

## WIRES AND CABLES

### PART 1 – GENERAL

#### 1.1 WORK DESCRIPTION

- A. The design manufacture, testing and supply of single core PVC insulated 1.1 KV grade stranded twisted wires under this specifications shall comply with latest edition of following standards.
  - IS-3961: Current rating for cables.
  - IS-5831: PVC insulation and sheath of electric cables.
  - IS-694: PVC insulated cables for working voltage up to and including 1100 volts.
  - IEC-54 (I): PVC insulated cable.
- B. Copper/Aluminium stranded twisted conductor PVC insulated wires shall be used in conduit as per item of work. Aluminium for power cables and copper for control cables shall be used.
- C. The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.
- D. Progressive automatic in line indelible, legible and sequential marking of the length of cable in meters at every one-meter shall be provided on the outer sheath of cable.
- E. The design, manufacture, testing and supply of the cable under this specifications shall comply with latest edition of following standards:
  - IS: 8130: Conductors for insulated electric cables and flexible cords.
  - IS: 5831: HRPVC/HR PVC insulation and LSZH sheath of electric cables.
  - IS: 3975: Mild steel wires, strips and tapes for armouring cables.
  - IS: 3961: Current rating of cables.
- F. The routing and the minimum rated current carrying capacity of the LV power cables shall be as indicated on the Drawings. The Contractor shall consider the manufacturer data and engineering the cable sizing to ensure it suit the conditions, viz grouping, ambient temperature etc., and for making any necessary adjustment to the Engineer's approval.
- G. All LV cables for normal power/control circuitries within buildings shall be copper conductor with XLPE insulated and PVC sheathed, denoted as XLPE/PVC cable or copper conductor with PVC insulated, denoted as PVC cable as specified.
- H. All LV cables for emergency power circuitries serving emergency lightings, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from standby generator sets or UPS systems or incoming and outgoing from the Emergency Main Switchboard shall be fire resistant cables as required.
- I. Cablings in service ducts, open trenches, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall be laid in conduits, trunkings or tray/ladder for mechanical protection.

#### 4.02 STANDARDS

- A. Complete cabling shall be manufactured and constructed in accordance with the latest revision of the following standards :

1.IS: 694:	HRPVC/XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
2.IS: 424-1475(F-3):	Power cable-flammability test.
3.IS: 7098(I):	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.IS: 1554:	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
5.ASTM-D: 2863:	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.ASTM-D: 2843:	Standard test method for measuring the density of smoke from the burning or decomposition.
7.IEEE: 383:	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8.ASTM E: 662/ IEC: 754(x):	Standard test method for specific optical density of smoke generated by solid materials
9.IS: 10418:	Cable drums.
10IS-10810:	Testing method of cable.
11.IS-6121:	Cable glands.
12.IS-9537:	Rigid steel conduit.

- B. The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision;
2. Local codes of practice;
3. Drawings;
4. Specification;
5. International standards and requirements.

#### 4.03 SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
1. Equipment submission with manufacturer's data
  2. Sample submission
  3. Shop Drawings of the cable routings showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included

4. Cable test reports and IS Certification
5. Builder's works requirement
6. Cable schedule indicate the following data include:
  - a. Cable code and type and installation method
  - b. Cable feed from and serve to
  - c. Cable route length and voltage drop
  - d. Cable capacity and
  - e. Upstream protection breaker rating

The cable schedule shall be prepare in according to the cable manufacturer's data..

## PART 2 – PRODUCT

### 2.01 LV CABLES

1. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.
2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
3. The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
4. The cable should withstand 2.5 KA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
5. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
6. Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'LSZH marking in case of 'LSZH cables.
7. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
8. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
9. The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS: 3961.
10. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
11. Outer sheath shall be provided by extrusion process as per IS: 5031.
12. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
13. In plant repairs to the cables shall not be accepted.
14. All the cables shall be supplied in non-returnable drums as per IS: 10418.
15. In Case of LSZH Cables
  - The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD : 2863.
  - The maximum acid gas generation by weight as per IEC:754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.
  - The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD:2843). In case the test for light transmission is conducted as per ASTM:E:662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTM:D:2843.
  - The cable shall pass the fire resistance test as per SS:42, 41, 475 (I) and flammability test as per EEE:383.

