



16. CABLING SYSTEM

16.1. Scope of Work

Scope of work under this section covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Owner's personnel, handing over to NHPC and guarantee for two years of cabling system as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

16.1.1. Cables and accessories

- i) 11 kV XLPE power cable (High voltage cable),
- ii) 600/1000 volt grade power cable (Low voltage cable),
- iii) Control cables,
- iv) Instrumentation cables,
- v) Cable terminals, termination kits, cable lugs, cable glands, button tape (strap and stud), and cable junction boxes and all other accessories.

16.1.2. Cable routing and support systems

- i) Cable trays, connectors, hardware etc.
- ii) Flexible/adjustable cable support system including pre-fabricated structures/fixtures, strut channels, embedment, hardware etc.
- iii) Cable ducts, conduits, channels, joints etc.

Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

16.2. Specific Parameters and Layout Conditions

16.2.1. Layout and General Arrangement

The 11kV power cables shall be required to interconnect the following:

- ◆ One (1) nos. 33/11kV Power transformer to 11kV panels,
- ◆ Two (2) nos. 1.0 MVA DG sets to 11 kV panels,
- ◆ One (1) nos. 11kV incoming supply to 11kV panels,



- ◆ Two (2) nos. outgoing from 11 KV Panels to 1.5 MVA, 11/0.415kV SSTs,
- ◆ One (1) no. outgoing from 11 KV Panels to 250 KVA, 11/0.415kV Switchyard Auxiliary Transformer,
- ◆ One (1) no. outgoing from 11 KV Panels to 250 KVA, 11/0.415kV Transformer at Valve House

The 415V/ 240V AC and 220V/ 48V DC cables shall be required to connect / interconnect all the equipment as per the scope of complete E&M package in power house complex, transformer cavern, switchyard surge shaft gallery/ switchyard/ butterfly valve house and other area in the vicinity of power house such as fire tank etc which shall include:

- Different auxiliary/station service boards,
- Various distribution boards to local control cubicles/ equipment.

Control, instrumentation, coaxial and communication cables shall include all cables required for the installation of the complete instrumentation, control, protection and communication systems in the power house complex, surge shaft gallery and other area in the vicinity of power house such as fire tank etc.

16.2.2. Design considerations

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

However, minimum sizes for the following cables conductor shall be taken as:

- ◆ 2.5 mm² copper for control cable conductor,
- ◆ 1.5 mm² copper for annunciation and RTD cable conductor,
- ◆ 4 core x 6 mm² copper for connection between CT junction boxes and panels having red, yellow, blue and black colour cover,
- ◆ 4 core x 4 mm² copper for connection between PT junction boxes and panels having red, yellow, blue and black colour cover.

The cables covered by this specification shall be supplied in one length or in standard length as approved by the Owner.

Normally all LV cables will be un-armoured and will be laid in cable trays. However any cable laid directly (without cable tray/pipe etc.) either underground or overhead shall be of armoured type. The armouring shall always be earthed at one end to ensure that it can not become live if a fault develops within the cable.

16.3. Rating and Functional Characteristics

i) Power and control cables

The power and control cables shall have the following properties:



- ◆ Oxygen index Min. 29,
- ◆ Smoke density Min. 40% light transmittance,
- ◆ Acid gas Max. 20% by weight,
- ◆ Flame propagation shall meet IEC 60332-1, IEEE 383.

16.4. Performance Guarantee

The power and control cabling system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

16.5. Design and Construction

16.5.1. Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IEC 61537	Cable tray systems and cable ladder systems for cable management
IEC 60331	Tests for electric cables under fire conditions
IEC 60332	Test on electric and optical fibre cables under fire conditions
IS 1554	Specification for PVC insulated (heavy duty) Electric cables
IS 7098	Specification for cross linked polyethylene insulated PVC sheathed cables
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating

16.5.2. Cables

16.5.2.1. Power cables –11kV system

11kV power cable shall be of heavy duty, stranded circular copper conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inter sheathed and armoured. The insulation and screening shall be extruded, semi-conducting and with copper tape screening (at least 0.075 mm thickness).



