . 1984.

NOTE — Where necessary, segmental construction is permissible

11.2 The smallest nominal conductor cross-section for each voltage grade shall be as per Table 4.

Table 4 Nominal Cross-Section of Conductor

Voltage Grade Uo/U (kV)	Smallest Nominal Cross-Section of Conductor (sq. mm)
(1)	(2)
38/66	95
64/110	150
76/132	185
127/220	400

12 CONDUCTOR SCREENING

12.1 The conductor screening shall consist of a layer of semi-conducting compound extruded over the conductor.

NOTE — Semi-conducting barrier tape tapes with suitable overlap may be applied between the conductor and extruded conductor screening Such barrier tape/ tapes when used shall be compatible with the insulating material and suitable for the operating temperature of the cable

12.2 The minimum thickness of extruded conductor screening shall be 0 8 mm.

13 INSULATION

13.1 The insulation shall be extruded Cross-linked Polyethylene (XLPE) satisfying the requirements of Table 2

13.2 The average thickness of insulation shall be not less than the nominal value (t_1) specified in Table 5.

13.3 The smallest of the measured values of thickness of insulation shall not fall below the nominal value (t_1) specified in Table 5 by more than 0 1 t_1

Table 5 Nominal Thickness of XLPE Insulation

Voltage Grade Uo/U (kV)	Nominal Insulation Thickness mm
38/66	11
64/110	16
76/132	18
127/220	27

14 INSULATION SCREENING

14.1 The insulation screening shall consist of two parts, namely, metallic and non-metallic

14.2 Non-metallic Part

14.2.1 The non-metallic part shall consist of a layer of semi-conducting compound extruded directly over the insulation

NOTE — Conductor screening insulation and insulation screening shall be extruded in one operation

14.2.2 The minimum thickness of extruded insulation screening shall be 0 8 mm

14.2.3 Semi-conducting tape/tapes with suitable overlap may be applied over the extruded insulation screening Such barrier tape/tapes when used shall be compatible with the insulating material and suitable for the operating temperature of the cable.

14.3 Metallic Part

14.3.1 The metallic part of the screening shall consist of Copper wires/Copper tape(s) helically applied over the lead alloy sheath or non-metallic screening.

14.3.2 The diameter of copper wire in the screening shall not be less than 0 8 mm The perpendicular gap between two adjacent wires shall not be more than 4.0 mm. The nominal thickness of copper tape shall be not less than 0.1 mm. The minimum thickness shall not fall below the nominal value by more than 10%.

14.3.3 A binder tape of copper shall be applied over the wire screen The nominal thickness of the tape shall be not less than 0 1 mm The minimum thickness shall not fall below the nominal value by more than 10%

NOTE — Where Lead Alloy Sheath is provided over the non-metallic part of the insulation screening as moisture barrier, it shall form the metallic part of the screening

15 MOISTURE BARRIER

15.1 The Moisture Barrier shall be provided as given below.

a) Water blocking tape/powder shall be suitably applied; and

b) Laminate tape shall be applied longitudinally with overlap and sealed;

OR

Metallic sheath of lead alloy 'E' shall be applied by extrusion

15.2 Metallic Sheath

15.2.1 This shall consist of extruded metallic sheath of lead alloy E as per **7.2**

15.2.2 Thickness of sheath shall not fall below the value specified in Table 6

Table 6 Thickness of Metallic Sheath

[1]Calculated Diameter Under Metallic Sheath mm		Minimum Thickness of Metallic Sheath mm
Over	Up to and Including	
—	40	1 9
40	45	2 0
45	45	2 1
50	55	2 2
55	60	2 3
60	65	2 4
65	70	2.5
70	75	2 6
75	80	2 7
80	85	2 8
85	90	2 8
90	95	2 9
95	100	3 0
100	105	3 1
105	110	3 2
110	115	3.3

[1]Fictitious diameter calculated as described in Annex B

16 INNER SHEATH

16.1 For armoured cables the extruded inner sheath shall be applied over the moisture barrier or the metallic screen.

16.2 The thickness of inner sheath at any point shall not be less than the minimum value specified in Table 7

Table 7 Thickness of Inner Sheath

[1]Calculated Diameter Under Inner Sheath mm		Minimum Thickness of Inner Sheath mm
Over	Up to and Including	
—	40	0 9
40	45	1 0
45	50	1 1
50	55	1 2
55	60	1 2
60	65	1 3
65	70	1 4
70	75	1 5
75	80	1 6
80	85	1 6
85	90	1 7
90	95	1 8
95	100	1 9
100	105	2 0
105	110	2 0
110	115	2 1
115	—	*2 2*

