

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATIONS FOR SUPPLY, LAYING, TESTING & COMMISSIONING OF 1000 Sq.mm., 220 KV XLPE INSULATED UNDERGROUND CABLE AND ACCESSORIES

1.00.0 SCOPE:

1.01.0 This specification provides for the establishment of an underground cable transmission scheme on total turnkey basis which includes the design, manufacture, inspection and testing before despatch, packing and delivery F.O.R. (destination) of 220 KV, 1000 Sq.mm, Single Core XLPE Insulated lead sheathed cable and accessories under the supply portion and laying, including obtaining permission for road cutting from Bruhath Bengaluru Mahanagara Palike (BBMP), Local Administrative Authorities and other agencies for execution of work, handling and installation of materials required in laying, site testing and commissioning under the erection portion.

1.01.1 SITE:

The site is located in Karnataka State, India.

Route: Please refer the enclosed drawing for the tentative route plan of the cable.

1.02.0 SCOPE OF WORKS

The scope of work includes:

1.02.1 Surveying of the proposed cable route including digging and closing of trial pits, preparation of requisite drawings and finalizing the cable route in consultation with the owner's representative.

NOTE: In the expected cable route, ground structure may change from one point to another, and in some places like Railway Crossing , Major Road Crossing, the local environment is especially bad which may lead to unexpected accelerated ageing of insulation and would limit the life expectancy of the cable itself. The successful bidder has to execute works by taking all the necessary precautions so as to get **800 Amps** of current flow in the cable per circuit (Refer clause No. 4.00 (B)(i)(10)(i) & (ii)).

Even after considering all the derating factors for laying cable in those locations, the minimum continuous current shall be **800 Amps** per circuit.

- 1.02.2 Testing and evaluation of the soil resistivity, soil thermal resistivity, pH value, of the soil along the cable route, and based on the data, recommend the final system design.
- a) Perform a through route soil thermal resistivity survey by in-situ testing along the entire cable route.
 - b) Conduct a detailed analysis of soils / strata encountered along the route for the thermal performance under specified cable loading.
 - c) Specify a suitable thermal backfill so that the soil thermal resistivity does not exceed $120^{\circ}\text{C cm/watt}$, to encapsulate the cables to prevent thermal run away of cable.
 - d) Design of optimum cable trench including RCC ducts and optimum backfill dimension.
 - e) Formulation of thermal backfill, quality control and supervision during backfill.
 - f) Obtaining Road cutting permission from Bruhath Bangalore MahanagaraPalike (BBMP), Local Administrative Authorities and any other permissions from other utilities.
- 1.02.3 Design the method of installation of U.G. Cables, cable laying, excavation and back-filling of cable trench, supply and installation of associated materials like sand, bricks, warning tape, protective slabs, pipes, ducts, civil works etc.
- 1.02.4 Design, manufacture, testing at works / test house, supply, storage, installation, testing and commissioning of 220 kV cables with all associated materials and accessories.
- 1.02.5 Design, supply erection, testing and commissioning of
- a) Surge Voltage limiters
 - b) Grounding Switches.
 - c) Link boxes with Links and with/without SVL
- 1.02.6 Design for the installation, supply of materials and construction of cable ducts, supports for cable crossings of storm water/sewerage drains wherever required. Design, supply of materials and laying of pipes/construction of cable ducts for railway crossing and road crossing wherever required.
- 1.02.7 Supply, installation, testing and commissioning of
- a) Normal straight through joints for Normal bonding/ Cross bonding of cables.
 - b) Outdoor cable terminations.
- 1.02.8 Design, supply and erection of structures for mounting / supporting cable with

terminations.

1.02.9 Supply of recommended essential spare parts.

1.02.10 Supply of tools and tackles.

1.02.11 Furnishing all relevant drawings, data and instruction manuals.

1.02.12 Supply of all consumable items, like cable end sealing caps for cable during transport and jointing and all others associated sundry materials.

1.03.0 SCOPE OF SERVICES:

1.03.1 The Scope of the services includes supply, installation, laying erection and commissioning of the cable system on total turnkey basis. The scope shall include but not limited to the following.

