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IS : 1554 (Part 1) - 1988

(Reaffirmed 1999)

Indian Standard

SPECIFICATION FOR PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES

PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Third Revision)

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Indian Standard

SPECIFICATION FOR PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES

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(Third Revision)

0. FOREWORD

0.1 This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards on 25 August 1988, after the draft finalized by Power Cables Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The current ratings of cables with general purpose insulation covered in this standard are given in IS : 3961 (Part 2)-1967*. The current ratings of HR PVC cables are under preparation.

0.3 The current ratings of the cables covered by this standard are covered in IS : 3961 (Part 2)-1967*.

0.4 The short circuit ratings of cables covered by this standard are under preparation.

0.5 Work is being taken up separately to identify requirements and tests for fire retardant low smoke (FRLS) cables. It is intended to bring out these requirements either as a separate standard or through an amendment to this standard at a later date.

0.6 In the preparation of this standard, assistance has been derived from the following:

a) IEC Pub 502 (1983) Extruded solid dielectric insulated power cables for rated voltage from 1 kV up to 30 kV. International Electrotechnical Commission.

b) BS 6346 : 1969 PVC insulated cables for electricity supply. British Standards Institution.

0.7 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 off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Recommended current ratings for cables: Part 2 PVC-insulated and PVC-sheathed heavy duty cables.

*Rules for rounding off numerical values (*revised*).

SECTION 1 GENERAL

1. SCOPE

1.1 This standard (Part 1) covers requirements and tests for armoured and unarmoured single-core, twin-core, three-core and multi-core PVC insulated and sheathed cables for electric supply and control purposes.

1.2 The cables covered in this standard are suitable for use on ac single phase or three phase (earthed or unearthed) systems for rated voltages up to and including 1 100 V. These cables may be used on d.c. systems for rated voltages up to and including 1 500 V to earth.

NOTE — The cables conforming to this standard may be operated continuously at a power frequency voltage up to 10 percent higher than the rated voltage.

1.3 The cables covered in this standard are suitable for use where the combination of ambient temperature and temperature rise due to load

results in conductor temperature not exceeding the following:

Type of Insulation	*Normal Continuous Operation*	*Short Circuit Condition*
General purpose	70°C	160°C
Heat resisting	85°C	160°C

The selection of type of insulation rests with the purchaser.

1.4 Armoured cables specified in this standard are suitable for use in mines also. However, for such cables, additional requirements have been included wherever necessary [*see* **3.1.1**, **13.5.2**, **15.3**(c) and **17.2**].

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions in addition to those given in IS : 1885 (Part 32)-1971*, shall apply.

2.1 Routine Tests — Tests made by the manufacturer on all finished cable lengths to demonstrate the integrity of the cable.

2.2 Type Tests — Tests required to be made before supply on a general commercial basis a type of cable 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 or design which might change the performance characteristics.

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

2.4 Optional Tests — Special tests to be carried out when required, by agreement between the purchaser and the supplier.

SECTION 2 MATERIALS

3. CONDUCTOR

3.1 The conductor shall be composed of plain copper or aluminium wires complying with IS : 8130-1984†.

3.1.1 Mining cables to be used in gassy mines shall be of copper conductor only.

4. INSULATION

4.1 The insulation shall be in accordance with **4.1.1** or **4.1.2**, as applicable.

4.1.1 *General Purpose Insulation* — The insulation shall be of Type A PVC compound conforming to the requirements of IS : 5831-1984*.

4.1.2 *Heat Resisting Insulation* — The insulation shall be of Type C PVC compound conforming to the requirements of IS : 5831-1984*.

5. FILLER AND INNER SHEATH

5.1 The filler and inner sheath shall be of the following:

a) Unvulcanized rubber, or

b) Thermoplastic materials, or

c) Proofed tape (for inner sheath only).

5.2 Unvulcanized rubber or thermoplastic material used shall not be harder than PVC used for insulation (**4.1**) and for outer sheath (**7.1**). The materials shall be chosen to be compatible with temperature ratings of the cable and shall have no deleterious effect on any other component of the cable.

6. ARMOURING

6.1 Armouring shall be of the following:

a) Galvanized round steel wire,

b) Galvanized steel strip, or

c) Any metallic non-magnetic wire/strip.

6.2 The galvanized steel wires/strips shall comply with the requirements of IS : 3975-1979†. The requirements of non-magnetic material shall be as agreed to between the purchaser and the supplier.

7. OUTER SHEATH

7.1 The outer sheath shall be in accordance with **7.1.1** or **7.1.2**, as applicable.

7.1.1 *For Cables with General Purpose Insulation* — The outer sheath shall be of Type ST 1 PVC compound conforming to the requirements of IS : 5831-1984*.

7.1.2 *For Cables with Heat Resisting Insulation* — The outer sheath shall be of Type ST 2 PVC compound conforming to the requirements of IS : 5831-1984*.

*Electrotechnical vocabulary: Part 32 Cables, conductors and accessories for electricity supply.

†Specification for conductors for insulated electric cables and flexible cords (*first revision*).

*Specification for PVC insulation and sheath of electric cables (*first revision*).

†Specification for mild steel wires, strips and tapes for armouring of cables (*first revision*).