[1]Fictitious diameter calculated as described in Annex B

17 ARMOUR

17.1 Armour, when specified, shall consist of non-magnetic metallic wires helically applied over the inner sheath.

17.2 The dimensions of armour wires shall be as specified in Table 8.

Table 8 Dimensions of Armour Round Wires

[1]Calculated Diameter Under Armour mm		Nominal Diameter of Round Wire mm
Above	Up to and Including	
—	40	20
40	55	2 50
55	70	3 15
70	—	400

[1]Fictitious diameter calculated as described in Annex B

17.3 The armour wires shall be applied as closely as possible

17.4 The direction of lay of armour shall be left hand

17.5 Joints in the armour wires shall be made by welding and surface irregularities shall be removed A joint in any wire shall be at least 300 mm from the nearest joint in any other armour wire in the completed cable

18 OUTER SHEATH

18.1 The outer sheath shall be applied by extrusion It shall be applied:

a) over the moisture barrier or metallic screen unarmoured cables, and
b) over the armour for armoured cables.

NOTE — A binder tape may be applied under the outer sheath

18.2 The colour of outer sheath shall be Black

18.3 Thickness of Outer Sheath

18.3.1 *Unarmoured Cables*

The thickness of outer sheath of unarmoured cables determined by taking the average of a number of measurements shall not be less than the nominal value specified in col 3 of Table 9 and the smallest of the measured values shall be not less than the minimum value specified in col 4 of Table 9

18.3.2 *Armoured Cables*

The thickness of outer sheath at any point for armoured cables shall not be less than the minimum value specified in col 5 of Table 9.

18.4 The outer sheath shall be coated with a suitable conducting material

Table 9 Thickness of Outer Sheath

(*Clauses* 18 3.1 *and* 18 3.2)

[1]Calculated Diameter Under Outer Sheath		Thickness of Outer Sheath for Unarmoured Cables		Minimum of Outer Sheath for Armoured Cable
mm		Nominal mm	Minimum mm	mm
Above	Up to and Including			
(1)	(2)	(3)	(4)	(5)
—	40	2 4	1 72	1 72
40	45	2 6	1 88	1 88
45	50	2 8	2 04	2 04
50	55	3.0	2 20	2 20
55	60	3 2	2 36	2 36
60	65	3 4	2 52	2 52
65	70	3 6	2 68	2 68
70	75	3 8	2 84	2 84
75	—	4 0	3.0	3 0

[1] ??? diameter calculated as described in Annex B

SECTION 4 TESTS

19 CLASSIFICATION OF TESTS

19.1 Type Tests

The following shall constitute the type tests.

Test	*Ref of Requirements*	*Ref for Test Method*[1]
a) Tests on conductor		
I) Annealing test (for copper)	IS 8130 : 1984	Part 1
II) Resistance test	IS 8130 : 1984	Part 5
b) Physical test on insulation		
I) Test for thickness and dimensions of insulation	Tables 5, 19, 16	Part 6
II) Tensile strength and elongation at break	Table 2	Part 7
III) Thermal ageing in air oven	Table 2	Part 11
IV) Hot set test	Table 2	Part 30
V) Shrinkage test	Table 2	Part 12
VI) Void and contaminants test	Under consideration	20 1
c) Resistivity test for semi-conducting layers	20 2 4	Annex C
d) Test for concentric metallic screen:		
I) Test for concentric copper wire	20.4, Note	20.3
II) Test for concentric copper tape	20 4	20 4

[1]Reference to various parts of IS 10810 series relevant clauses of this standard

Test	*Ref of Requirements*	*Reffor Test Method^*
e) Thickness of metallic sheath	20.5	Part 34
f) Tests for armouring material:		
i) Dimensions	20.6	Part 36
ii) Tensile strength and elongation at break	Under consideration	Part 37
iii) Wrapping test	Under consideration	Part 3
iv) Resistivity test	Under consideration	Part 42
g) Physical tests for outer sheath.		
1) Measurement of thickness	Table 9	Part 6
2) PVC sheath		
i) Tensile strength and elongation at break	IS 5831 : 1984	Part 7
ii) Thermal ageing in air oven	IS 5831 : 1984	Part 11
iii) Loss of mass	IS 5831 : 1984	Part 10
iv) Heat shock test	IS 5831 : 1981	Part 14
v) Hot deformation test	IS 5831 : 1984	Part 15
vi) Shrinkage test	IS 5831 : 1984	Part 12
vii) Thermal stability	IS 5831 : 1984	IS 5831 1984
3) PE sheath		
i) Carbon black content	Nominal value: 2 5% ± 0.5%	Part 32
ii) Tensile strength and elongation at break before and after ageing	8.3	Part 7
iii) Hot-detormation	8 3	Part 15
h) Flammabihty test (for PVC outer sheathed cables only)	20 7	Part 53
j) Water tightness test	20 8 3	20 8
k) i) Thermal ageing on complete cable sample	20.9 1	20 9
ii) Tensile strength and elongation at break for insulation and outer sheath	Table 2 and IS 5831 : 1984	Part 7
iii) Resistivity test for semi-conducting layer	20 2	20 2
m) Bending test followed by P D test	20.11 1	20 11
n) Dielectric power factor and capacitance measurement at ambient temperature	20 12, 20 18	20 12, 20 18 Part 48
p) Dielectric power factor measurement at elevated temperature	20 13	20 13
q) Load cycle test followed by P.D measurement	20.14 1	20 14
r) Impulse withstand test followed by HV test	20 15.1	20 15

