SECTION-B 2.1

HT CABLES

2.1.1 PREAMBLE

A. In line with the requirements of the Mumbai Fire Brigade (No FB/HR/City/155, date 04/07/2010) the following items shall incorporated into the electrical design. The Contractor shall make full allowance for these requirements in his overall electrical tender return:

- Electrical cables shall be low smoke fire resistance, non flammable, and non toxic type in electrical shafts. PVC cables shall have an additional sheathing or protection provided by components sprayed on after installation

2.1.2 SUMMARY

A. General: This section of specification defines the technical requirements for HT Cables, as specified in accordance with the requirements of the Contract Documents and codes having jurisdiction.
B. Scope of work: Design, Manufacture, Inspection, Testing at Manufacturer's Works, Delivery to Site and Commissioning HT Cables, complete as specified in the schedule of requirement meeting the intents of the Tender. This specification shall be used in conjunction with all drawings, Schedule of requirement and BOQ attached. Scope of work includes supervision of erection, testing and commissioning services.
C. Codes & Standards: The cables shall be designed, manufactured and tested in accordance with the latest applicable sections of the IEC standards or the National Standards as listed. Since IS Standards are originated from IEC standards, technical requirements listed in the latest IEC standards supersedes IS standards requirements which do not cover them.
D. Requirements of IEC/ANSI or any other internationally recognised standard which ensure a quality equal to or better than as per the standards indicated below shall also be acceptable. When the product conforms to any other standards, salient points of difference between the standards adopted and those prescribed in this specification shall be clearly brought out in the tender and a copy of the applicable standards(s) in English language shall also be enclosed by the supplier with the tender.

IEC 60183 & Am1	Guide to the selection of high voltage cables
IEC 60228	Conductors of insulated cables. Guide to the dimensional limits of circular conductors.
IEC 60331 Parts11 & 21	Fire resisting characteristics of electric cables.
IEC 60332 Part 4-10	Tests on electric cables under fire conditions. Part 4: Tests on bunched wires or cables.
IEC 60502part 2&4	Extruded solid dielectric insulated power cables for rated voltages from 1kV to 40 kV.
IEC 60754 Part 1	Test on gases evolved during combustion of materials from cables. Part 1: Determination of the amount of halogen acid gas evolved during combustion of polymeric material taken from cables.
IEC 60811 Parts 1 & 2	Common test methods for insulating and sheathing materials of electric cables.
IEC 60885 Parts 1, 2 & 4	Electric test methods for electric cables.
IEC 60304	Standard colours for insulation for low frequency cables and wires.
IEC 61034 Parts 1 & 2	Measurement of smoke density of electric cables burning under defined conditions.
IEC 60028	International Standard of Resistance for Copper
IEC 60060	High Voltage Test Techniques - Part I: General Definitions and Test Requirements.
IEC 60230	Impulse Tests on Cables and their Accessories.
IEC 60986	Guide to the short circuit temperature limits of electric cables with a rated voltage from 1.8/3 (3.6) kV to 18/30 (36) kV.
IEC 60287	Electric Cables - Calculation of the current rating.
BS 8519:2008	Selection & installation of fire-resistant power and control cable system for life safety and fire fighting application –Code of practice.
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits - BS EN 50200 with a 930°C flame and with water spray (+A2:2009)

BS 8491:2008	Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems
Indian Standards	
IS- 1554 : 1988	PVC insulated (heavy duty) electric cables.
IS- 7098 : 1988	Crosslinked polyethylene insulated PVC sheathed cables.
IS 10418	Drums for electric cables
IS- 5831 : 1984	PVC insulation & sheath of electric cables.
IS- 10810 : 1984	Methods of test for cables.
IS- 8130 : 1984	Conductors for insulated electric cables and flexible cords.
IS- 3975 : 1988	Mild steel wires, formed wires and tapes for armouring of cables.

2.1.3 SUBMITTALS

A. Technical Data: Submit data for approval including, but not limited to, the following:

- Constructional details, standards to which cables comply, current carrying capacities, de-rating factors for grouping and temperature
- Manufacturer's catalogue cuts
- Dimensional and electrical characteristics
- Joints and terminations.

B. Samples of each cable and, if requested by the Engineer, other accessories.

C. Shop and Construction Drawings: Submit Drawings for approval including, but not limited to, the following:

- Exact routing layouts, with relevant sections showing coordination between various trades.
- Details of supports and fixings for trays and cables.
- Details of connections to transformers, switchgear, etc.
- Details of terminations, splices and tapings where permitted, glands and bushings at enclosures.
- Joints and terminations.