SECTION 3 CONSTRUCTION

8. CONDUCTOR

8.1 The construction of conductor shall be as follows:

Nominal Copper mm^2	*Cross-Sectional Aluminium* mm^2	*Solid/ Stranded*	*Flexibility Class Ref to IS : 8130-1984**
—	1·5	Solid	Class 1
1·5 to 6	2·5 to 10	Solid/ stranded	Class 1 for solid Class 2 for stranded
10 and above	16 and above	Stranded	Class 2

8.2 Cables with reduced neutral conductor shall have sizes as given in Table 1.

TABLE 1 CROSS SECTIONAL AREA OF REDUCED NEUTRAL CONDUCTORS

Nominal Cross Sectional Area of Main Conductor	Cross Sectional Area of Reduced Neutral Conductor
(1)	(2)
mm^2	mm^2
25	16
35	16
50	25
70	35
95	50
120	70
150	70
185	95
240	120
300	150
400	185
500	240
630	300

9. INSULATION

9.1 The conductor shall be provided with PVC insulation applied by extrusion.

9.2 Thickness of Insulation — The average thickness of insulation shall be not less than the nominal value (t_i) specified in Table 2.

*Specification for conductor for insulated electric cables and flexible cords (*first revision*).

TABLE 2 THICKNESS OF INSULATION

[*Clauses* 9.2, 9.3 *and* 15.1(c)]

Nominal Area of Conductor	Nominal Thickness of Insulation (t_i)	
	Single Core Armoured Cables	Single Core Unarmoured and Multi-core Cables
(1)	(2)	(3)
mm^2	mm	mm
1·5	1·1	0·8
2·5	1·2	0·9
4	1·3	1·0
6	1·3	1·0
10	1·3	1·0
16	1·3	1·0
25	1·5	1·2
35	1·5	1·2
50	1·7	1·4
70	1·7	1·4
95	1·9	1·6
120	1·9	1·6
150	2·1	1·8
185	2·3	2·0
240	2·5	2·2
300	2·7	2·4
400	3·0	2·6
500	3·4	3·0
630	3·9	3·4
800	3·9	3·4
1 000	3·9	3·4

9.3 Tolerance on Thickness of Insulation — The smallest of the measured values of thickness of insulation shall not fall below the nominal value (t_i in mm) specified in Table 2 by more than 0·1 mm $+0{\cdot}1\ t_i$.

9.4 Application of Insulation — The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

10. CORE IDENTIFICATION

10.1 Cores shall be identified by different colouring of PVC insulation by adopting the following scheme:

a) 1 Core : red, black, yellow, blue or natural (non-pigmented);

b) 2 Cores : red and black;

c) 3 Cores : red, yellow and blue;

d) 4 Cores : red, yellow, blue and black;

e) 5 Cores : red, yellow, blue, black and grey; and

f) 6 Cores and above : Two adjacent cores (counting and direction core) in each layer, blue and yellow, remaining cores grey, or in accordance with the scheme given in **10.3**.

10.2 For reduced neutral conductors, the insulation colour shall be black.

10.3 For cables having more than 5 cores, as an alternate to the provisions of **10.1**, the core identification may be done by numbers. In that case, the insulation of cores shall be of the same colour and numbered sequentially, starting with number 1 for the inner layer. The numbers shall be printed in Hindu-Arabic numerals on the outer surface of the cores. All the numbers shall be of the same colour which shall contrast with the colour of the insulation. The numerals shall be legible.

10.3.1 *Arrangement of Marking* — The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm. The arrangement of the marks is shown in Fig. 1.

11. LAYING UP OF CORES

11.1 In twin, three-and multi-core cables, the cores shall be laid up together with a suitable lay; the outermost layer shall have right-hand lay and the successive layers shall be laid with opposite lay; where necessary, the interstices shall be filled with non-hygroscopic material.

11.2 The recommended plan for lay-up of cores up to 100 is given in Table 3.

12. INNER SHEATH

12.1 The laid up cores shall be provided with inner sheath applied either by extrusion or by wrapping. It shall be ensured that the shape is as circular as possible.

12.2 The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

12.3 Thickness of Inner Sheath — The thickness of the inner sheath shall be as given in Table 4. Single core cables shall have no inner sheath.

12.3.1 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as part of the inner sheath.

13. ARMOURING

13.1 Application

13.1.1 Armouring shall be applied over the insulation in case of single core cables and over the inner sheath in case of twin-, three-and multi-core cables.

13.1.2 The armour wires/strips shall be applied as closely as practicable.

13.1.3 The direction of lay of the armour shall be left hand. For double wire/strip armoured cables, this requirement shall apply to the inner layer of wires/strips. The outer layer shall, except in special cases, be applied in the reverse the direction to the inner layer and there shall be a separator of suitable non-hygroscopic material, such as, plastic tape, bitumenized cotton tape, bitumenized hessian tape, rubber tape, proof tape, etc, between the layers of armour wires/strips.

13.1.4 A binder tape may be provided on the armour.

13.2 Type of Armour — Where the calculated diameter below armouring does not exceed 13 mm, the armour shall consist of galvanized round steel wires. Where the calculated diameter below armouring is greater than 13 mm, the armour shall consist of either galvanized round steel wires or galvanized steel strips.

13.2.1 In the case of single core cables intended for use on a.c. systems, the armouring shall be of non-magnetic material.

