BUREAU OF INDIAN STANDARDS
DRAFT FOR COMMENTS ONLY

Draft Indian Standard

PVC insulated (Heavy Duty) electric cables - Specification Part 1 for working voltages up to and including 1100 V

(Fourth Revision of IS 1554-1)

Power Cables Sectional Committee, ETD 09	Last date for comments 12 10 2024

FOREWORD

(Formally Clause will be added later)

This draft Indian Standard (Part 1) (Fourth Revision) will be adopted by the Bureau of Indian Standards on the recommendation of the Power Cables Sectional Committee and approval of the Electrotechnical Division Council.

This fourth revision has been undertaken to align it with the international practices to the extent possible.

All amendments to third revision has been incorporated in this fourth revision.

Another part of this series of Indian Standard cover PVC insulated (Heavy Duty) electric cables: Part 2 For working voltages from 3.3 kV up to and including 11 kV.

In the preparation of this standard, assistance has been derived from IEC 60502 series.

The composition of the Committee, responsible for the formulation of this standard is given in Annex D.

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: 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES — SPECIFICATION PART 1 FOR WORKING VOLTAGES UP TO AND INCLUDING 1 100 V

(Fourth Revision)

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 This standard also covers cables with improved fire performance, categories C1 and C2, as given in Annex A. For such cables additional requirements have been included wherever necessary in **8.1.3, 16.1.1, 16.1.2** and **18.2.2**).

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

1.3 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 1100 V. These cables may be used on d.c. Systems for rated voltages up to and including 1500 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.

1.4 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.

1.5 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* **4.1.1**, **14.5.2**, **16.1**(a) (3) and **18.2**].

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibilityof applying the most recent editions of the standard indicated below:

IS No.	*Title*
IS 1885 (Part 32) : 2019	Electrotechnical Vocabulary Part 32 Electric Cables (Second Revision)
IS 3961 (Part 2) : 2017	Recommended current ratings for cables: Part 2 PVC insulated and PVC sheathed heavy duty cables (First Revision)
IS 3975 : 1999	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables - Specification (Third Revision)
IS 4826 : 2023	Hot-Dip Galvanized Coatings on Round Steel Wires - Requirements
IS 4905 : 2015	Random sampling and randomization procedures (First Revision)
IS 5831 : 1984	Specification for PVC insulation and sheath of electric cables (First Revision)
IS 8130 : 2013	Conductors for insulated electric cables and flexible cords - Specification (Second Revision)
IS 10418 : 2024	Drums for Electric Cables- Specification (First Revision)
IS 10462 (Part 1) : 1983	Fictitious calculation method for determination of dimensions of protective coverings of cables: Part 1 elastomeric and thermoplastic insulated cables
IS 10810 (Part 0) : 1984	Methods of test or cables
IS 10810 (Part 1) : 1984	Methods of test for cables: Part 1 annealing test for wires used as conductors
IS 10810 (Part 2) : 1984	Methods of test for cables: Part 2 tensile test for aluminium wires
IS 10810 (Part 3) : 1984	Methods of test for cables: Part 3 wrapping test - For aluminium wires
IS 10810 (Part 5) : 1984	Methods of test for cables: Part 5 conductor resistance test
IS 10810 (Part 6) : 1984	Methods of test for cables: Part 6 thickness of thermoplastic and elastomeric insulation and sheath
IS 10810 (Part 7) : 1984	Methods of test for cables: Part 7 tensile strength and elongation at break of thermoplastic and elastomeric insulation and sheath
IS 10810 (Part 10) : 1984	Methods of test for cables: Part 10 loss of mass test
IS 10810 (Part 11) : 1984	Methods of test for cables: Part 11 thermal ageing in air
IS 10810 (Part 12) : 1984	Methods of test for cables: Part 12 shrinkage test
IS 10810 (Part 14) : 1984	Methods of test for cables: Part 14 heat shock test
IS 10810 (Part 15) : 1984	Methods of test for cables: Part 15 hot deformation test
IS 10810 (Part 36) : 1984	Methods of test for cables: Part 36 dimensions of armouring material
IS 10810 (Part 37) : 1984	Methods of test for cables: Part 37 tensile strength and elongation at break of armouring materials
IS 10810 (Part 38) : 1984	Methods of test for cables: Part 38 torsion test on galvanized steel wires for armouring