D. Certificate of Origin: For each lot of cable supplied, provide a certificate of origin issued by manufacturer stating origin, date of manufacture, composition, Standards to which it complies and test certificates. All test certificates are to comply with the test requirements of the relevant standard to which the cable is manufactured, (i.e. type).

E. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed electrical ducts, and manholes, in accordance with requirements.

F. Product Certificates: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

G. Routine tests at factory.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

J. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

K. Maintenance Data: For cables and accessories to be included in the maintenance manuals.

2.1.3 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, those specified in Section G.

2.1.4 CABLE CONSTRUCTION

A. Cable construction shall be as detailed below.

Abbreviations:

PVC	Polyvinyl-chloride	
XLPE	Cross linked polyethylene	
SWA	Single Wire Armoured	– (Galvanised steel flat or round wire armour for multicore cables.) – (Aluminium wire armour for single core cables.)
PE	Polyethylene	
FRLS	Fire Retardant Low Smoke	

A **For normal load application**

Cable Type: XLPE. SWA. PVC. 11 kV, grade.

Rated Voltages: 11/11 kV, (IS 7098 part 2),

System Voltages: 11 kV, 3 phase, U=11kV, Uo=11kV

Service: Power distribution

Construction:

Conductors (As specified in the material requisition)
Annealed stranded Aluminium, circular or shaped section.

Core Screen
Extruded semi-conducting compound.

Insulation
XLPE

Insulation Screen
Semi-conducting layer: Extruded compound, cold strippable for
11/11 kV grade cable.
Metallic layer: Copper tape

Core Identification
Colours
1 core – Natural
4 core – As per NEC 2011 colour code requirements

Laying Up
Cores to be laid up together with non hygroscopic fillers

Bedding
Extruded PVC, ST-2

Armouring

Multi core cables - single layer of galvanised steel wires (round or flat)
Single core cables - single layer of aluminium wires

Over sheath
Extruded PVC, ST-2 colour Black.

B **For Emergency/Fire Load application**

Cable Type: FR (PH120) XLPE. SWA. PVC. 11 kV, grade.

Rated Voltages: 11/11 kV, (IS 7098 part 2),

System Voltages: 11 kV, 3 phase, U=11kV, Uo=11kV

Service: Power distribution

Construction: Conductors (As specified in the material requisition)
Annealed stranded Aluminium, circular or shaped section.

Core Screen
Extruded semi-conducting compound.

Insulation
Glass mica fire barrier tape covered by an extruded layer of cross linkable halogen free Ethylene Propylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1,BS 8519 latest edition.

Insulation Screen
Semi-conducting layer: Extruded compound, cold strippable for
11/11 kV grade cable.
Metallic layer: Copper tape

Core Identification
Colours
1 core – Natural
4 core – As per NEC 2011 colour code requirements

Laying Up
Cores to be laid up together with non hygroscopic fillers

Bedding
Extruded PVC, ST-2

Armouring
Multi core cables - single layer of galvanised steel wires (round or flat)
Single core cables - single layer of aluminium wires

Over sheath

Cross linkable halogen free Ethylene Propylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1,BS 8519 (latest edition) suitable for maximum conductor temperature 850ºC

a. Cable cross sectional area, conductor material, number of cores, rated voltage and type shall be as stated in the contract documents.
b. The cable shall be multi-core and outer sheath should have high resistance to flame propagation.
c. Cable fillers shall be solid, non-hygroscopic and fill the cable cross section to form a compact and reasonably circular cable. Any one of the two types of inner sheath materials, ST1 or ST2 compound as per IS-5841 shall be used in multi core power cables. Filler materials used to fill up the interstices space between the power cable cores, under the inner sheath shall be PVC or Polypropylene fillers, such that the transmission of gas and hydrocarbons along the length of the cable, under normal pressure is not possible and shall prevent /reduce the water propagation through the cable. The properties of the Filler material shall be same as that of the inner sheath ST1 or ST2.
d. The outer sheath of cables shall be embossed or engraved with
    - The voltage designation
    - Manufacturers identification
    - Number of Cores and nominal cross sectional area of conductors
    - The drum progressive length of cable at every metre. (The starting point being the cable end at its inner coil on the cable drum)
    - In case of XLPE insulated PVC sheathed cables, cable filler, inner and outer sheath shall confirm to ST-2 compound as per IS-5841. The inner sheath shall be applied over laid cores by extrusion.
e. Cable shall have uniformity in insulation and outer sheath colour. The XLPE insulation and insulation screen shall be extruded in one operation by triple extrusion process.
f. The insulation of the cable shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cables shall be of high standard quality. The thickness of the insulation shall not be less than that specified in the relevant standards.
The cable should also offer a specially formulated Flame Retardant Low Smoke compound (FRLS) for outer sheath. Suitable additives be added to prevent attack by rodents and termites. All serving must be given anti-termite treatment. The thickness of the sheaths shall be as per relevant standards.

