CHAPTER-2: HT, LT POWER & CONTROL CABLES

1.0.0 INTENT OF SPECIFICATION

This specification covers Design, engineering, manufacture, assembly and testing at works, packing/dispatch and transportation to site with Transit Insurance, delivery of HT Power & LT Power & Control Cable as specified for efficient and trouble-free operation of Proposed Plant.

To maintain voltage at motor terminals /equipment end with in desirable limit, it is proposed to limit the voltage drop in the cables with in the following limits:

- Steady state Voltage drop (Continuous running condition) : 3 %
- Transient state voltage drop (During Motor Starting) : 10%

2.0.0 HT CABLE

2.1.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, IEC publications and any other standards of latest edition including amendments, except where modified and /or supplemented by this specification.

IS 3975	Mild steel wires formed wires and tapes for armouring of cables.
IS 4905	Methods for random sampling.
IS 5831	PVC insulation and sheath of electric cables.
IS 7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltages upto and including 33 kV. (Part-II)
IS 8130	Conductors for insulated electric cables and flexible cords.
IS 1885	Cables, Conductors and accessories for electricity supply.
IS 10418	Drums for electric cables.
IS 10810	Methods of tests for cables.
IS 401	Code of Practice for Preservation of Timber
ASTMD 2863	Standard methods for measuring the min. oxygen concentration to support candle like combustion of plastics.
ASTM 2843	Standard test method for Density of smoke from the burning or Decomposition of plastics.
IEC 754-I	Test on Gases evolved during combustion of electric cable.
IEC 60332	Test on electric cables under fire condition
IS 1554	PVC insulated (heavy duty) Electrical cable Part-2 for working voltages from 3.3KV up to and including 11KV (Second Revision)

2.2.0 TECHNICAL REQUIREMENTS

Cables shall be capable of operating satisfactorily under the power supply and frequency variations, high ambient, high humid tropical climatic conditions as specified in project information.

Copper tape/Aluminium wire shield shall be capable of carrying system earth fault current as stated below:

- 11/11 kV Cables : 400 A for 3 second

Method of curing for XLPE insulation shall be **gas/steam curing**. (Gas curing is preferred)

The Cables are proposed to be laid in multi-tier overhead cable racks, in concrete cable trenches, directly buried in soil.

All the cables shall be flame retardant low smoke (FRLS) type designed to withstand mechanical, electrical and thermal stresses developed under steady state and transient operating conditions.

XLPE insulation shall be suitable for continuous conductor temperature of 90° C and short circuit conductor temperature of 250° C. The insulation material shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

Colour coding shall provide core identification of multicore cables.

The cable cores shall be laid up with fillers between the cores wherever necessary. All the cables shall have distinct extruded PVC inner sheath, except single core cables.

Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.

For armoured cables, armouring shall be of aluminium for single core armoured cables. For multicore armoured cables, armouring shall be of galvanized steel.

To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have low smoke, non-propagating, and self-extinguishing characteristics. Outer sheath shall be of PVC blue in colour. These cables shall meet the following test requirements.

- Oxygen index of minimum 29 (As per ASTMD 2863).
- Temperature index of minimum 250° C.
- Acid gas emission of max. 20% (As per IEC 754-1)
- Average light Transmission- 40% minimum (Average Smoke Density- 60% Max.) as per ASTM 2843
- Flame test requirements of IEEE 383
- Flame test requirements of IEC-332 Part 3,

All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.

In plant repair of cable shall not be acceptable. Damaged cable shall be removed from the site. Both ends of cables shall be sealed with heat shrink PVC/rubber caps.

Three core HT cables shall constitute the following as per IS: 7098 Part-II.:

- Circular Stranded and compacted Aluminium Conductor
- Extruded Semi conducting compound as Conductor Screen
- Extruded XLPE insulation
- Extruded Semi conducting compound as insulation Screen
- Copper tape as metallic screen for each core
- Extruded PVC inner sheath
- Galvanised steel formed wire (strip) (for armoured cables only)
- Extruded FRLS PVC outer sheath

Single core HT Cables shall constitute the following as per IS: 7098 Part-II.:

- Stranded and compacted Aluminium Conductor
- Extruded Semi conducting compound as Conductor Screen
- Extruded XLPE insulation
- Extruded Semi conducting compound as insulation Screen
- Metallic Screen (for unarmoured cables)
- Hard drawn aluminium wire armour (for armoured cables only)
- Extruded FRLS PVC outer sheath

No separate metallic screen for insulation is required, in case of single core armoured cable, as Armour constitute the metallic screen.

3.0.0 LT POWER & CONTROL CABLE

3.1.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, IEC publications and any other standards of latest edition including amendments, except where modified and /or supplemented by this specification.

