

मध्यम एवं उच्च वोल्टेज
केबल एवं असेसरिज
के लिए विनिर्देश

SPECIFICATION
FOR
MEDIUM AND HIGH VOLTAGE
CABLES & ACCESSORIES

6	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	<i>Revised</i> PS	<i>Amig</i> ANPS	<i>UAP</i> UAP	<i>DM</i> DM
5	20.04.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	PB	UAP	JMS	ND
4	15/03/04	REVISED AND ISSUED AS STANDARD SPECIFICATION	RKM	AAN	VPS	SKG
3	30/07/98	REVISED AND ISSUED AS STANDARD SPECIFICATION	SKG	RKM	VPS	AS
2	08/12/92	REVISED AND ISSUED AS STANDARD SPECIFICATION	RKM	SG	GNT	
1	04/06/84	REVISED AND ISSUED AS STANDARD SPECIFICATION	RCD	SG	GNT	
Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
DGMS	:	Director General of Mines and Safety
EPR	:	Ethylene Propylene Rubber
FR	:	Flame Retardant
HR PVC	:	Heat Resistant Polyvinyl Chloride
ICEA	:	Insulated Cable Engineers Association
IEC	:	International Electro technical Commission
IS	:	Indian Standards
NEMA	:	National Electrical Manufacturers Association
PVC	:	Polyvinyl Chloride
UV	:	Ultra Violet
XLPE	:	Cross linked Polyethylene

Electrical Standards Committee

Convenor: Mr. UA Patro

Members: Mr. AK Tickoo
Mr. MP Jain
Mr. BR Bhogal
Mr. Arun Kumar
Mr. KK Gera
Mr. Saeed Akhtar

CONTENTS

1.0	SCOPE.....	4
2.0	STANDARDS.....	4
3.0	GENERAL CONSTRUCTION.....	5
4.0	CABLE ACCESSORIES.....	7
5.0	INSPECTION, TESTING AND ACCEPTANCE.....	8
6.0	PACKING AND DESPATCH.....	9

1.0 SCOPE

This specification along with data sheets covers requirements for design, manufacture, testing at works and supply of Flame Retardant Medium & High Voltage cables and cable jointing / terminating accessories for medium and high voltage systems.

2.0 STANDARDS

2.1 The cables and cables jointing & terminating accessories shall comply with the latest edition of the following standards as applicable:

IS: 209	:	Specification for zinc.
IS: 1554	:	PVC insulated (heavy duty) electric cables.
IS: 3961(Pt-2)	:	Recommended current ratings for cables: Part - 2 PVC Insulated and PVC sheathed heavy-duty cables.
IS: 3975	:	Mild steel wires, strips and tapes for armouring of cables.
IS: 5831	:	PVC insulation and sheath of electric cables.
IS: 6380	:	Specification for elastomeric insulation and sheath of electric cables.
IS: 7098	:	Cross-linked polyethylene insulated PVC sheathed cables.
IS: 8130	:	Conductors for insulated electric cables and flexible cords.
IS: 10418	:	Drums for electric cables.
IS: 10462 (Pt-1)	:	Fictitious calculation method for determination of dimensions of protective coverings of cables: Part - I Electrometric and thermo-plastic insulated cables.
IS: 10810	:	Methods of test for cables: - Part 41: Mass of zinc coating on steel armour - Part 58: Oxygen index test - Part-61: Flame retardant test - Part-62: Fire resistance test for bunched cables.
IS: 13573	:	Joints and terminations for polymeric cables for working voltages from 6.6kV up to and including 33kV.
IEC: 60331-21:	:	Tests for electric cables under fire conditions circuit integrity – Procedures and requirements – Cables of rated voltage up and including 0.6/1.0kV.
IEC: 60332-3	:	Tests on electric cables under fire conditions.
NEMA-WC70	:	Standard for non shielded power cables rated 2000V or less for the distribution of electrical energy.
NEMA-WC53	:	Standard test methods for extruded dielectric power, control, instrumentation and portable cables for test.
DIN-53387	:	Artificial weathering and ageing of plastics and elastomers by exposure to filtered xenon arc radiation.
ASTM-G-154	:	Standard practice for operating fluorescent light apparatus for UV exposure of non metallic materials.
BS: 7846	:	Electric cables- 600/1000V armoured fire resistant cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire.