2.1.5 SPLICE KITS

A. Connectors and Splice Kits: Comply with recommended by cable or splicing kit manufacturer for the application.
B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

2.1.6 SOLID TERMINATIONS

A. Multi conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
    - Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable [**with**] [**without**] external plastic jacket.
B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

2.1.7 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 486, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

2.1.8 DELIVERY, STORAGE, AND HANDLING

A. Cables shall be drummed in maximum continuous lengths on:
   - Returnable steel drums for all H.T. cables of large cross sectional areas or long drum lengths.
   - Non-returnable wooden drums where the manufacturer can guarantee that such drums are of sufficient strength to protect cable during shipping, handling and outdoor storage for three year period.

B. Cable ends shall be sealed and fixed to the drum so that both ends are accessible. To protect the cable during shipment battens shall be fitted around the entire periphery of the drum. Drums shall be suitable for long-term outdoor storage at site.

C. All cable drums shall have the Purchase Order Number, Purchase Order Item Number, Drum Number and Stock Code Number clearly stencilled on the outside of both flanges.

D. Drum identification labels shall be of non-corrosive, non-hygroscopic material and attached to the outside and inside of the drum flanges. Labels shall be protected by transparent plastic envelopes and give the following information:
   1. Drum identification number and its direction of rotation for cable removal.
   2. Cable voltage grade
   3. Cable construction (e.g. PVC SWA PVC or AYFY, PH120)
   4. Number of cores and cross sectional area
   5. Cable quantity (Metres)
   6. Purchase order number and item number
   7. Total weight of cable and drum (kg)
   8. Manufacturer's name
   9. Year of manufacture
   10. Stock code number

E. The Seller shall provide the following data with his quotation:
   1. Standard and maximum drum lengths for all the types of cable offered and his proposed drum lengths for all items.
   2. Inspection test plan.
   3. Cable dimensions (together with tolerances) as follows:
      1. Diameter of (individual in case of multi stranded) conductor wire
      2. Percentage of compaction as per data sheet.
      3. Diameter under conductor screen (where applicable)
      4. Diameter over conductor screen (where applicable)
      5. Diameter over individual core insulators
      6. Lay of cable in case of multi-core cable
      7. Diameter over inner sheath (mm)
      8. Diameter over centre sheath (mm)
      9. Diameter over lead sheath (mm) where applicable
      10. Diameter under armour (mm)
      11. Diameter over armour (mm)
      12. Diameter of armour wires (mm)
      13. Overall diameter (mm)

   4. Cable Physical Properties
      1. The filler materials to be used.
      2. Cable weight in kg/km
      3. Minimum bending radius (x OD)
      4. Maximum conductor continuous operating temperature (℃)
      5. Suitability of outer sheath to resist attack from chemicals.

   5. Cable electrical data as follows:
      1. Conductor dc resistance per km at 20℃
      2. Conductor ac resistance per km at operating temperature and system frequency
      3. Conductor inductive reactance per km at system frequency
      4. Conductor impedance per km at operating temperature and system frequency

5. Conductor capacitance per km
6. Cable armour resistance per km

F. The current carrying capacity of single and multi-core cables when installed in defined conditions in air, in ducts and direct buried in the soil, together with rating factors for varying ambient temperatures, grouping and installation conditions and methods.
G. Cable short circuit withstands capacity presented in graphical form or by formulae.
H. Descriptive literature (catalogues etc.).
I. Cross sectional view of the physical make up of each cable.
J. Recommended temperatures below which installation of cable should not be carried out.
K. Minimum ambient temperature at which cables can be used.
L. Maximum pulling force for each cable and any special pulling instructions.
M. Maximum unsupported run of cable both horizontally and vertically.