NOTES

1 Before commencement of the electrical type tests from 'n' to 'q' compliance of **19.5** shall be ensured.

2 After completion of electrical type tests from 'n' to 'r', the sheath and any armouring or tapes shall be removed from the sample for physical inspection of the shield and the insulation screen The observation should not reveal broken wires/tape in the shield and no damages shall have occurred on the insulalion screen causing discontinuity.

[1)]Reference to various parts of IS 10810 series, relevant clauses of this standard

19.1.1 The tests from (n) to (r) shall be performed successively on the same test sample of complete cable not less than 10 metres in length between the cable accessories.

19.1.2 *Special Provision*

Tests at (p) and (q) may be carried out on different samples

19.2 Acceptance Tests

19.2.1 The following shall constitute acceptance tests:

a) Conductor resistance test
b) Annealing test
c) Test for dimensions of insulation
d) Hot set test for insulation
e) Void and contaminants test
f) Test for thickness of metallic sheath
g) Test for thickness of outer sheath
h) Partial discharge test
j) High voltage test (as per **20.17**)
k) Measurement of capacitance (as per **20.18**)

NOTE — Partial discharge test shall be carried out on full drum length.

19.3 Routine Test

19.3.1 The following shall be carried out as routine test:

a) Conductor resistance test
b) Partial discharge test
c) High voltage test

19.4 Optional Test

Cold impact test shall constitute the optional test.

19.5 Check on Insulation Thickness Before the Electrical Type Tests

The average value of the insulation thickness shall be measured at both ends of the sample (as per Part 6 of IS 10810). If the average of the two measurements of the insulation thickness is:

— not more than 10% over the declared nominal value for the cable, the test voltages as specified in relevant clauses of this specification shall be used

— more than 10% but not more than 15% over the declared nominal value for the cable, the test voltages as specified in relevant clauses of this specification shall be increased to give an electrical field stress at the conductor screen, which will be the ssme value as with nominal insulation thickness and specified test voltage.

— more than 15% over the declared nominal value for the cables another test sample shall be chosen.

20 METHOD OF TESTS

20.1 Void and Contaminants Test for Insulation

20.1.1 Preparation of test sample and determination of voids and contaminates.

Five centimetres of the sample shall be cut helically or in some other convenient manner to produce thin samples of the insulation. Wafers (or the turns of the helix) shall be approximetely 0.6 mm thick The cutting blade shall be sharp and shall produce a sample with very smooth cut surfaces. The sample shall be kept clean and shall be handled carefully to prevent scratching the sample surface

The entire specimen shall be viewed by transmitted light for determination of voids, contaminants and translucent materials in the insulation

A contaminant is any solid or liquid material which is opaque or not homogenous cross linked polyethylene insulation, including opaque or discoloured, translucent material of more than 0 127 mm in its radial vector projection.

The entire area of 20 consecutive wafers (or equivalent turns of the helical sample) shall be examined with a minimum of 15 power magnification, including any areas which appear suspect during the above examination by transmitting light

A tabulation of numbers and sizes shall be made with a minimum of 15 power magnification of:

i) All voids, 5 µm in greatest dimensions and larger
ii) All contaminants, 5 µm in greatest dimensions and larger
iii) Discoloured, translucent material of more than 5 µm This tabulation shall be recorded and reported

The largest void, the largest contaminant and the largest translucent material shall be marked by encircling and must be subsequently measured on a micrometer microscope of minimum of 40 power magnification

The number of voids, contaminants and translucents per unit length of insulation shall be calculated from the tabulation

20.1.2 The insulation of the completed cable shall be free from.

a) Any void larger than 76 µm. The number of voids larger than 5 µm shall not exceed 2 per cubic cm of insulation.
b) Any contaminants (opaque material or material that is not homogenous with insulation) larger than 127 µm in its greatest dimensions. The number of contaminants of sizes between 5 µm and 127 µm shall not exceed 1 per cubic cm of insulation.
c) Any translucent material that is larger than 1.27 mm in its radial vector projection

20.2 Resistivity Test for Semi-conducting Layer

20.2.1 The resistivity test for extruded semi-conducting layers applied over the conductor and over the insulation shall be determined by measurements on test pieces taken from the core

20.2.2 The procedure for measurement shall be in accordance with Annex C

20.2.3 The measurements shall be made at a temperature within ± 2°C of the rated maximum normal operating conductor temperature.