A. Inspection:

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

**B. Joints in Cables:**

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilization and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

**C. Joint Boxes for Cables:**

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

**D. Cable Joints:**

1. All cable joints shall be made in suitable, approved cable joints boxes, on the jointing of cables in the joint box and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.
2. End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.
3. All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.
4. Cable lugs shall be tinned copper/aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.
5. Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.
6. Fire resistant paint has to be applied 1 Meter on either side of cable joint.
7. The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

## **2.01 H.T. CABLE (XLPE) (33 KV)**

- A. The cross linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS:7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.
- B. The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.
- C. While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 1200mm for cable upto 33 KV(E) below the ground level in a trench 450mm wide.
- D. After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

**Note:** All other procedure will be followed as per L.T. cables.

## **PART 3 - EXECUTION**

### **3.01 ERECTION OF CABLES**

- A. Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively
- B. The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

### **3.02 CABLE PULLING**

- A. Winching of cables through ducts/pipes shall only be carried out with the approval of the Engineer in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance and under no circumstances and cable shall be run diagonally across a room, cable basement, corridor, etc.
- B. A cable sheath stocking may be employed on cables where no undue stress in the sheath is likely to occur.
- C. Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

### **3.03 CABLE LAYING**

- A. The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.
- B. The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.
- C. In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.
- D. Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally conveyed on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.
- E. Cables laid in trenches in single tier formation, 10 cms. allaround sand cushioning be provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion be provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms. over the outer sides of the end cables.

- F. Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.
- G. PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.
- H. Where the cables are to be laid in ducts (pucca trenches) inside the building, they will have to be laid on MS rack/ on MS cable trays grouted in walls trenches. Cables sizing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.
- I. Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.
- J. Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape & bitumen compound or by any other proven to prevent ingress of water.
- K. After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

### **3.04 INTERNAL WIRING**

- A. All the wiring installation shall be as per IS:732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts grade. Colour Code for wiring shall be followed.
- B. Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the consultant. No reduction of strands are permitted at terminations. No wire smaller than 1.5 sq.mm shall be used and shall be as per B.O.Q. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for submains, sub-circuit wiring. The ferrules shall be provided at both end of each submain and sub-circuit.
- C. Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.
- D. All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

- E. Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

### 3.05 Fire Seal System

- A. All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.
- B. The fire proof sealing system shall fully comply with the requirements of relevant IS/BS:476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.
- C. The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antiodent and anti-termite.
- D. The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.
- E. Type of fire proof seal system shall be foaming type or flamemastic type compound or approved equivalent.
- F. After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.
- G. Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.
- H. Cable shall be installed so that separations shown in the table below are observed.
 

1. HV Cable (33 KV)	-	HV Cable (33 KV)	50 mm
2. ELV & LV 230 V/433 V	-	ELV & LV cable 230 V/433 V	50 mm
3. HV cables (33 KV)	-	ELV & LV cables 230 V/433 V	300 mm
4. LV cables 433 V	-	Telephone/Instrument cable	350 mm
5. All cables	-	All hot pipe work	200 mm

### 3.05 FACTORY TESTS

- A. Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.
- B. Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.
- C. The type test shall include the following test:
  - 1. Partial discharge test;
  - 2. Bending test, plus partial discharge test;
  - 3. Tan  $\delta$  measurement as a function of the voltage and capacitance measurement;
  - 4. Tan  $\delta$  measurement as a function of the temperature;
  - 5. Heating cycle test plus partial discharge test ;
  - 6. Impulse withstand test, followed by a power frequency voltage test;
  - 7. Medium-voltage alternating current test;
  - 8. Type test (non-electrical) as stipulated in IEC 502, Table VI.
- D. Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests:
  - Measurement of the electrical resistance of conductors.
  - Partial discharge test,
  - 4-hour MV test.

**3.06 SITE ACCEPTANCE TEST**

- A. The Contractor shall supply all necessary testing equipment for site testing. When required, these testing equipment shall be calibrated at the expense of the Contractor at a recognized national laboratory.
- B. The Contractor shall engage an Authorised Medium Voltage Testing Engineer who is recognised by SEB to perform all site tests.
- C. In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:
  - 1. Continuity test,
  - 2. Earth test,
  - 3. Polarity test,
  - 4. Insulation resistance test,
  - 5. DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

**END OF SECTION**