16.5.2.2. Power cables - 600/1000 volt grade

i) Single core cables

These cables shall be at least 600/1000 volt grade, heavy duty, single core, stranded Aluminium / Copper conductor, HR-PVC insulated and PVC sheathed. The outer sheath shall be of specially formulated PVC compound.

ii) Multi core cables:

The cable shall be at least 600/1000 volt grade, heavy duty multi core, stranded Aluminium conductor, HR-PVC insulated, colour coded, laid up, inner sheathed with extruded PVC, 2/3.5 cores.

16.5.2.3. Control and instrumentation cables

The control and instrumentation cables shall be multi core, colour coded, annealed stranded high conductivity Copper, single conductor, insulated with HR-PVC insulation, PVC sheathed. The outer sheath shall be of specially formulated PVC compound.

16.5.3. Colour scheme and identification

To facilitate easy identification of phases a colour scheme of red, yellow and blue for phases and black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for identification of cores as per IS: 1554 1988 / IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least three (3) meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information. Permanent sequential marking to indicate length of the cable shall be embossed at every meter along with Owner's name (NHPC).

16.5.4. Accessories

16.5.4.1. Termination kit

The termination kits required for 11kV XLPE cables terminations shall be heat shrinkable type. Any other latest type having proven performance in the field can also be accepted subject to approval of Owner.

The Contractor shall supply all hardware consumables such as plumbing metal, sealing compound, tapes and other materials required for the making of these terminal connections of various sizes of cables and should leave at least 5% of these items for future use by the Owner.

16.5.4.2. Cable lugs

The Contractor shall ensure that no bimetallic action takes place, between the conductor of the cable and the cable-connecting lug by filling the lugs



with suitable compound. The lugs shall be of standard quality conforming IEC / IS and of make approved by the Owner.

16.5.4.3. Cable glands

The cable glands shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. Glands shall provide neat, tight, dust and vermin proof termination. Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

16.5.4.4. Compression type terminals for control wiring

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of Copper electro tinned.

16.5.4.5. Button tape (strap and stud)

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

16.5.4.6. Self adhesive marker

Self-adhesive marker in the form of strips of any one character, which can be easily peeled from the backing cards and can be applied on the cable, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per cable schedule such that each core of each cable can be identified easily.

16.5.4.7. Aluminium strip

Aluminium strip of adequate size for making tags for labels shall be supplied.

16.5.5. Cable trays and support structure

The cable trays including accessories like bends, elbows, tees, cross etc. shall be of perforated (long slots) type, for proper ventilation of the cables, made out of 14-gauge mild steel sheet. The trays shall have minimum 50 mm edge height.



The cable trays shall be fully galvanized and the Owner reserves the right to test galvanizing as per approved standard in presence of its representative.

Stainless steel cable trays shall be provided for humid premises and the area prone to water dripping and spray.

Supports and screws and bolts for cable trays shall be made of the same materials as the cable trays they support.

Tray support system shall be flexible/adjustable type having pre-fabricated sections and supports that can be assembled and bolted for quick and easy installation.

Trays provided in tiers shall have minimum 300 mm spacing between tiers.

Ladder type tray with double bends may be used wherever required.

16.5.6. Fire proofing

Cables passing through different fire zones shall be provided with fireproof barriers with the same fire rating as the penetrated walls or partitions.

16.5.7. Cable junction boxes

Junction box shall be constructed of sheet steel of thickness not less than two (2) mm. Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits.

Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness.

16.5.8. Terminal blocks

Terminal blocks shall be in accordance to clause 1.5.2.5 "Electrical equipment" of "Section 1- General Technical Requirements".

16.6. Drawings, Documents and Design Calculations

16.6.1. Design memorandum

The Contractor shall submit to Owner a design memorandum prepared in accordance to clause 1.6 "Record and Documentation" of "Section 1- General Technical Requirements."



16.6.2. Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 2 - Technical Documents" of "General Technical Specification (GTS)".