20.2.4 The resistivity shall not exceed the following'

i) Conductor screen	1 000 ohm-metre
ii) Core scieen:	500 ohm-metre

20.3 Test for Concentric Copper Wire

On a test piece with a length of at least 1 metre, all layers over the copper wire shall be removed Copper wires numbering 10% or 5 whichever is more, shall be- straightened, and the electrical resistance measured as per relevant test method

While measuring the resistance of the concentric copper wires, all the wires are connected together at both ends of the test piece

20.4 Test of Concentric Screen of Copper Tape

On a test piece with a length at least 1 metre, all layers over the screen including sheath are removed All parts of the screen are unwound and straightened. The electrical resistance of the tape shall be measured

NOTE — The resistivity of the copper wire/tape at 20°C shall not exceed 0 178 6 ohm n m^2 per metre cable length

20.5 Measurement of Thickness of Metallic Sheath

This test shall be applicable if the cable has a metallic sheath [as per 10810 (Part 34) - 1984] Minimum thickness shall not fall below the specified value in Table 6

20.6 Dimensions of Armour

The dimensions of non-magnetic armour shall not be less than the specified nominal values

20.7 Flammability Test

Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (uncharred) portion from the lower edge of the top clamp shall be at least 50 mm

20.8 Water Tightness Test

20.8.1 *Longitudinal Water Tightness Test*

This test shall be carried out as specified in Annex D.

20.8.2 ***Radial Water Tightness Test***

Under consideration.

20.8.3 There shall be no water leak from the ends of the sample

20.9 Thermal Ageing Tests on Complete Cable

This test shall be carried out to check that the insulation, non-metallic sheath and extruded semi-conducting layers over the conductor and insulation are not liable to deteriorate in operation due to contact with their components in the cable

Three pieces of complete cable about 200 mm long shall be suspended vertically and substantially in the centre of the oven at least 20 mm away from each other and shall not occupy more than 2 percent of the volume of the oven The pieces of cable shall be kept in the oven at the temperature of 10 ± 2°C above the rated maximum normal operating conductor temperature of the cable for a duration of 168 h

The test pieces of insulation and sheath from the aged pieces of cable shall be prepared and subjected to tensile strength and elongation at break

The resistivity of the extruded semi-conducting layers shall be determined on the test pieces from the aged cable sample in accordance with Annex C

20.9.1 The test results for tensile strength and elongation at break shall comply with the values of insulation and sheath after ageing as given in Table 2 for insulation and IS 5831 1984 fo-PVC outer sheath and **8.3** for thermoplastic polyethylene outer sheath.

The resistivity of semi-conducting screen layers measured as per Annex B shall not exceed the following values'

i) Conductor screen	1 000 ohm m
ii) Insulation screen	500 ohm m

20.10 Partial Discharge Test

The partial discharge test shall be carried out in accordance with IS 10810 (Part 46) : 1984, except lor the test voltages and durations

The test voltage shall be gradually increased to 1 75 times the rated voltage, maintained for 10 seconds and then slowly reduced to 1 5 times the rated voltage and Partial Discharge magnitude measured

The maximum level of the Partial Discharge magnitude at 1 5 *Uo* shall not exceed 5 pC for type test and 10 pC for routine test

20.11 Bending Test

The bending test shall be carried out as per IS 10810 (Part 50) 1984.

The diameter of the test cylinder shall not be greater than

i) 25 ($d + D$) + 5% for cables with lead sheath or with longitudinally applied metal foil; and

ii) 20 ($d + D$) + 5% for others.

where

D = measured external diameter of the cable in mm, and

d = measured diameter of the conductor in mm

20.11.1 On completion of this test the cable shall be subjected to the Partial Discharge test as in **20.10** and shall comply with the requirements specified therein

20.12 Dielectric Power Factor and Capacitance Measurements

This test shall be carried out as per IS 10810 (Part 48) : 1984 at rated voltage and at ambient temperature.

The power factor at rated voltage shall not exceed 10×10^{-4}.