1.03.2 Complete checking, monitoring, storing of the materials at the site, and co-ordination of work. Transporting of materials from site stores to site and returning unused material to KPTCL stores.

1.03.3 Finalize procedure of installation and erection in consultation with owner.

1.03.4 Regular supervision and following up of erection / installation work

1.03.5 Testing and commissioning the system / equipments for successful commercial operation.

1.04.0 The cables and its accessories shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer / erection and the owner shall have the power to reject any work or material, which in owner's judgement is not in full accordance therewith.

1.05.0 All the volumes of this bid documents along with amendments thereof be read and interpreted together. However, in case of a contradiction between the "Technical Specification (Vol. II)" (i.e., this volume) and any other volume, the provisions of this volume will prevail.

1.06.0 It is not intent to specify completely all the details of Design and construction of cable and accessories. However, the cable and accessories shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing continuous commercial operation up to the suppliers guarantee period in a manner acceptable to the Owner who will interpret the meanings of drawings and

specifications and shall have power to reject any work or material, which in Owner judgment, is not in accordance therewith. The cable offered shall be complete with all the components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of the bidder irrespective of whether they are specifically brought out in this specification and/or in the commercial document or not.

NOTE:

1. The scope shall cover supply of all required equipments, accessories, spares and jointing kits and tools and plant, competent supervision and consumables. All other matching materials required (whether specifically mentioned or not) for complete installation, testing and commissioning of the system shall also be covered.
2. After completion of laying and back filling the road shall be restored as per specification of BBMP and applicable local Authorities. Specification of the same is enclosed.

1.07.0 QUANTITIES:

The quantities, length of cable, number of accessories and other materials indicated in the bid proposals are solely for the purpose of bid evaluation. The successful bidder after detailed route survey shall estimate the actual quantities and take up manufacture and procurement action for materials after approval of the Owner.

2.00.0 STANDARDS:

- 2.01.0 The construction of the cable shall generally conform to IS 7098 (Part-3) and IEC 62067 with exception to the specific requirements of these specifications and tests as per **IEC-62067**. Except to the extent mentioned in the specification, the cables and the accessories shall conform to the latest editions and amendments of the standards listed hereunder wherever applicable.

IEC-60050	Electro Technical vocabulary.
IEC-60060	High Voltage Test Techniques.
IEC-60093	Recommended tests for volume and resistivity of electrical insulating materials.
IEEE-48	Test procedures and requirement for AC cable terminations 2.5 to 765kV
IEC-60122	Recommended method for determining the comparative tracking index of solid insulating materials under moist condition.

IEC-60183	Guide to selection of high voltage cables.
IEC-60216	Guide for the determination of thermal endurance properties of electrical insulating materials.
IEC-60228	Conductors of insulated cables.
IEC-60228-A	(First supplement) Guide to the dimensional limits of circular conductors.
IEC-60229	Test on cable over sheaths which have a special protective function and are applied by extrusion.
IEC-60230	Impulse test on cables and their accessories.
IEC-60243	Recommended method of tests for electrical strength of solid insulating materials.
IEC-60250	Recommended method for determination of permittivity, dielectric dissipation factor of electrical insulation materials at power, audio frequencies.
IEC-60270	Partial Discharge measurements
IEC-60287	Calculation of continuous current rating of cables, 100% load factor.
IEC-60540	Test methods for insulation and sheaths of electric cables and cores.
IEC-60811	Common test methods for insulating and sheathing materials of electric cables. (Applicable parts / sections of different editions)
IEC-60840	<u><i>Applicable clauses only</i></u> Power cable with extruded insulation for voltages above 30kV ($U_m=36kV$) up to 150 ($U_m=170kV$). Test methods & requirements.
IEC-60853	Calculation of cyclic & emergency current rating of the cable.
IEC-60885-2	Electrical test methods for electric cables, part-2: Partial discharge tests.