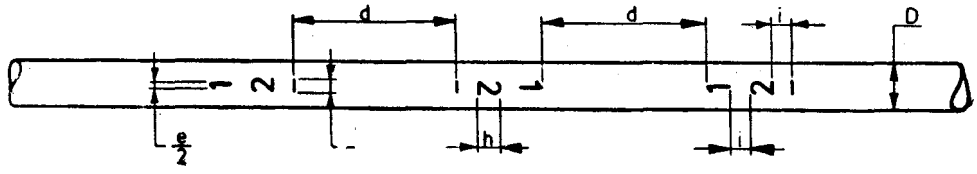

FIG. 1 CORE IDENTIFICATION BY NUMBERS

TABLE 3 LAY-UP OF CORES

(*Clause* 11.2)

No. of Cores	Lay-up	No. of Cores	Lay-up	No. of Cores	Lay-up
(1)	(2)	(1)	(2)	(1)	(2)
2	2	36	0-6-12-18	70	2-8-14-20-26
3	3	37	1-6-12-18	71	2-8-14-20-27
4	4	38	1-6-12-19	72	2-8-14-21-27
5	5	39	1-6-13-19	73	3-9-15-20-26
6	6	40	1-7-13-19	74	3-9-15-21-26
7	1-6	41	1-7-13-20	75	3-9-15-21-27
8	1-7	42	2-8-13-19	76	3-9-15-21-28
9	1-8	43	2-8-14-19	77	3-9-15-22-28
10	2-8	44	2-8-14-20	78	4-10-15-21-28
11	3-8	45	2-8-14-21	79	4-10-16-22-27
12	3-9	46	3-9-14-20	80	4-10-16-22-28
13	3-10	47	3-9-15-20	81	4-10-16-22-29
14	4-10	48	3-9-15-21	82	4-10-16-23-29
15	5-10	49	3-9-15-22	83	4-10-17-23-29
16	5-11	50	3-9-16-22	84	5-11-17-23-28
17	5-12	51	4-10-16-21	85	5-11-17-23-29
18	0-6-12	52	4-10-16-22	86	5-11-17-23-30
19	1-6-12	53	4-10-16-23	87	5-11-17-24-30
20	1-7-12	54	4-10-17-23	88	5-11-18-24-30
21	1-7-13	55	4-11-17-23	89	0-6-11-18-24-30
22	2-7-13	56	5-11-17-23	90	0-6-12-18-24-30
23	2-8-13	57	5-11-17-24	91	1-6-12-18-24-30
24	2-8-14	58	5-11-18-24	92	1-6-12-18-24-31
25	2-8-15	59	5-12-18-24	93	1-6-12-18-25-31
26	3-9-14	60	0-6-12-18-24	94	1-6-12-19-25-31
27	3-9-15	61	1-6-12-18-24	95	1-6-13-19-25-31
28	3-9-16	62	1-6-12-18-25	96	1-7-13-19-25-31
29	4-10-15	63	1-7-12-18-25	97	1-7-13-19-26-31
30	4-10-16	64	1-7-13-18-25	98	2-8-13-19-25-31
31	4-10-17	65	1-7-13-19-25	99	2-8-14-19-25-31
32	5-11-16	66	1-7-13-19-26	100	2-8-14-20-25-31
33	5-11-17	67	2-8-13-19-25		
34	5-11-18	68	2-8-14-19-25		
35	5-12-18	69	2-8-14-20-25		

NOTE 1 — The figures indicate the number of cores in each successive layer, for example, 5-11-18 means, 5 cores in the first, 11 cores in the second and 18 cores in the third layer, etc.

NOTE 2 — This table is for guidance only.

TABLE 4 THICKNESS OF INNER SHEATH

[*Clauses* 12.3 *and* 15.1(c)]

All dimensions in millimetres.

Calculated Diameter Over Laid up Cores [Ref IS : 10462 (Part 1)-1983*]		Thickness of Inner Sheath (Minimum)
Over	Up to and Including	
(1)	(2)	(3)
—	25	0·3
25	35	0·4
35	45	0·5
45	55	0·6
55	—	0·7

*Fictitious calculation method for determination of dimensions of protective coverings of cables: Part 1 Elastomeric and thermoplastic insulated cables.

13.3 Dimensions — The dimensions of galvanized steel wires and strips shall be as specified in Table 5.

TABLE 5 DIMENSIONS OF ARMOUR — ROUND WIRES AND STRIPS

All dimensions in millimetres.

	Calculated Diameter Under Armour [Ref IS : 10462 (Part 1)-1983*]		Nominal Thickness of Steel Strip	Nominal Diameter of Round Wire
	Over	Up to and Including		
	(1)	(2)	(3)	(4)
a)	For all diameters in excess of 13		0·8	—
		or		
b)	—	13	—	1·40
	13	25	0·8	1·60
	25	40	0·8	2·00
	40	55	1·4	2·50
	55	70	1·4	3·15
	70	—	1·4	4·00

NOTE — (a) and (b) indicate the methods of practice in the application of armouring.

*Fictitious calculation method for determination of dimensions of protective coverings of cables: Part 1 Elastomeric and thermoplastic insulated cables.