20.12.1 The capacitance of the test sample shall be measured between conductor and metallic screen and shall not exceed the nominal value declared by the manufacturer by more than 8 percent

20.13 Dielectric Power Factor Measurement at Elevated Temperature

The sample shall be heated by passing current through the conductor until the conductor reaches a steady temperature not less than 10°C and not greater than 15°C above the maximum rated temperature of the conductor in normal operation

The dielectric power factor shall be measured as per IS 10810 (Part 48) 1984 at rated voltage at the temperature specified above The measured value of dielectric power factor shall not exceed 10×10^{-4}

20.14 Load Cycle Test Followed by P.D. Measurement

The sample shall be laid on the floor of the test room in a U bend having the diameter specified in **20.11**.

The sample shall be heated by passing current through the conductor so that the conductor reaches a steady temperature not less than 10°C and not more than 15°C above the maximum rated temperature of the insulation in normal operation.

The heating current not less than the rated current shall be applied for at least 8 hours and shall be followed by at least 16 h of natural cooling. The conductor shall attain the specified temperature for the last two hours of each heating cycle.

The cycle of heating and cooling shall be carried out 20 limes at least 5 cycles per week. During the entire period of test a voltage of 2 *Uo* shall be applied to the sample.

20.14.1 There shall be no breakdown during the test and after the final cycle, the sample shall be subjected to and shall comply with the requirements of partial discharge test in accordance with **20.10**.

20.15 Impulse Voltage Test Followed by High Voltage Test

The cable shall withstand without failure 10 positive and 10 negative voltage impulses at conductor temperature not less than 10°C and more than 15°C above the maximum rated temperature of the conductor of the appropriate value specified below:

Rated Voltage Uo/U (kV)	*Impulse Test Voltage (kV)*
38/66	325
64/110	550
76/132	650
127/220	1 050

20.15.1 After the impulse test, the cable sample shall be subjected to power frequency AC voltage test as per Part 45 of IS 10810 at 2 5 times the rated voltage for 15 minutes at room temperature and no breakdown of the insulation shall occur.

20.16 Test for Dimensions of Insulation

Following tests shall be carried out.

20.16.1 *Insulation Thickness*

The average thickness of insulation shall be not less than the specified nominal value (t_1).

20.16.2 *Test for Eccentricity*

The eccentricity of the insulation shall be checked as follows:

$$\% \text{ Eccentricity} = \frac{t_{max} - t_{min}}{t_{max}} \times 100$$

where t stands for the thickness of insulation.

The % eccentricity shall not be more than 15%.

20.16.3 *Test for Ovality*

The ovality of the core shall be checked as follows:

$$\% \text{ Ovality} = \frac{d_{core\ max} - d_{core\ min}}{d_{core\ max}} \times 100$$

where d stands for the diameter of the core.

The % ovality shall not be more than 5%.

2017 High Voltage Test (as Routine and Acceptance Tests)

The cable shall withstand without any failure the power frequency AC voltage of 2 5 times the rated voltage for 30 minutes between conductor and metallic screen at the room temperature, when it is under routine test. For acceptance test the voltage shall be 3 times rated voltage for 4 hours

20.18 Measurement of Capacitance

Capacitance shall be measured between conductor and metallic screen The measured value shall not exceed the nominal value declared by the manufacturer by more than 8%.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1885 (Part 32) 1971	Electrotechnical vocabulary Part 32 Cables, conductors and accessories for electricity supply
5831 : 1984	PVC insulation and sheath of electric cables
8130 : 1984	Conductors for insulated electric cables and flexible cords
10810	Methods of test for cables
Part 1	Annealing test for wires used in conductors
Part 3	Wrapping test for aluminium wires
Part 5	Conductor resistance test
Part 6	Thickness for thermoplastic and elastomeric insulation and sheath
Part 7	Tensile strength and elongation at break of thermoplastic and elastomenc insulation and sheath
Part 10	Loss of mass test
Part 11	Thermal ageing in air
Part 12	Shrinkage test
Part 14	Heat shock test
Part 15	Hot deformation test
Part 30	Hot set test
Part 32	Carbon content test for polyethylene
Part 34	Measurement of thickness of metallic sheath
Part 36	Dimensions of armouring material
Part 37	Tensile strength and elongation at break of armouring materials
Part 42	Resistivity test of armour wires and strips and conductance test of armour (wires/ strips)
Part 53	Flammability test

ANNEX B

(*Clauses* 15.2.2, 16.2, 17 2 *and* 18.4)

FICTITIOUS CALCULATION METHOD FOR DETERMINATION OF DIMENSIONS OF PROTECTIVE COVERINGS

B 1 GENERAL

B-1.1 The thickness of cable covering such as sheaths and armour, has been related to cable diameters by means of 'step tables'. This sometimes causes problems. The calculated diameters are not necessarily the same as the actual values achieved in the production. In border line cases, queries can arise, if the thickness of a covering does not correspond to the actual diameter because the calculated diameter is slightly different. Variation in conductor dimensions between manufacturers cause difference in calculated diameters and may, therefore, lead to variation in the thickness of covering used on the same basic design of cable.