2.1.9 SERVICE CONDITIONS

A. The cables shall in all respects be suitable for operation under the service conditions stated in the attachments to the Material Requisition. They shall have a design life of at least twenty years.
B. All armoured cables shall be suitable for operation when installed:
   1. Direct buried in the ground (including waterlogged ground).
   2. In underground ducts.
   3. Above ground, fastened to cable ladder rack or tray in the open air exposed to direct sunlight.
   4. Below ground in enclosed, air filled trenches, fastened to cable ladder rack or tray.

2.1.10 INSPECTION & TESTING AT MANUFACTURER'S PREMISES

Following Routine Tests shall be witnessed by the Buyer/ his authorized representative at the manufacturer's shop:

A. General Arrangement check of the entire system components
B. Tests recommended by the Supplier as a part of Routine test
C. Fire Resistance Test.
D. All the expenses towards the Inspection or witnessing the testing of equipment by the Lodha **Representative** will be in the **Contractors** scope excluding boarding and lodging of Lodha Representative.
E. The **Contractor** /Manufacturer shall submit detailed Quality Assurance plan (QAP), Inspection Test Plan (ITP) & test procedures for review/approval of Lodha.
F. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.
G. The results of all tests carried out shall be tabulated and signed jointly by manufacture and Engineer-in-charge. In case the test results are not satisfactory and in accordance of contract specification and there are defects in the materials the same shall be attended and notified to Engineer-in-charge. The equipment shall be dispatched to site of work only after receipt of acceptance of materials and clearance from Engineer-in-charge.

2.1.11 EXECUTION

2.1.11.1 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.

2.1.11.2 CABLE PULLING

A. Winching of cables through ducts / pipes shall only be carried out with the approval of the Engineer-in-charge 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. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

B. A cable sheath stocking may be employed or 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.

2.1.11.3 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. Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. H.V. cables shall be laid in top trays and cables of subsequent voltage grade in lower tier of trays.
C. HV power cables of 4.4 kV and above shall be laid in trays/on racks as follows:

a) In single layer only without exception.

b) 4 core cables shall be laid in touching formation.

c) Single core cables shall be laid in tre-foil groups with a spacing equal to diameter of the cable between edges of the trefoils.

d) Cables in trefoil groups of the same circuit shall be laid as indicated below so as to ensure balanced current distribution:

Y		Y		Y		Y		
R	B	B	R	R	B	B	R	and so on.
(1)		(2)		(4)		(4)		

D. The cable of 11KV grade shall be laid not less than 1000mm below ground level in a 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 inter axial spacing between the cables except where otherwise specified is at least 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.
E. In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (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 dia meter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is. Minimum 4 meter long loop shall be provided at both sides of every straight through joint & 4 meters at each end of cable or as directed at site.
F. Great care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey 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.
G. Cables laid in trenches in single tier formation, 10 cms all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 40 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 240 x 115 x 75mm, 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.
H. Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by 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.
I. PVC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100mm dia. pipes are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 40 meters and at the point of

direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

J. Where the cables are laid in ducts (trenches) in side the building, they will be laid on MS rack / cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

K. 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 multi core cables shall be fabricated of 25x4 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.

L. Cable openings in wall/floor shall be sealed by the contractor suitably by Hessian tape & Bitumen compound or by any other proven material to prevent ingress of water.

M. 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.

2.1.11.4 CABLE JOINTING AND TERMINATING

A. Through joints will not be allowed in feeder cables where adequate manufacturer's lengths are available. Where a joint is necessary, it has to be made inside boxes, hand holes or manholes.

B. Recommendations: Through joints and terminations are to be carried out strictly in accordance with cable manufacturer's recommendations, and made with correct specified materials, boxes, tapes, compounds or mixtures, stress cones, glands and bonds as applicable. Joint/termination materials are to be inspected on site by the Engineer just before usage.

C. Jointing: Skilled operatives certified by Manufacturer are to be employed for jointing of cables. Qualifications of operatives are to be submitted to the Engineer prior to work commencing on site. Sample site constructed cable terminations and through-joints are to be submitted to the Engineer prior to commencing work on site. Samples are to be constructed in the presence of the Engineer and are to be available to the Engineer for test and inspection in accordance with manufacturer's recommendations.

D. Cutting tools for jointing and terminating cables are to be purpose made, to prevent damage to insulation in general, and to cable shielding of MV cables.

E. Cleaning of lacquer on conductors is to be by use of 'Scotch Brite' sponge and white spirit or equal approved.

Tighten electrical connectors and terminals including screws and bolts, in accordance with manufacturers published torque-tightening values. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with international standards.