13.4 Joints — The joints in armour wires/strips shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any wire/strip shall be at least 300 mm from the nearest joint in any other wire/strip in the completed cable.

13.5 Resistance

13.5.1 If specified by the purchaser, the d.c. resistance of the galvanized steel wire/strip armour shall be measured. The result, when corrected to 20°C, shall comply with the appropriate values given in Table 6.

13.5.2 In case of cables for use in mines, the resistance of armour shall not exceed that of the conductor as specified in IS : 8130-1984* by more than 33 percent. To satisfy this, substitution of galvanized steel wires/strips in armouring by the required number of tinned copper wires/strips is permissible.

14. OUTER SHEATH

14.1 The outer sheath shall be applied by extrusion. It shall be applied:

a) over the insulation in case of unarmoured single-core cables;

b) over the inner sheath in case of unarmoured twin, three-and multi-core cables; and

c) over the armouring in case of armoured cables.

14.2 The outer sheath shall be so applied that if fits closely over insulation inner sheath/armouring. It shall be possible to remove it without damage to the insulation/inner sheath.

14.3 The colour of the outer sheath shall be black, unless any other colour is agreed to between the purchaser and the supplier.

14.4 Thickness of Outer Sheath

14.4.1 *Unarmoured Cables* — The average thickness of PVC outer sheath of unarmoured cables shall be not less than the nominal value specified under col 3 of Table 7 and the smallest of the measured values shall not be less than the minimum value specified in col 4 of Table 7.

NOTE — In case of multi-core unarmoured cables, it is permissible to supply the inner and outer sheaths in a single extrusion out of the material intended for outer sheath. The thickness of such extruded sheath shall be not less than the sum of the inner sheath thickness specified in Table 4 and the nominal outer sheath thickness specified in col 3 of Table 7 and the smallest of the measured values shall not be less than the sum of the inner sheath thickness specified in Table 4 and the minimum value of outer sheath thickness specified in col 4 of Table 7.

14.4.2 *Armoured Cables* — The minimum thickness of PVC outer sheath of armoured cables shall not fall below the nominal value (t_s) specified in Table 7 by more than 0·2 mm $\pm$ 0·2 t_s.

*Specification for conductor for insulated electric cables and flexible cords (*first revision*).

TABLE 6 ARMOUR RESISTANCE OF CABLES

(*Clause* 13.5.1)

Nominal Area of Conductor	Maximum d.c. Resistance of Armour of Cable at 20°C											
	Two Core			Three Core			Four Core			Four Core with Reduced Neutral		
	Round wire	Strip		Round wire	Strip		Round wire	Strip		Round wire	Strip	
		4·0 × 0·8 mm	6·1 × 1·4 mm		4·0 × 0·8 mm	6·1 × 1·4 mm		4·0 × 0·8 mm	6·1 × 1·4 mm		4·0 × 0·8 mm	6·1 × 1·4 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
mm²	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km	ohm/km
1·5	6·37	—	—	6·02	—	—	5·52	—	—	—	—	—
2·5	5·54	—	—	5·22	—	—	4·77	—	—	—	—	—
4	4·83	—	—	4·54	—	—	4·14	—	—	—	—	—
6	4·40	—	—	4·14	—	—	3·76	—	—	—	—	—
10	3·86	—	—	3·62	—	—	2·84	4·68	—	—	—	—
16	2·85	4·69	—	2·67	4·40	—	2·42	3·99	—	—	—	—
25	2·77	4·58	—	2·49	4·11	—	2·14	3·53	—	2·21	3·64	—
35	2·67	4·41	—	2·35	3·88	—	1·99	3·28	—	2·05	3·38	—
50	2·26	3·73	—	2·03	3·35	—	1·39	2·92	—	1·84	3·04	—
70	2·04	3·36	—	1·41	2·96	—	1·18	2·47	—	1·23	2·57	—
95	1·41	2·95	—	1·22	2·54	—	1·05	2·18	—	1·10	2·39	—
120	1·30	2·71	—	1·11	2·32	—	0·962	2·01	—	1·05	2·20	—
150	1·19	2·49	—	1·00	2·09	—	0·703	1·86	1·02	0·959	2·00	—
185	1·08	2·26	—	0·733	1·93	1·06	0·623	1·64	0·902	0·684	1·80	0·990
240	0·749	1·98	1·08	0·642	1·69	0·930	0·563	1·48	0·816	0·596	1·56	0·863
300	0·684	1·80	0·990	0·586	1·54	0·850	0·389	1·30	0·719	0·429	1·44	0·793
400	0·464	1·56	0·860	0·408	1·36	0·755	0·361	1·20	0·666	0·367	1·22	0·679
500	0·397	1·33	0·734	0·359	1·20	0·663	0·233	0·992	0·552	0·264	1·13	0·627
630	0·274	1·17	0·651	0·248	1·06	0·589	0·203	0·861	0·480	0·227	0·967	0·538

NOTE 1 — The resistance of armour for single core cables has not been covered since such cables are generally armoured with non-magnetic materials (*see* 13.2).

NOTE 2 — The resistance of the armour may be measured at room temperature and corrected to 20°C by means of correction factors given in IS : 10810 (Part 42)-1984*.

*Methods of tests for cables: Part 42 Resistivity test of armour wires and strips and conductance test of armour wires/strips.