2.2 The cables and accessories shall also conform to the provisions of CEA Regulations and other statutory regulations, as applicable.

2.3 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 GENERAL CONSTRUCTION

- 3.1** The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.
- 3.2** Outer sheath of all cables shall be black in colour and the minimum value of oxygen index shall be 29 at $27 \pm 2^\circ \text{C}$. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
- 3.3** All cables covered in this specification shall be flame retardant (FR). The outer sheath of cables shall possess flame propagation properties meeting requirements as per IS-10810 (Part-62) category AF.
- 3.4** Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing/engraving shall be legible and indelible.
- 3.5** The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of $\pm 2 \text{ mm}$ up to overall diameter of 60mm and $\pm 3 \text{ mm}$ for beyond 60mm.
- 3.6** PVC/ Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.
- 3.7** The cables meant to be used in mining area under the jurisdiction of DGMS shall comply with the requirements as specified in the Job specification/ Datasheet.

3.8 Medium Voltage Cables

- 3.8.1** All power/control cables for use on medium voltage systems shall be heavy-duty type, 650/1100V grade with aluminium/ copper conductor, PVC insulated, inner-sheathed, armoured/ unarmoured and overall PVC sheathed.
- 3.8.2** The conductors shall be solid for conductor of nominal area up to and including 6 mm^2 and stranded beyond 6 mm^2 . Conductors of nominal area less than 16 mm^2 shall be circular only. Conductors of nominal area 16 mm^2 and above may be circular or shaped as per IS 8130. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1).
- 3.8.3** The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of type 'A' compound as per IS: 5831. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table 2 of IS: 1554 (Part-1). Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50 mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per Indian standard.
- 3.8.4** The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST-1 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS: 1554 (Part-1). Single core cables shall have no inner sheath.

- 3.8.5 All cables shall be provided with armour except those specifically specified as unarmoured. For multicore cables, the armour shall be by single round galvanised steel wires where the calculated diameter below armouring does not exceed 13 mm and by galvanised steel strips where this dimension is greater than 13 mm. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS - 3975 and IS -10810 (Part 41). The dimensions of armour shall be as per method (b) of IS - 1554 (Part -1). For single core cables, the armour shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.

For mining cables, the size and type of armour shall be such that the combined conductance of armour shall be equivalent to 75 percent of the conductance of the largest conductor of the cable.

- 3.8.6 The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming to the requirements of type ST-1 compound as per IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS: 1554 (Part -1).

- 3.8.7 Where specified, 1100V grade power cables shall also be XLPE insulated and shall meet the requirement specified in IS-7098 (Part-1).

- 3.8.8 If heat resisting PVC cables are specified in the data sheet, the following shall be the requirements:

It shall be possible to continuously operate the cable at a maximum conductor temperature of 85° C. PVC compounds used for HR PVC cables shall be as follows:

- a. Conductor insulation -Type C
- b. Inner sheath -Type ST 2
- c. Outer sheath -Type ST 2

- 3.8.9 The fire survival cables shall meet the following additional requirements :

- i) The insulation shall be of EPR or equivalent material with glass mica tape below or above insulation.
- ii) The cables shall meet requirement of circuit integrity test for a minimum period of 3 hours at max. Temperature of 950° C.

3.9 High Voltage Cables

- 3.9.1 Power cables for 3.3kV up to and including 33kV systems shall be Aluminium/ Copper conductor, XLPE insulated, sheathed, armoured/ unarmoured and overall PVC sheathed.

- 3.9.2 The conductors shall be stranded and compacted circular for all cables.

- 3.9.3 All cables rated 3.8/ 6.6kV and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semi conducting screen.

- 3.9.4 The core insulation shall be with cross linked polyethylene insulating compound dry cured, applied by extrusion. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall conform to the properties given in Table-1 of IS: 7098 (Part -2).

- 3.9.5 The insulation screen shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic copper screen. The copper screen for all the three cores together shall be capable of carrying the single line to ground fault current value and the duration specified in the data sheet.
- 3.9.6 The conductor screen, XLPE insulation and insulation screen shall all be extruded in one operation by 'Triple Extrusion' process to ensure perfect bonding between the layers. The core identification shall be by coloured strips or by printed numerals.
- 3.9.7 The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST 2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness. In case of single core cables, there shall be extruded inner sheath between insulation metallic screen and armouring.
- 3.9.8 All cables shall be provided with armour except those specifically specified as unarmoured. For multicore cables, the armour shall be by galvanised steel strips. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS - 3975 and IS - 10810 (Part 41). The dimensions of armour shall be as per method (b) of IS - 7098 (Part -2). For single core cables, the armour shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.
- 3.9.9 The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of Type ST 2 compound of IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS: 7098 (Part-2).
- 3.9.10 The thickness of the insulation, inner sheath shall be governed by values given in IS: 7098 (Part -2).