IS 10810 (Part 39) : 1984	Methods of test for cables: Part 39 winding test on galvanized steel strips for armouring
IS 10810 (Part 40) : 1984	Methods of test for cables: Part 40 uniformity of zinc coating on steel armour
IS 10810 (Part 41) : 1984	Methods of test for cables: Part 41 mass of zinc coating on steel armour
IS 10810 (Part 42) : 1984	Methods of test - For cables: Part 42 resistivity test of armour wires and strips and conductance test of armour (Wires strips)
IS 10810 (Part 43) : 1984	Methods of test for cables: Part 43 insulation resistance
IS 10810 (Part 45) : 1984	Methods of test for cables: Part 45 high voltage test
IS 10810 (Part 53) : 1984	Methods of test for cables: Part 53 flammability test
IS 10810 (Part 58) : 1998	Method of tests for cables: Part 58 oxygen index test
IS 10810 (Part 59) : 1988	Method of tests for cables: Part 59 determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables
IS 10810 (Part 60) : 1988	Methods of test for cables: Part 60 thermal stability of PVC insulation and sheath
IS 10810 (Part 61) : 1988	Methods of test for cables: Part 61 flame retardant test
IS 10810 (Part 62) : 1993	Method of tests for cables: Part 62 flame retardance test for bunched cables
IS 10810 (Part 64) : 2003	Methods of test for cables: Part 64 measurement of temperature index
IS 13360 (Part 6/Sec 9) : 2001	Plastics - Methods of testing: Part 6 thermal properties section 9 determination of density of smoke from the burning or decomposition of plastics

3 TERMINOLOGY

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

3.2 Routine Tests - Tests carried out by the manufacturer on all the finished cable length to check the requirements which are likely to vary during manufacture.

3.3 Type Tests - Tests intended to prove that the quality and design of a given type of cable are in accordance with the specifications.

NOTES

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

    a) The same grade of insulation and manufacturing process are used.

b) The conductor cross-sectional area is not larger than that of the tested cable

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

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

4 CONDUCTOR

4.1 The conductor shall be composed of annealed, bare or tinned copper or aluminium wires complying with IS 8130.

4.1.1 Mining cable to be used in gassy mines shall be of copper conductor only.

5 INSULATION

5.1 The insulation shall be in accordance with **5.1.1** or **5.1.2**, as applicable.

5.1.1 *General Purpose Insulation* — The insulation shall be of Type A PVC compound conforming to the requirement of IS 5831.

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

6 FILLER AND INNER SHEATH

6.1 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).

6.2 Unvulcanized rubber or thermoplastic material used shall not be harder than PVC used for insulation (**5.1**) and for outer sheath (**8.1**).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.

7 ARMOURING

7.1 Armouring shall be of the following:

a) Galvanized round steel wire,
b) Galvanized steel formed wire (strip)
c) Any metallic non-magnetic wire/strip.

7.2 The galvanized round steel wires/formed steel wires (strips) used for armouring shall conform to IS 3975. The requirements of non-magnetic material shall be as agreed to between the purchaser and the manufacturer.

8 OUTER SHEATH

8.1 The outer sheath shall be in accordance with **8.1.1**, **8.1.2** or **8.1.3** as applicable.

8.1.1 *For Cables With General Purpose Insulation* — The outer sheath shall be of Type ST1 PVC compound conforming to the requirements of IS 5831.

8.1.2 *For Cables With Heat Resisting Insulation* — The outer sheath shall be of Type ST2 PVC compound conforming to the requirements of IS 5831.

8.1.3 For cables with improved fire performance, the outer sheath shall, in addition, meet the requirement of tests applicable for the required category (*see* **16.1.1** and **16.1.2**).

9 CONDUCTOR

9.1 The Construction of Conductor shall be as follows:

Nominal cross sectional area		**Solid/Stranded**	**Flexibility Class Ref to IS 8130**
Copper mm²	Aluminium mm²		
-	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

Note — Tinned copper conductor may also be used as agreed between purchaser and manufacturer

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

TABLE 1
CROSS SECTIONAL AREA OF REDUCED NEUTRAL CONDUCTORS
(*Clause* 9.2)

NOMINAL CROSS SECTIONAL AREA OF PHASE CONDUCTOR	**CROSS SECTIONAL AREA OF REDUCED NEUTRAL CONDUCTORS**
(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

10 INSULATION

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

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

10.3 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 + 0.1 t_i .