TABLE 7 THICKNESS OF OUTER SHEATH

[*Clauses* 14.4.1, 14.4.2 *and* 15·1(c)]

All dimensions in millimetres.

Calculated Diameter Under the Outer Sheath [Ref IS : 10462 (Part 1) - 1983*]		Thickness of Outer Sheath for Unarmoured Cables		Minimum Thickness of Outer Sheath for Armoured Cables
Over	Up to and Including	Nominal	Minimum	
(1)	(2)	(3)	(4)	(5)
—	15	1·8	1·24	1·24
15	25	2·0	1·40	1·40
25	35	2·2	1·56	1·56
35	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	3·00	3·00

*Fictitious calculation method for determination of dimensions of protective coverings of cables: Part 1 Elastomeric and thermoplastic insulated cables.

SECTION 4 TESTS

15. CLASSIFICATION OF TESTS

15.1 Type Tests — The following shall constitute type tests:

Tests	*For Requirements, Ref to*	*For Test Method, Ref to Part No. of* IS : 10810*
a) Tests on conductor:		
1) Annealing test (for copper)	IS : 8130-1984†	1
2) Tensile test (for aluminium)	IS : 8130-1984†	2
3) Wrapping test (for aluminium)	IS : 8130-1984†	3
4) Conductor resistance test	IS : 8130-1984†	5
b) Test for armouring wires/strips	Table 5 and IS : 3975-1979‡	36 to 42
c) Test for thickness of insulation and sheath	9, 12, 14, Table 2, Table 4 and Table 7	6
d) Physical tests for insulation and outer sheath:		
1) Tensile strength and elongation at break	IS : 5831-1984§	7
2) Ageing in air oven	IS : 5831-1984§	11
3) Shrinkage test	IS : 5831-1984§	12
4) Hot deformation	IS : 5831-1984§	15

*Methods of test for cables.

†Specification for conductors for insulated electric cables and flexible cords (*first revision*).

‡Specification for mild steel wires, strips and tapes for armouring of cables (*first revision*).

§Specification for PVC insulation and sheath of electric cables (*first revision*).

Tests	*For Requirements, Ref to*	*For Test Method, Ref to Part No. of* IS : 10810*
5) Loss of mass in air oven	IS : 5831-1984†	10
6) Heat shock test	IS : 5831-1984†	14
7) Thermal stability	IS : 5831-1984†	*See* Note
e) Insulation resistance test	IS : 5831-1984†	43
f) High voltage test (water immersion test)	16·3	45
g) High voltage test at room temperature	16·2	45
h) Flammability test	16·4	53

NOTE — Under preparation. In the meantime, test method in IS : 5831-1984† shall be followed.

*Methods of test for cables.

†Specification for PVC insulation and sheath of electric cables (*first revision*).

15.2 Acceptance Tests — The following shall constitute acceptance tests:

a) Annealing test (for copper),

b) Tensile test (for aluminium),

c) Wrapping test (for aluminium),

d) Conductor resistance test,

e) Test for thickness of insulation and sheath,

f) Tensile strength and elongation at break of insulation and sheath,

g) Insulation resistance test, and

h) High voltage test at room temperature.

15.2.1 A recommended sampling plan for acceptance tests is given in Appendix A.

15.3 Routine Tests — The following shall constitute routine tests:

a) Conductor resistance test,

b) High voltage test at room temperature, and

c) Armour resistance test (for mining cables).

15.4 Optional Tests — The following shall constitute optional tests:

a) Cold bend test,

b) Cold impact test, and

c) Armour resistance test (for other than mining cables).

16. DETAILS OF TESTS

16.1 General — Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS : 10810*; taking into account additional information given in this standard.

16.2 High Voltage Test at Room Temperature — The cable shall withstand an a.c. voltage of 3 kV (rms) or a dc voltage of 7·2 kV. The duration of test shall be 5 minutes for each connection.

16.3 High Voltage Test (Water Immersion Test)

16.3.1 *a.c. Test* — The core or cores (not exceeding five cores in the case of multicore cables) shall be carefully removed from a sample approximately 3 m long taken from the finished cable. They shall be so immersed in water bath that their ends protrude at least 200 mm above the water level. The temperature of the water bath shall be $60 \pm 3°C$ for cores with general purpose PVC insulation and $70 \pm 3°C$ for cores with heat resisting PVC insulation. After 24 hours, a voltage of 3 kV (rms) shall be applied between the conductors and water. This voltage shall be raised to 6 kV (rms) within 10 seconds and held constant at this value for 5 minutes. If the sample fails in this test, one more sample shall be subjected to this test. There shall be no failure in the repeat test.

16.3.2 *d.c. Test* - The cores which have passed the preliminary test in **16.3.1** shall be subsequently tested with a d.c. voltage of 1·2 kV in the same water bath at the same temperature. The core shall withstand this voltage for 240 hours without breakdown.

NOTE — The selected cores shall represent all colours included.

*Methods of test for cables.

16.4 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.

SECTION 5 IDENTIFICATION, PACKING AND MARKING

17. IDENTIFICATION

17.1 Manufacturer's Identification — The manufacturer shall be identified throughout the length of the cable by means of a tape bearing the manufacturer's name or trade-mark, or by manufacturer's name or trade-mark being indented, printed or embossed on the cable. In case none of these methods can be 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. The indentation, printing or embossing shall be done only on the outer sheath.