B-1.2 To minimize these difficulties, the fictitious calculation method was invented The idea is to ignore the shape and degree of compactness of conductors and to calculate fictitious diameters from formulae based on the cross-sectional area of conductors and insulation thickness. Thicknesses of sheath and other coverings are then related to fictitious diameters by tables. The method of calculating fictitious diameters is precisely specified and there is no ambiguity about the thicknesses of covering to be used, which are independent of differences in manufacturing practices. This standardizes cable designs, thicknesses being precalculated and specified for each size of cable.

B-1.3 The fictititious calculation is used only to determine dimensions of sheaths and cable coverings It is not a replacement for the calculation of normal diameters required for practical purposes, which should be calculated separately.

B-2 METHOD

B-2.1 The following fictitious method of calculating thicknesses of various coverings in a cable has been adopted to ensure that any difference which can arise in independent calculations, for example, due to the assumption of conductor dimensions and the unavoidable differences between calculation and actual achieved diameters, are eliminated

B-2.2 Holding strips and counter-helix are not taken into account in this calculation method unless their thickness is greater than 0 3 mm

B-2.3 The calculated value of fictitious diameter at each stage shall be rounded off to one significant place of decimal, that is, 0 1 mm, before proceeding to next step The rounding off shall be done in accordance with IS 2 : 1960.

B-3 CALCULATIONS

B-3.1 Conductor

The fictitious diameter (d_L) of a conductor for each cross sectional area shall be taken from Table 10 irrespective of shape or compactness of conductor

Table 10 Fictitious Diameter of Conductor (d_L)

Nominal Cross-Sectional Area of Conductor mm²	d_c mm	Nominal Cross-Sectional Area of Conductor mm²	d_L mm
95	11.0	630	28 3
120	12 4	*800*	31 9
150	13.8	1 000	35 7
185	15 3	1 200	39 1
240	17 5	1 600	45 1
300	19 5	2 000	50 3
400	22.6	2 500	56 4
200	25 2		

B-3.2 Cores

The fictitious diameter D_L (mm) of a core is given by.

$$D_c = d_L + 2n + 3\ 0 \text{ (mm)}$$

where

t_1 is the nominal thickness of insulation (mm).

NOTE — 3 0 mm is allowed for semi-conducting labels

B-3.3 Metal Sheath

The increase in fictitious diameter due to metal sheath shall be twice the minimum thickness of metal sheath (tm).

B-3.4 Copper Screen

The increase in fictitious diameter due to copper screen (???) is given in Table 11.

Table 11 Increase in Diameter Due to Copper Screen

Nominal Cross-Sectional Area of Copper Screen mm²	Increase in Diameter mm	Nominal Cross Sectional Area of Copper Screen mm²	Increasein Diameter mm
1 5	0 5	50	1 7
2 5	0 5	70	2 0
4	0 5	95	2 4
6	0 5	120	2 7
10	0. 8	150	3 0
16	1 1	185	4 0
25	1 2	240	5 0
35	1 4	300	6 0

If the cross-section of the copper screen lies between two of the values given in the table above, then the increase in diameter is that given in the table above, then the increase in diameter is that given for the higher of the two cross-sections

Area of copper screen shall be calculated as under

i) Concentric copper wire:

$$\text{Copper screen area} = \frac{n \pi d^2}{4} \text{ sq mm}$$

where, n is the number of copper wires and d is the nominal diameter of each wire in mm

ii) Copper tapes.

Copper screen area = $n\ W\ T$ sq mm

where

n is the number of copper tape(s),

W is the nominal width of copper tape in mm,

T is the nominal thickness of each copper tape in mm.

NOTE — An increase in fictitious diameter of core *D??* shall be taken into account as per **A-3.3** and **A-3.4** or both, as the case may be, depending upon whether metallic part of insulation screen of cable has metal sheath/copper screen or both

$$D_{sc} = D_c + 2\ tm + tc \text{ (mm)}$$

B-3.5 Inner Sheath

The fictitious diameter over the inner sheath (Ds) is given by.

$$D_s = S_{sc} + 2\ ts \text{ (mm)}$$

where ts is the minimum thickness of inner sheath in mm.