10.4 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.

TABLE 2
THICKNESS OF INSULATION
[*Clause* 10.2, 10.3 *and* 16.1(c)]

Sl.	**NOMINAL AREA OF CONDUCTOR**	**NOMINAL THICKNESS OF INSULATION (t_i)**	
		Single core Armoured cable	Single core unarmoured and multi-core cable
	(1)	(2)	(3)
	mm^2	mm	mm
1.	1.5	1.1	0.8
2.	2.5	1.2	0.9

3.	4	1.3	1.0
4.	6	1.3	1.0
5.	10	1.3	1.0
6.	16	1.3	1.0
7.	25	1.5	1.2
8.	35	1.5	1.2
9.	50	1.7	1.4
10.	70	1.7	1.4
11.	95	1.9	1.6
12.	120	1.9	1.6
13.	150	2.1	1.8
14.	185	2.3	2.0
15.	240	2.5	2.0
16.	300	2.7	2.4
17.	400	3.0	2.6
18.	500	3.4	3.0
19.	630	3.9	3.4
20.	800	3.9	3.4
21.	1 000	3.9	3.4

11 CORE IDENTIFICATION

11.1 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 **11.3**.

(Note: Specific core identification if any may be agreed between supplier and manufacturer)

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

11.3 For cables having more than 5 cores, as an alternate to the provisions of **11.1**, 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.

12 LAYING UP OF CORES

12.1 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.

12.2 The recommended plan for lay-up of cores up to 100 shall be in accordance with **Table 3**.

12.3 The assembly co-efficient shall be as per IS 10462-1

TABLE 3
LAY-UP OF CORES
(*Clause* 12.2)

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		

NOTES — The figure 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. This table is for guidance only.

13 INNER SHEATH

13.1 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.

13.2 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.

13.3 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.

13.3.1 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.

TABLE 4
THICKNESS OF INNER SHEATH
[*Clause* 13.3, *and* 16.1(c)]

Sl.	**CALCULATED DIAMETER OVER LAID UP CORES [REF IS 10462 (PART 1)]**		**THICKNESS OF INNER SHEATH (MINIMUM)**
	Over	Up to and including	
	mm	mm	mm
	(1)	(2)	(3)
1.	—	25	0.3
2.	25	35	0.4
3.	35	45	0.5
4.	45	55	0.6

5.	55	—	0.7

14 ARMOURING

14.1 Application

14.1.1 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.

14.1.2 The armour round wires/formed wire shall be applied as closely as possible with a coverage of not less than 90 percent. The determination of coverage of armour shall be done as per **Annex C**.

14.1.3 The direction of lay of the armour shall be left hand. For double round wires/formed wire armoured cables, this requirement shall apply to the inner layer of round wires/formed wire. 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, bituminized cotton tape, bituminized hessian tape, rubber tape, proof tape, etc., between the layers of armour round wires/formed wire.

14.1.4 A binder tape may be provided on the armour.

14.2 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 formed wires.

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

14.3 Dimensions - The dimension of the galvanized steel wires and strips shall be as specified in **Table 5**.

The tolerance on nominal dimensions shall be as per IS 3975. However, for formed steel wires compliance shall be ensured only for dimensions ‘A’ and ‘C’.

TABLE 5
Diameter of armour wires
(*Clause* 14.3)

Calculated diameter under Armour [Ref IS 10462 (Part 1)]		**Nominal Thickness of formed wires**	**Nominal Diameter of round wires**
mm	mm	mm	mm
Over	Up to and including		
(1)	(2)	(3)	(4)
Method A:			
For all diameters in excess of 13		0.8	-
Method B:			
-	13	-	1.4
13	25	0.8	1.6
25	40	0.8	2.0
40	55	1.4	2.50
55	70	1.4	3.15
70	-	1.4	4.00

NOTE—Method A and Method B indicate two methods of practice in the application of armouring.

14.4 Joints — The joints in armour round wire/formed wire shall be made by brazing or welding and the surface irregularities shall be removed. A joint in any round wire/formed wire shall be at least 300 mm from the nearest joint in any other round wire/formed wire in the Completed cable.