17.2 Cable Identification — In order to distinguish these electric cables from telephone cables, the word 'ELECTRIC' shall be indented, printed or embossed throughout the length of the cable. In case of cables intended for use in mines, the word 'MINING' also shall be indented, printed or embossed throughout the length of the cable. The indentation, printing or embossing shall be done only on the outer sheath.

17.2.1 Cables with heat resisting insulation suitable for 85°C conductor temperature shall be identified by the letters 'HR 85' marked on it in any of the manner specified in **17.2**.

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

Constituent	*Code Letter*
Aluminium conductor	A
PVC insulation	Y
Steel round wire armour	W
Steel strip armour	F
Steel double round wire armour	WW
Steel double strip armour	FF
PVC outer sheath	Y

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

18. PACKING AND MARKING

18.1 The cable shall be wound on a drum (*see* IS : 10418-1972*) of suitable size and packed. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

18.2 The cable shall carry the following information stencilled on the drum:

a) Reference to this Indian Standard, for example, Ref IS : 1554 (Part 1);

b) Manufacturer's name, brand name or trade-mark;

c) Type of cable and voltage grade;

d) Number of cores;

e) Nominal cross-sectional area of the conductor;

f) Cable code;

g) Colour of cores (in case of single core cables);

h) Length of the cable on the drum;

j) Number of lengths on drum (if more than one);

k) Direction of rotation of drum (by means of an arrow);

m) Approximate gross mass;

n) Running end of cable;

p) Country of manufacture; and

q) Year of manufacture.

18.2.1 The cable (drum) may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

*Specification for drums for electric cables.

APPENDIX A

(*Clause* 15.2.1)

SAMPLING OF CABLES

A-1. LOT

A-1.1 In any consignment, the cables of same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

A-2. SCALE OF SAMPLING

A-2.1 Samples shall be taken and tested from each lot for ascertaining the conformity of the lot to the requirements of the specification.

A-2.2 The number of samples to be selected shall depend on the number of drums in the lot as indicated below. These samples shall be taken at random:

Number of Drums in the Lot	*Number of Drums to be Taken as Sample*	*Permissible Number of Defectives*
N	*n*	*a*
Up to 50	2	0
51 to 100	5	0
101 to 300	13	0
301 to 500	20	1
501 and above	32	2

A-2.2.1 In order to ensure the randomness of selection, random number tables shall be used (*see* IS : 4905-1968*).

A-3. NUMBER OF TESTS AND CRITERION FOR CONFORMITY

A-3.1 Suitable length of test sample shall be taken from each of the drums selected. These test samples shall be subjected to each of the acceptance tests (*see* **15.2**). A test sample is called defective if it fails in any of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number given in **A-2.2** the lot shall be declared as conforming to the requirements of acceptance tests; otherwise not.

*Methods for random sampling.

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TO
IS 1554 (Part 1) : 1988 SPECIFICATION FOR PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES
PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Third Revision)

(*Page* 1, *clause* **0.3**) — Delete this clause and renumber the subsequent clauses.

(*Page* 1, *clause* **0.5**) — Substitute the following for the existing clause:

'**0.4** A special category of cables with improved fire performance has been included in this standard. Classification of such cables is given in Appendix A.'

(*Page* 1, *clause* **1.1**) — Insert the following new clause **1.2** after **1.1** and renumber the subsequent clauses:

'**1.2** This standard also covers cables with improved fire performance, categories C1 and C2, as given in Appendix A. For such cables additional requirements have been included wherever necessary in **7.1.3**, **15.1.1**, **15.2.1** and **17.2.2**).

NOTE — Normal cables to this standard can be classified as meeting the requirements of category 01.'

[*Page* 2, *clause* **6.1**(b)] — Substitute 'formed wire' *for* 'strip'.

(*Page* 2, *clause* **6.2**) — Replace first sentence by the following:

'The galvanized steel wires/formed wires/tapes shall comply with the requirements of IS 3975 : 1988, except that the provisions of **3.3.1** and **3.3.2** of IS 3975 shall not apply.'

(*Page* 2, *clause* **7.1.2**) — Insert the following new clause **7.1.3** after **7.1.2**:

'**7.1.3** For cables with improved fire performance, the outer sheath shall, in addition, meet the requirement of tests applicable for the required category (*see* **15.1.1** and **15.2.1**).

(*Page* 3, *clause* **8.1**, *Informal table, captions for col* 1 *and* 2) — Substitute the following for the existing:

'Nominal Cross Sectional Area	
Copper mm^2	Aluminium mm^2

(*Page* 4, *clause* **10.3.1**, *para* 2) — Delete letter '*d*' in line five; also delete the last sentence.

(*Page* 4, *Fig.* 1) — Delete.

(*Page* 6, *clause* **14.4.2**) — Substitute the following for the existing:

'**14.4.2** *Armoured Cables* — The thickness of outer sheath shall be not less than the minimum value specified in col 5 of Table 7.'