B-3.6 Armour

The fictitious diameter over the armour (D_A) is given by:

$$D_A = D_s + 2\ dA \text{ (mm)}$$

where d_A is the nominal diameter of armour wire in mm.

ANNEX C
(*Clause* 20.2.2)

METHOD OF MEASURING RESISTIVITY OF SEMI-CONDUCTING SCREEN

C-1 Test pieces shall be prepared from 150 mm lengths of completed cable

C-2 The conductor screen test piece shall be prepared by culling a sample of core in half longitudinally and removing the conductor (Fig. 1). The insulation screen test pieces shall be prepared by removing all the coverings from a sample of core (Fig 1).

C-3 The procedure for determining the specific resistivity of the screens shall be as follows

C-3.1 Four silver painted electrodes *A, B, C* and *D* (Fig. 1) shall be applied to the semi-conducting surfaces. The two potential electrodes, *B* and *C* shall be each placed at least 25 mm beyond the potential electrodes

C-3.2 Connections shall be made to the electrodes by means of suitable clips In making connections to the conductor screen electrodes it shall be ensured that the clips are insulated from the insulation screen on the outer surface of the test sample.

C-3.3 The assembly shall be placed in an oven preheated to 90° ± 2°C and after an interval of 30 minutes, the resistance between the electrodes shall be measured by means of a circuit, the power of which shall not exceed 100 milliwatts

C-3.4 After the electrical measurements, the diameter over the conductor screen and insulation and the thickness of the conductor screen and insulation screen shall be measured optically each being the average of six measurements.

C-3.5 The volume resistivity in ohm-metres shall then be calculated as follows:

i) Conductor Screen $= \frac{R \times \pi (D - T) \times T}{L}$

where

R = resistance in ohms,

D = diameter over the conductor screen in metres,

T = average thickness of screen in metres, and

L = distance between potential electrodes in metres.

ii) Insulation Screen $= \frac{R \pi (D + T) \times T}{L}$

where

R = resistance in ohms,

D = diameter over the insulation in metres,

T = average thickness of screen in metres, and

L = distance between potential electrodes in metres

ANNEX D
(*Clause* 20.8.1)

METHOD FOR TEST FOR LONGITUDINAL WATER TIGHTNESS

D-1 GENERAL

D-1.1 This test is intended to be applicable to cables which are designed and constructed to meet the requirement of preventing the longitudinal propagation of water along the cable in case of accidental damages to the outer sheath of the cable.

D-2 TEST SAMPLE

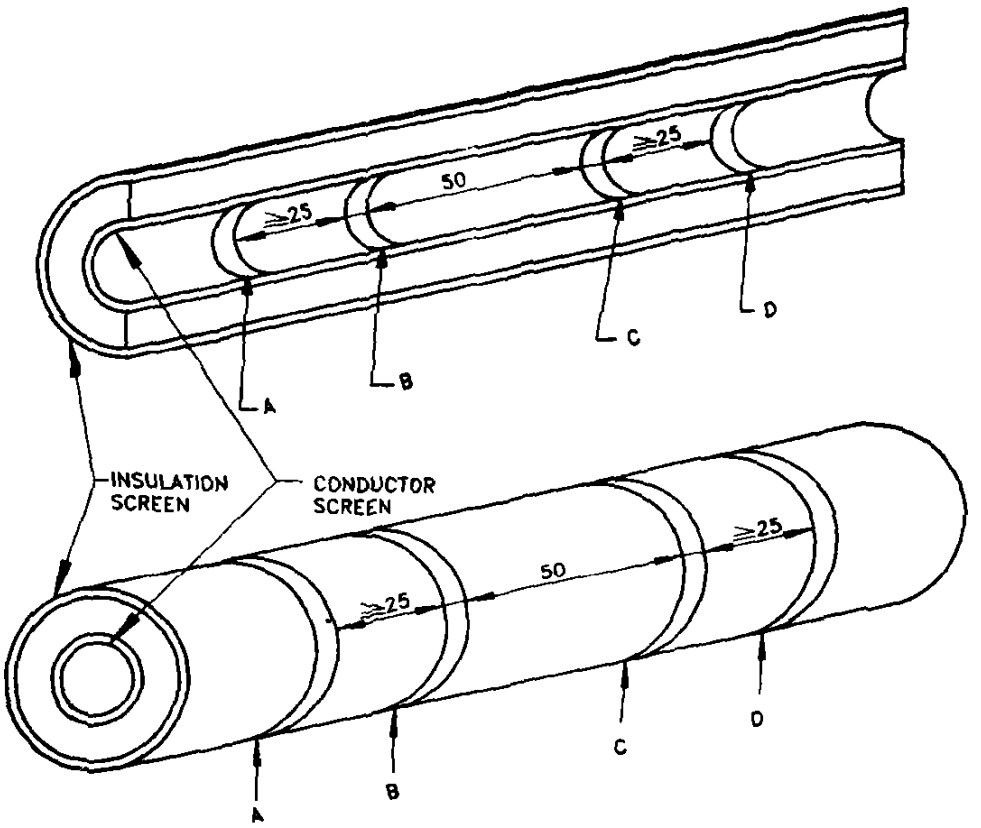
D-2.1 A six metre long piece of a complete cable is subjected to bending test as per **20.11** Three metres of this cable is cut for water tightness test. All coverings over the moisture barrier shall be removed. This test piece is straightened and placed horizontally. An annular ring of 50 mm width is cut in the middle of the sample so that the semi-conducting layer over the insulation is exposed for testing the longitudinal water tightness of the cable.