14.5 Resistance

14.5.1 If specified by the purchaser, the d.c. resistance of the galvanized steel wire/strip armour shall be measured.

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

14.6 The round steel wire/formed wire 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/mm² and not more 580 N/mm².

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 tums without break shall be as per **Table 6** of IS 3975.

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 subject to the following:

1) The minimum number of dips shall be reduced by one half-minute dip
2) 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.

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

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

15 OUTER SHEATH

15.1 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.

15.2 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.

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

15.4 Thickness of Outer Sheath

15.4.1 *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 6 and the smallest of the measured values shall not be less than the minimum value specified in col 4 of **Table 6**.

NOTE — In case of multi-core unarmoured cables, it is permissible to apply 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 Table 6 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 **Table 6.**

15.4.2 *Armoured Cables* — The thickness of outer sheath shall be not less than the minimum value specified in **Table 6**.

TABLE 6
THICKNESS OF OUTER SHEATH
[*Clause* 15.4.1, 15.4.2 *and* 16.1(c)]

Sl.	**CALCULATED DIAMETER UNDER THE OUTER SHEATH [REF IS 10462 (PART 1)]**		**THICKNESS OF OUTER SHEATH FOR UNARMOURED CABLES**		**MINIMUM THICKNESS OF OUTER SHEATH FOR ARMOURED CABLES**
	Over	**Up to and including**	**Nominal**	**Minimum**	
	mm	mm	mm	mm	mm
1.	(1)	(2)	(3)	(4)	(5)
2.	-	15	1.8	1.24	1.24
3.	15	25	2.0	1.40	1.40
4.	25	35	2.2	1.56	1.56
5.	35	40	2.4	1.72	1.72
6.	40	45	2.6	1.88	1.88
7.	45	50	2.8	2.04	2.04
8.	50	55	3.0	2.20	2.20
9.	55	60	3.2	2.36	2.36
10.	60	65	3.4	2.52	2.52
11.	65	70	3.6	2.68	2.68
12.	70	75	3.8	2.84	2.84
13.	75	-	4.0	3.00	3.00

16 CLASSIFICATION OF TESTS

16.1 The following shall constitute different tests as applicable.

Tests	For Requirements, Ref to	For Test Method, Ref to Part No. of IS 10810
(1)	(2)	(3)
a) Routine test		
1. Conductor resistance test	IS 8130	5
2. High voltage test	17.2	45
3. Armour resistance test (for mining cables).	14.5	42
b) Acceptance test		
1. Annealing test (for copper):	IS 8130	1
2. Tensile Test ((for aluminium):	IS 8130	2
3. Wrapping test (for aluminium);	IS 8130	3
4. Conductor resistance test;	IS 8130	5
5. Test for thickness of insulation and sheath	**9, 12, 14**, Table 2, Table 4 and Table 6	6
6. Tensile strength and elongation at break of insulation and sheath	IS 5831	7
7. High voltage test	17.2	45
8. Insulation resistance test	IS 5831	43
c) Type test		
1) Tests on conductor:		
i. Annealing test (for copper)	IS 8130	1
ii. Tensile test (for aluminium)	IS 8130	2
iii. Wrapping test (for aluminium	IS 8130	3
iv. Conductor resistance test	IS 8130	5
2) Test for thickness of insulation and sheath	**9, 12, 14**, Table 2, Table 4 and Table 6	6
3) Physical tests for insulation and outer sheath:		
i. Tensile strength and elongation	IS 5831	7
ii. Ageing in air oven	IS 5831	11
iii. Shrinkage test	IS 5831	12
iv. Hot deformation	IS 5831	15
v. Loss of mass in air oven	IS 5831	10
vi. Heat shock test	IS 5831	14

vii. Thermal stability	IS 5831	60
4) Insulation resistance test	IS 5831	43
5) High voltage test (water immersion test)	**17.3**	45
6) High voltage test at room temperature	**17.2**	45
7) Flammability test	**17.4**	53
8) Test for armouring round wires/formed wires	**14.6**, Table 5 and IS 3975	36 to 42
d) Optional test		
1. Cold bend test	IS 5831	20
2. Cold impact test	IS 5831	21
3. Armour resistance test (for mining cables).	**14.5**	42