(*Page* 8, *clause* **15.1**) — Insert the following new clause **15.1.1** after **15.1**:

'**15.1.1** The following shall constitute additional type tests for cables with improved fire performance as per the categories given in Appendix A:

Category	Tests	For requirement, Ref	For Test Methods, Ref. Part No. of IS 10810
(1)	(2)	(3)	(4)
01	No Additional tests	—	—
C1	a) Oxygen index test	16.5	58 (Under preparation)
	b) Flame retardance test on single cable	16.6	61
	c) Flame retardance test on bunched cables	16.7	62
	d) Temperature index	16.10	Under consideration
C2	a) Oxygen index test	16.5	58 (Under preparation)
	b) Flame retardance test on single cable	16.6	61
	c) Flame retardance test on bunched cables	16.7	62

d)	Test for specific optical density of smoke	16.8	Under Consideration
e)	Smoke density	16.11	63
f)	Test for halogen acid gas evolution	16.9	59
g)	Temperature index	16.10	Under consideration

NOTES :

1. For category C1, tests (a) and (d) are to be performed on samples taken from outer sheath, as applicable, and prepared in the manner given in the relevant test method.

2. For categpry C2, tests (a), (e), (f) and (g) are to be performed on samples taken from outer sheath, as applicable, and prepared in the manner given in the relevant test method.

(*Page* 9, *clause* **15.2**) — Add clause **15.2.1**: and renumber the existing clause as **15.2.2.**

'**15.2.1** The following shall constitute additional acceptance tests for cables with improved fire performance as per the categories given in Appendix A:

Category	Test
01	No additional Test
C1	a) Oxygen index test
	b) Flame retardance test on single cable
C2	a) Oxygen index test
	b) Flame retardance test on single cable
	c) Test for specific optical density of smoke
	d) Test for halogen acid gas evolution
	e) Test for smoke density

(*Page* 10, *clause* **16.4**) — Add the following clauses:

'16.5 Oxygen Index Test

The test on samples of inner/outer sheath (as applicable) shall be done at $27 \pm 2^{\circ}C$. The oxygen index shall not be less than 29.

16.6 Flame Retardance Test on Single Cables

After the test, there should be no visible damages on the test specimen within 300 mm from its upper end. Marks from fixing devices, soot or changing of the colour are not considered damages.

16.7 Flame Retardance Test on Bunched Cables

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 m above the bottom edge of the burner, measured at the front and rear of the cable assembly.

NOTE — Requirements for this test are split in 3 categories i.e. A, B and C as described in IS 10810 (Part 62) : 1993. For the purpose of this standard, category B and C test methods shall be used. In the absence of any special requirements for method B, method C shall be used for both the categories C1 and C2.

16.8 Test for Specific Optical Density of Smoke

Under Consideration.

16.9 Test for Halogen Acid Gas Evolution

The level of HC1 evolved shall not exceed 20 percent by weight.

16.10 Test for Temperature Index

The measured value of Temperature Index shall be 21 at a temperature of $250^{\circ}C$.

16.11 Smoke Density

Under consideration.'

(*Page* 10, *clause* **17.2.1**) — Add new clause:

'**17.2.2** The following special cables shall be identified by indenting, embossing or printing the appropriate legend on the outer sheath throughout the cable length, in addition to the existing marking requirements.'

Type of Cable	Legend
i) Improved fire performance or Category C1	FR
ii) Improved fire performance for Category C2	FR—LSH

(*Page* 11, *Appendix* A) — Insert the following new 'Appendix A' and renumber the existing 'Appendix A' as 'Appendix B':

APPENDIX A

(*Clauses* 0.4, 1.2 *and* 15.1.1)

CLASSIFICATION OF CABLES FOR IMPROVED FIRE PERFORMANCE

Category	Environment Description	Type	Cable Definition
01	Cables in open areas	—	Flame retardent, Single cable self-extinguishing, does not propagate flame
C1	Cables in constrained areas	FR	Flame retardent, Does not propagate fire even when installed in groups in vertical ducts
C2	Cables in constrained areas with limited human activity and/or presence of sophisticated systems	FR—LSH	Flame retardent cables with reduced halogen evolution and smoke

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PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Third Revision)

[*Page* 8, *clause* **15.1.1**, *col* 4 (*see also Amendment No.* 1)] — Delete '(Under preparation)' for Category C1 and Test (a).

[*Page* 8, *clause* **15.1.1**, *col* 4 (*see also Amendment No.* 1)] — Substitute '64' *for* 'Under consideration' for Category C1 and Test (d).

[*Page* 8, *clause* **15.1.1**, *col* 4 (*see also Amendment No.* 1)] — Delete '(Under preparation)' for Category C2 and Test (a).

[*Page* 8, *clause* **15.1.1**, *col* 4 (*see also Amendment No.* 1)] — Substitute '64' *for* 'Under consideration' for Category C2 and Test (g).

(ET 9)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 NOVEMBER 2007
TO
IS 1554 (PART 1) : 1988 SPECIFICATION FOR PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES

PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Third Revision)

[*Page* 2, *clause* **6.1**(b) (*see also Amendment No.* 1)] — Substitute 'Galvanized steel formed wire (strip), or' *for* 'Galvanized steel strip, or'.

[*Page* 2, *clause* **6.2**, *line* 1 (*see also Amendment No.* 1)] — Substitute the following for the existing matter:

'The galvanized round steel wires/formed steel wires (strips) used for armouring shall conform to IS 3975 : 1999†'

(*Page* 2, *footnote marked* †) — Substitute the following for the existing footnote:

'†Low carbon galvanized steel wires, formed wires and tapes for armouring of cables — Specification (*third revision*).'