D-2.2 Suitable arrangements shall be made as in Fig. 2 for allowing the relevant interstices to be exposed to water pressure of 1 m height.

D-2.3 The assembly for maintaining the water pressure shall be suitably mounted on the outer sheath without causing any mechanical stress on it. Normal tap water at ambient temperature shall be used in the pressure head. The conductor ends shall be fitted with connections for circulation of suitable current through the conductor Arrangements for the temperature measurements at the conductor shall be made.

D-3 TEST PROCEDURE

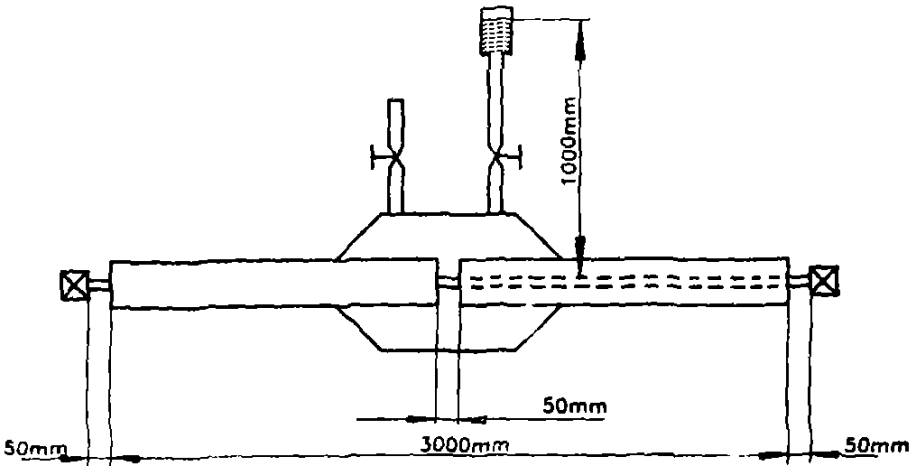
The test assembly as shown in Fig. 2 shall be filled with normal tap water at ambient temperature and kept for a period of 24 h The cable shall then be subjected to heating cycles. The heating period shall be 8 h followed by 15 h of natural cooling. During heating period suitable current shall be passed through the conductor, so that the conductor temperature is raised to a value between 95°C and 105°C The specified conductor temperature shall be attained during first two hours of the heating period.



B, C = potential electrodes
A. D = current electrodes

All dimensions in millimetres

FIG. 1 PREPARATION OF SAMPLE FOR MEASUREMENT OF THE VOLUME RESISTIVITY OF THE CONDUCTOR AND INSULATION SCREENS



All dimensions in millimetres.

FIG. 2 ARRANGEMENT FOR WATER-TIGHTNESS TEST

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AMENDMENT NO. 4 MARCH 2013
TO
IS 7098 (PART 3) : 1993 CROSS-LINKED POLYETHYLENE INSULATED THERMOPLASTIC SHEATHED CABLES PART 3 FOR WORKING VOLTAGES FROM 66 kV UP TO AND INCLUDING 220 kV

(*Page* 7, *clause* **19.1.2**) — Insert new clause after **19.1.2**:

'**19.1.2.1** During electrical type testing, if the damage or failure of accessories of cable sample occurs it may be repaired or replaced and the testing shall be continued from the point of break.'

(*Page* 7, *clause* **20.1**) — Delete the clause and renumber the subsequent clauses.

(*Page* 7, *clause* **20.17**) — Substitute the following for the existing clause:

'**20.17** The cable shall with stand without any failure the power frequency AC voltage of 2.5 times the rated voltage for 30 min between conductor and metallic screen at room temperature.'

(ETD 09)

Reprography Unit, BIS, New Delhi, India