16.6.3. Design calculation

The Contractor shall submit the design calculation in accordance to Clause 2.6 of "General Technical Specification (GTS)" covering at least the following, for review / acceptance.

- ◆ Calculation for fault level and short circuit calculation for selecting the cable size,
- ◆ Cable schedule.

16.7. Delivery, Installation and Commissioning

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.7 "Delivery, Installation and commissioning" of "Section 1 - General Technical Requirements."

16.7.1. Construction methodology

16.7.1.1. Fixing of supports

The fixing arrangement shall be approved by the Owner. Strut channels shall be embedded for fixing of the supports and shall be provided, installed and supervised during concreting for correctness of positioning and alignment by the Contractor. Anchor fasteners shall be used wherever required to fix the anchors / supports. Field welding for support system shall not be allowed except fixing of strut channels / supports to embedment. All such welds shall be treated with galvanized compound. Welding to cable trays in any case shall not be allowed.

16.7.1.2. Cable routing

For the main cableways, a system of cable racks and trays as well as cable ducts and trenches shall be provided.

The cables for emergency lighting, fire alarm systems, etc., shall be run on separate trays.

The 11kV XLPE cables, power and control cables shall be run separately on racks/trays, in cable trenches/cable tunnels and on columns, walls, ceiling and pulled through pipes. The Contractor shall be responsible for carrying out proper dressing of the cables and supply non-magnetic/moulded fiber-glass cable fixing cleats, fasteners and clamps wherever necessary to hold the cables firmly to the trays.

Contractor shall take proper care in the handling of cables against external damage of any kind. Necessary rollers etc. shall be used while



pulling and laying of the cables. Owner shall have the right to stop the work in case of improper handling of the cables.

Cables shall be properly clamped at regular intervals with the help of non-magnetic/moulded fibreglass strip clamps/PVC sleeved clamps, of suitable size. Contractor shall submit typical drawings along with tender giving proposed clamping arrangement and give distance of clamping at bends and in regular run of cables.

16.7.1.3. Cable markers and cable binding

Suitable cable markers of Aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable could be easily identified.

16.7.1.4. Cable binding/strapping

All control cables after glanding shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

For L.T. Power cables, suitable holding clamps will be provided in the panel if required.

The Contractor shall do the cable glanding suitable for each cable size at both ends of termination of each cable.

16.8. Spare Parts

Recommended spare parts shall be supplied in accordance to clause 1.8 "Spare Parts" of "Section 1 - General Technical Requirements". Specified spare parts to be supplied under this section are as follows:

S. No.	Description	Quantity
1	Cable 11kV	10 % of installed quantity
2	LV power cable of each type	10 % of installed quantity
3	Control cable of each type	10 % of installed quantity
4	Communication cable of each type	10 % of installed quantity
5	Termination kits -11kV Outdoor type Indoor type	10 % of installed quantity 10 % of installed quantity
6	Lugs of each size	10 % of installed quantity
7	Coaxial cables	10 % of installed quantity
8	Cable glands of each size	20 % of installed quantity
9	Junction boxes of each size	20 % of installed quantity



10	Cable tray of each size	10 % of installed quantity
11	Cable supports, hardware etc.	20 % of installed quantity

16.9. Tools and Instruments

The Contractor shall supply all necessary tools and instruments etc. for installation, repair and maintenance in accordance to clause 1.9 "Tools and Instruments" of "Section 1 - General Technical Requirements".

16.9.1. Special tools

The Contractor shall propose the list of special tools including their make and detailed specification as recommended by manufacturer(s), to be accepted by the Owner.

The proposed list of special tools must include the following in addition to tools recommended by manufacturer(s)

- ◆ Two (2) sets of hydraulically operated crimping tools,
- ◆ Two (2) sets of control cable crimping tools,
- ◆ Two (2) sets of wire cutters for all sizes of cables,
- ◆ Two (2) sets of wire strippers for all sizes of cables.

16.10. Quality Assurance and Testing

The Contractor shall follow the quality assurance and testing requirements specified separately in "Quality assurance and Testing Specifications (QTS)".