2.1.11.5 IDENTIFICATION

A. Labelling and ferrules shall be metallic type with black engravement and as per standards & site requirement. Cable belts shall be stainless steel with PVC jacketing.

B. Jointers ID with date of jointing shall be labelled on the joint/termination for future reference.

2.1.11.6 FIRE SEAL SYSTEM

A. All the floor/wall openings 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, ant rodent 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 flame mastic 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.

2.1.11.5 FIELD QUALITY CONTROL

A. Testing: Contractor will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.
C. Perform the following field tests and inspections and prepare test reports:
    1. Perform each visual and mechanical inspection and electrical test stated in IS. Certify compliance with test parameters.
    2. After installing cables and before electrical circuitry has been energized, test for compliance with requirements.
D. The Contractor shall supply all necessary testing equipment for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.
E. In addition to SEB's/Local electricity board. requirements and those recommended by the manufacturer, the following tests shall be carried out:
    Continuity test,
    1. Earth test,
    2. Polarity test,
    3. Insulation resistance test,
    4. DC high voltage test. The test voltage shall be in accordance with SEB's/Local electricity board requirements and Engineer's approval.

    Remove and replace malfunctioning units and retest as specified above.

DATA SCHEDULE FOR 11 kV XLPE CABLES (To be filled by Bidders/Contractors)

A. System

1. Nominal System Voltage — kV
2. Conductor Short Circuit Current (kA)
3. Short Circuit duration (sec.)
4. Earth Fault Current (kA)
5. Earth Fault duration (sec.)

(* For design of armor + metallic screen)

B. Design Criteria

1. Conductor normal operating temperature	90 °C
2. Conductor overloading temperature	105 °C
3. Conductor maximum short circuit temperature	250 °C
4. Conductor and metallic screen temperature before short circuit and earth fault respectively (maximum)	65 °C
5. Laying depth in ground	0.9 metre
6. Formation of single core cables	Trefoil
7. Bonding	Both ends
8. No of 3 phase cables/groups in parallel	* 1 or 2
9. Distance between cables/groups	* 0.4 metre
10. Laying conditions	In ground/pipes/ducts/racks

(*Unless otherwise shown on the Drawings)

C. Type of Cables: — Single core unarmored or 3 core armoured

D. Construction

TYPE OF CABLE		SINGLE CORE CABLES	THREE CORE CABLES	
Sec. Ref.	Features	Individual Core	Individual Core	3 Core assembly
1	Conductor			
2	Conductor Screen			
3	**Insulation**			
4				
5	Insulation Screen			
6	Metallic Screen			
	Water Sealing:			
	i) Conductor			
	ii) Longitudinal (metallic Screen)			
7	iii) Radial			
8	Armour bedding(**)			
9	Armour (**)			
10	Oversheath			
11	Extrusion			
12	Core identification			
13	Laying up			
14	Embossing			
15	Overall dimensions			
16	Inspection			
17	Work Tests			

x Applicable
- Not applicable
** When applicable

SITE ACCEPTANCE TEST

Insulation and High Voltage Test Report for HV cables

1. Cable Details

Cable Route : From To
Cable Type : Size:
Approx. Cable Length :

2. Visual Inspection data

a. Cable data as per drawing ……..
b. No Physical damage ……..
c. Shield grounding, cable support and termination ……..
d. Cable bends as per manufacturer's recommendation ……..
e. Insulation condition ……....
f. Correct identification & arrangement ……..

3. Test Data

Ambient temp : ^{0}C

4. IR Test (Before HV test)

Applied Voltage : 5kV DC for 1 Min.

Phase	IR Value in M Ohms
R (Y& B shorted and earthed)	
Y (Y& B shorted and earthed)	
B (Y& B shorted and earthed)	

3. HV Test

Applied Voltage : ---- kV DC

Phase	Leakage Current (mA)						Remarks
	0 Min	1 Min	3 Min	5 Min	10 Min	15 Min	
R (Y & B Phases shorted and Earthed)							
Y (R & B Phases shorted and Earthed							
B (R & Y Phases shorted and Earthed							

4. IR Test (After HV)

Applied Voltage : 5kV DC for 1 Min.

Phase	IR Value in M Ohms
R (Y& B shorted and earthed)	
Y (Y& B shorted and earthed)	
B (Y& B shorted and earthed)	

END OF SECTION- B 2.1