16.1.1 The following shall constitute additional type tests for cables with improved fire performance as per the categories given in Annex 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	**17.5**	58
	b) Flame retardance test on single cable	**17.6**	61
	c)Flame retardance test on bunched cables	**17.7**	62
	d) Temperature index	**17.9**	64
C2	a) Oxygen index test	**17.5**	58
	b) Flame retardance test on single cable	**17.6**	61
	c)Flame retardance test on bunched cables	**17.7**	62
	d)Smoke density rating	**17.10**	IS 13360 (Part 6/Sec 9)
	e) Test for halogen acid gas evolution	**17.8**	59
	f)Temperature index	**17.9**	64

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

16.1.2 The following shall constitute additional acceptance tests for cables with improved fire performance as per the categories given in **Annex 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	**17.5**	58
	b) Flame retardance test on single cable	**17.6**	61
	c)Flame retardance test on bunched cables	**17.7**	62
C2	a) Oxygen index test	**17.5**	58
	b) Flame retardance test on single cable	**17.6**	61
	c)Flame retardance test on bunched cables	**17.7**	62
	d)Smoke density rating	**17.10**	IS 13360 (Part 6/Sec 9)
	e) Test for halogen acid gas evolution	**17.8**	59

16.2 A recommended sampling plan for acceptance tests is given in Annex **B**.

17 DETAILS OF TESTS

17.1 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.

17.2 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.

17.3 High Voltage Test (Water Immersion Test)

17.3.1 *AC 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 ± 3 °C for cores with general purpose PVC insulation and 70 ± 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.

17.3.2 *DC Test* —The cores which have passed the preliminary test in **17.3.1** 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.

17.4 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.

17.5 Oxygen Index Test- The test on samples of inner/outer sheath (as applicable) shall be done at 27± 2°C. The oxygen index shall not be less than 29.

17.6 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.

17.7 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). 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 Cl and C2.

17.8 Test for Halogen Acid Gas Evolution- The level of HCL evolved shall not exceed 20 percent by weight.

17.9 Test for Temperature Index- The minimum measured value of temperature index shall be 21 percent at a temperature of 250°C

17.10 Smoke Density — Smoke density rating shall be 60 percent maximum

18 IDENTIFICATION

18.1 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.

18.2 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.

Single core cables with magnetic armour for DC applications shall be additionally marked as 'DC Cable'

18.2.1 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 **18.2**.

18.2.2 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
(1)	(2)
Improved fire performance category C1	FR
Improved fire performance category C2	FR—LSH

18.3 Cable Code – The following code shall be used for designating the cable:

CONSTITUENT	CODE LETTER
(1)	(2)
Aluminium conductor	A
Tinned copper conductor	ATC
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 — When plain copper conductor material is used, no code letter is required for conductor.

19 PACKING AND MARKING

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

19.2 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;
o) Country of manufacture; and
p) Year of manufacture.

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

19.3.1 *BIS Certification Marking* —The use of the Standard Mark is covered by the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A
(*Clause* 16.1.1)
CLASSIFICATION OF CABLE FOR IMPROVED FIRE PERFORMANCE

Category	Environment description	Type	Cable definition
01	Cables in open areas	—	Flame retardant, single cable self-extinguishing, does not propagate flame
C1	Cable in constrained areas	FR	Flame retardant, Does not propagate fire even when installed in group in vertical ducts
C2	Cable in constrained areas with limited human activity and/or presence of sophisticated systems	FR—LSH	Flame retardant cables with reduced halogen evaluation and smoke

ANNEX B
(*Clause* 16.2)
SAMPLING OF CABLES

B-1. LOT

B-l.1 In any consignment, the cables of same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

B-2. SCALE OF SAMPLING

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

B-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.

NUMBERS OF DRUM IN THE LOT	NUMBERS OF DRUM TO BE TAKEN AS SAMPLE	PERMISSIBLE NUMBER OF DEFECTIVES
N	*n*	*a*
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 to 500	20	1
501 and above	32	2

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

B-3. NUMBER OF TESTS AND CRITERION FOR CONFORMITY

B-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* **16**). 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 **B-2.2** the lot shall be declared as conforming to the requirements of acceptance tests, otherwise not.

ANNEX C
(*Clause* 14.1.2)
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.