(*Page* 6, *clause* **13.3**) — Insert the following at the end:

"The tolerance on nominal dimensions shall be as per IS 3975 : 1999. However, for formed steel wires compliance shall be ensured only for dimensions 'A' & 'C'."

(*Page* 6, *clause* **13.5.2**) — Insert the following new clause after **13.5.2**:

'**13.6** The round steel wires/formed steel wires taken from the cable shall meet the following requirements:

a) The tensile strength of round steel wire/formed steel wire shall be not less than 250 N/mm^2 and not more 580 N/mm^2.

b) The Elongation at break of round steel wire/formed steel wire shall be not less than 6 percent.

c) Round steel wire shall meet the requirements of torsion test. The gauge length between Vices and the minimum number of turns without break shall be as per Table 6 of IS 3975 : 1999.

d) The zinc coating shall not show any cracks and shall not flake off on rubbing by the bare finger when the formed steel wire is subjected to winding test.

e) The uniformity of zinc coating of round steel wire/formed steel wire shall comply with the requirements of IS 3975 : 1999 subject to the following:

- The minimum number of dips shall be reduced by one half-minute dip
- In case of formed wires, dip test is applicable only for the face

f) The mass of zinc coating of round steel wire shall be not less than 95 percent of the mass specified in Table 2 of IS 4826 : 1979.

The mass of zinc coating of formed steel wire shall be not less than 95 percent of the mass specified in IS 3975 : 1999.

g) The resistivity of the round steel wire/formed steel wire shall meet the requirements of IS 3975 : 1999.

[*Page* 8, *clause* **15.1**, *informal table*, *Sl No.* (b)] — Substitute the following for the existing matter:

b)	Tests for round steel wire/formed steel wire (strip) armour:		
	1) Dimensions	**13.3** of IS 1554 (Part 1)	Part 36 of IS 10810
	2) Physical tests on round/formed wire:		
	i) Tensile strength	**13.6**(a) of IS 1554 (Part 1)	Part 37 of IS 10810
	ii) Elongation at break	**13.6**(b) of IS 1554 (Part 1)	Part 37 of IS 10810
	iii) Torsion test for round wires	**13.6**(c) of IS 1554 (Part 1)	Part 38 of IS 10810
	iv) Winding test for formed wires	**13.6**(d) of IS 1554 (Part 1)	Part 39 of IS 10810

v) Uniformity of zinc coating	**13.6**(e) of IS 1554 (Part 1)	Part 40 of IS 10810
vi) Mass of zinc coating	**13.6**(f) of IS 1554 (Part 1)	Part 41 of IS 10810
vii) Resistivity	**13.6**(g) of IS 1554 (Part 1)	Part 42 of IS 10810

(*Page* 8, *footnote marked* ‡) — Substitute the following for the existing matter

'‡Low carbon galvanized steel wires, formed wires and tapes for armouring of cables — Specification (*third revision*).'

(ET 09)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 5 APRIL 2012
TO
IS 1554 (PART 1) : 1988 SPECIFICATION FOR PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES

PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Third Revision)

(*Page* 2, *clause* **2.2**) — Renumber the existing Note as Note 1 and add Note 2 as given below:

'NOTE 2 — When type tests have been successfully performed on a type of cable covered by this standard with a specific conductor cross-sectional area and rated voltage, type approval shall be accepted as valid for cables of the same type with other conductor cross-sectional areas and/or rated voltages provided the following two conditions are satisfied:

a) The same material of insulation and manufacturing process are used.
b) The conductor cross-sectional area is not larger than that of the tested cable.

Approval shall be independent of the conductor material.'

(*Page* 4, *clause* **13.1.2**) — Substitute the following for the existing clause:

'The armour wires/formed wire shall be applied as closely as possible with a coverage of not less than 90 percent. The coverage of armour shall be done as per Appendix C.'

[*Page* 12, *Appendix* B (*see also Amendment No.* 1)] — Add the following 'Appendix C' after 'Appendix B':

APPENDIX C

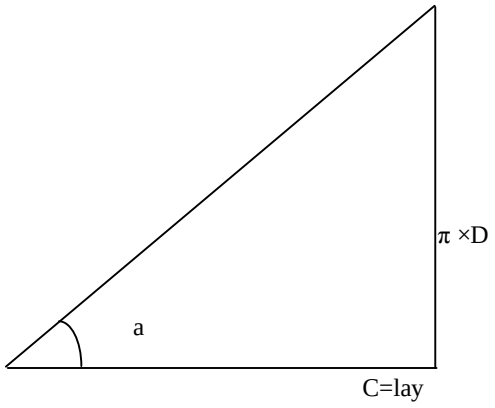
(*Clause* 13.1.2)

ARMOUR COVERAGE PERCENTAGE

Percent coverage $= \frac{N \times d}{W} \times 100$

where

N = number of parallel wires,
d = diameter of wire/width of formed wires,
$W = \pi \times D \times \cos a$,
D = diameter under armour,
a = angle between armouring wire/ formed wires and axis of cable,
$\tan a = \pi \times D/C$, and
C = lay length of armouring wires/ formed wires.



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