IS 3975	Mild steel wires formed wires and tapes for armouring of cables.
IS 4905	Methods for random sampling.
IS 5831	PVC insulation and sheath of electric cables.
IS 7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltages up to and including 33 kV. (Part-II)

IS 8130	Conductors for insulated electric cables and flexible cords.
IS 1885	Cables, Conductors and accessories for electricity supply.
IS 10418	Drums for electric cables.
IS 10810	Methods of tests for cables.
IS 401	Code of Practice for Preservation of Timber
ASTMD 2863	Standard methods for measuring the min. oxygen concentration to support candle like combustion of plastics.
ASTM 2843	Standard test method for Density of smoke from the burning or Decomposition of plastics.
IEC 754-I	Test on Gases evolved during combustion of electric cable.
IEC 60332	Test on electric cables under fire condition
IS 1554	PVC insulated (heavy duty) electric cables: Part 1 For working voltages up to and including 1100 V

3.2.0 TECHNICAL REQUIREMENTS

Cables shall be capable of operating satisfactorily under the power supply and frequency variations, high ambient, high humid tropical climatic conditions as specified in project information.

The Cables are proposed to be laid in multi-tier overhead cable racks, in concrete cable trenches, directly buried in soil.

All the cables shall be flame retardant low smoke (FRLS) type designed to withstand mechanical, electrical and thermal stresses developed under steady state and transient operating conditions.

XLPE insulation shall be suitable for continuous conductor temperature of 90° C and short circuit conductor temperature of 250° C. The insulation material shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

Number coding is to be used for cables having more than 5 cores. For cables below 5 cores, colour coding can be used.

The cable cores shall be laid up with fillers between the cores wherever necessary. All the cables shall have distinct extruded PVC inner sheath, except single core cables.

For armoured cables, armouring shall be of aluminium for single core armoured cables. For multicore armoured cables, armouring shall be of galvanised steel.

To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have low smoke, non-propagating, and self-extinguishing

characteristics. Outer sheath shall be of PVC black/blue in colour. These cables shall meet the following test requirements.

- Oxygen index of minimum 29 (As per ASTMD 2863).
- Temperature index of minimum 250° C.
- Acid gas emission of max. 20% (As per IEC 754-1)
- Average light Transmission- 40% minimum (Average Smoke Density- 60% Max.) as per ASTM 2843
- Flame test requirements of IEEE 383
- Flame test requirements of IEC-332 Part 3,

All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.

In plant repair of cable shall not be acceptable. Damaged cable shall be removed from the site. Both ends of cables shall be sealed with heat shrink PVC/rubber caps.

Multi core 1.1 KV XLPE Cables shall constitute the following as per IS: 7098 Part-I.:

- Stranded and compacted Aluminium Conductor
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel Strip/ Wire armour (for armoured cable only)
- Extruded FRLS PVC outer sheath

Single core 1.1 KV XLPE Cables shall constitute the following as per IS: 7098 Part-I.:

- Stranded and compacted Aluminium Conductor
- Extruded XLPE insulation
- Hard drawn aluminium wire armour (for armoured cable only)
- Extruded FRLS PVC outer sheath.

Multi core 1.1 kV PVC Cables shall constitute the following as per IS: 1554 Part-I:

- Stranded and compacted Aluminium / Copper Conductor as specified.
- PVC insulation
- Extruded PVC inner sheath
- Galvanized steel strip/wire armour (for armoured cable only)
- Extruded FRLS PVC outer sheath

4.0.0 Cable identification system

In addition to manufacturer's identification on cables as per IS, following marking shall also be printed/ embossed on the outer sheath at an interval of **One metre** throughout the length of Cables.

- Manufacturer's Name and or Trade name.
- Year of Manufacture
- Cable code

- Type of Cable & Voltage class.
- Nominal cross section area of Conductor & no. of cores.
- Progressive sequential length marking.
- Drum Number

Cables shall be marked either with printing or embossing as having FRLS outer sheath at every 5 meters.

The printing/ embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

Multi-core cable color coding shall be as follows:
a) Red, yellow & blue for three core cables
b) Outer sheath shall be of black colour for Aluminium Cable and Blue for Copper cable.
c) For cables having more than 5 (five) cores, the core marking shall be by numbering.

5.0.0 Cable drums

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. Wooden drums shall comply with IS 10418.

All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit & storage. All wooden parts shall be manufactured from durable quality wood duly seasoned & treated with copper Nepthenates or zinc Nepthenates for preserving the wood (Ref. IS: 401). The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by `U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

Each drum shall carry manufacturer's name, Owner's name, address and contract number item number and type, size and length of cable and net and gross weight stencilled on both side of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled. The standard drum length shall be 500 M.

The tolerance on the dispatched cable length on each drum verified and accepted by Inspector shall be limited to (±2%) of standard drum length. However, the overall tolerance on the total dispatched quantity of each size shall be (-)2% and (+)2%. Cable consumed for testing & inspection will be to bidder's account.

A clear space of min. 40 mm shall be left between the cables & logging.

Cable overall diameter tolerance shall be less than ±2.0 percent. Eccentricity of the cable core shall not exceed 10 percent and the ellipticity of the cable core (insulated aluminium conductor) shall not exceed 2 percent.