4.0 CABLE ACCESSORIES

- 4.1 The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this specification and shall meet requirements of IS 13573.
- 4.2 The accessories shall be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.
- 4.3 The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.
- 4.4 The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 45° C, with shelf life extending to more than 5 years.

4.5 Terminating Kits

The terminating kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/ motor. For outdoor terminations, weather shields/ sealing ends and any other accessories required shall also form part of the kit. The terminating kits shall be from one of the makes/ types mentioned in the data sheet.

4.6 Jointing Kits

The straight through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, and ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. The inner sheath similar to that provided for cables shall be provided as part of straight through joint. The jointing kits shall be from one of the makes/ types mentioned in the data sheet.

5.0 INSPECTION, TESTING AND ACCEPTANCE

The cables shall be tested and inspected at the manufacturer's works. Manufacturer shall furnish all necessary information concerning the raw material supply to EIL/ Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality. For HV cables, the vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

5.1 Cables

- 5.1.1 After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. The test reports for all cables shall be got approved from the Engineer before despatch of the cables.
- 5.1.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 1554 (Part-1) and IS: 7098 (Part-2) on PVC and XLPE insulated cables respectively.
- 5.1.3 The test requirements for PVC insulation and sheath of cables shall be as per latest revision of IS: 5831.
- 5.1.4 Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ASTM-G-154 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60 % of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognised test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.
- 5.1.5 Acceptance tests as per IS-1554 (Part-1) and IS-7098 (Part-2) and the following special tests to be performed on the cables as per sampling plan for all cables. However these tests are required to be witnessed by EIL/ Owner for HV cables.
 - a. Accelerated water absorption test for insulation as per NEMA-WC-70. (For PVC insulated cables) and as per NEMA-WC-53 (for XLPE/ EPR insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.

b. Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA-WC-70 at $75 \pm 1^\circ \text{C}$ shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly and once for each order.

c. Oxygen Index Test: The test shall be carried out as per IS-10810 (Part 58). Sampling to be done for every offered lot/size as per sampling plan.

d. Flammability Test: The test shall be carried out on finished cable as per IS-10810 (Part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:

Part-61-The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end

Part-62-The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.

e. Test for rodent and termite repulsion property shall be done by analysing the property by chemical method.

5.1.6 The test for circuit integrity for fire survival cables shall be carried out as per IEC-60331 (Part-21).

5.2 Cable Accessories

Type tests should have been carried out to prove the general qualities and design of a given type of termination/ jointing system as per IS-13573. The type test certificates from independent testing laboratory shall be submitted before despatch.

6.0 PACKING AND DESPATCH

6.1 Cables shall be despatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

6.2 On the flange of the drum, necessary information such as project title, manufacturer's name, type, size, voltage grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.

6.3 Cables shall be supplied in drum lengths as follows:

6.3.1 MV Cables

-	Multicore Power cables upto 6 mm ²	:	1000 m
-	Multicore Power cables from 10 mm ² up to 300 mm ²	:	500 m
-	Single Core Power cables upto 630 mm ²	:	1000 m
-	Control cables upto 61 cores	:	1000 m

6.3.2 HV Power Cables Upto 11kV (E) Grade

-	Three Core cables upto 400 mm ²	:	500 m
-	Single Core cables upto 400 mm ²	:	1000 m
-	Single Core cables above 400 mm ² and upto 1000 mm ²	:	750 m

6.3.3 HV Power Cables Above 11kV (E) Grade and upto 33kV (E) Grade

-	Three Core cables upto 300 mm ² grade	:	350 m
-	Single Core cables upto 400 mm ²	:	1000 m
-	Single Core cables above 400 mm ² and upto 1000 mm ²	:	500 m

However exact drum lengths shall be finalised during order execution. A tolerance of $\pm 3\%$ shall be permissible for each drum. However overall tolerance on each size of cable shall be limited to $\pm 2\%$.