IEC-60885-3	Electrical test methods for electric cables part-3 Test methods for partial discharge measurement on lengths of extruded power cables.
IEC-62067	Power cable with extruded insulation and their accessories for rated voltage above 150 kV – Test Methods & requirements.
IEC-60949	Calculation of thermally permissible short circuit currents, taking into account non-adiabatic heating effects.
IS-3043	Code of practice for earthing
IS-1255	Code of practice for laying of power cables.
IS-1885	Electro Technical vocabulary applicable parts.
IS-5216	Guide for safety procedures and practices in electrical works
IS-5831	PVC insulation and sheath of electric cables.
IS 7098 (Part 3)-93	Cross-linked polyethylene insulated, thermoplastic sheathed cables 66kV to 220kV.
IS-8130	Conductors for insulated cables and flexible cords.
IS-10810	Method of test for cables: Applicable parts.
IEC-62271-209	Cable Connection for gas insulated metal enclosed switch gear for rated voltage above 52kV.
Indian Electricity Act - 2003	
Indian Electricity Rules, 1956 (Or its Latest Amendments).	

NOTE: i) For the purpose of this specification all technical terms used hereinafter shall have the meaning as per relevant IEC/IS specification.

2.02.0 The Standards mentioned above are available from:

<u>Standard</u>	<u>Name & Address</u>
-----------------	---------------------------

- IS** Bureau of Indian Standards, Manak Bhavan, 9,
Bahadurshah Zafar Marg, New Delhi – 110 001,
INDIA.
- IEC** International Electro-Technical Commission, Bureau
Central De 1a commission, Electro Technique
Internationale, 3, Rue De Verembe, P.O. Box 131
CH - 1211 Geneva 20 – Switzerland.

2.03.0 Cables/Cable accessories satisfying the quality requirements of other National/International standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the bidder conforms to other standards, salient points of difference between the standards preferred and the specified standards shall be clearly brought out in the offer. Four (4) copies of the reference standards in English language shall be furnished along with the offer.

3.00.0 SYSTEM DATA:

a) Rated voltage:

The cable defined in this specification have the following rated voltage:

$$U_o/U (U_m) = 127/220 (245) \text{ kV}$$

“U_o” is the r.m.s. rated voltage at power frequency, between the conductor and the earth or the metallic sheath:

$$U_o = 127 \text{ kV}$$

U is the r.m.s. rated voltage at power frequency, between two phase conductors:

$$U = 220 \text{ kV}$$

“U_m” is the maximum r.m.s. voltage at power frequency, between two conductors for which the cable and its accessories are to be designed:

$$U_m = 245 \text{ kV}$$

b) Operating Conditions:

- | | | |
|---|---|---------|
| 1. Nominal rated voltage (KV rms) | - | 220 KV |
| 2. Highest system voltage (kV rms) | - | 245 KV |
| 3. Number of phases | - | 3 |
| 4. System frequency (Hz) | - | 50 ± 3% |
| 5. Impulse withstand voltage 1.2/50 micro seconds
wave of positive/negative polarity | | |

(kVp)	-	1050
6. Power frequency withstand voltage (kV rms)	-	460
7. System earthing	-	Effectively Earthed (Solidly grounded)
8. Maximum fault level & its duration	-	50KA for 1 Sec
9. Dynamic withstand capability	-	125 KA
10. Total Relay & Breaker operating time (Milli seconds)	-	90-120

4.00.0 A. CLIMATIC CONDITIONS:

1. Ambient air temperature	-	Min 5 ⁰ C
	-	Max 50 ⁰ C
2. Average daily ambient air temperature	-	30 ⁰ C
3. Relative humidity	-	10-100%
4. Ground temperature at a depth of 1500 mm	-	30 ⁰ C
5. Altitude above Mean Sea Level (M)	-	1000
6. Average Rainfall (mm)/ annum	-	1000
7. Ceraunic level (days/year)	-	40-50
8. Seismic level (horizontal acceleration)	-	0.3 g

B. OPERATING CONDITIONS:

i. CABLES:

1. Method of installation - Directly buried in ground/RCC cable duct		
2. No. of Circuit	-	Single
3. Depth of laying (average)	-	1500 mm from the center of cable arrangement
4. Soil Condition	-	Dry Heterogeneous garden Soil
5. Thermal Resistivity of soil (assumed) Deg. C-cm/watt	-	120 to 150

Bidder shall furnish the current rating of 1000 Sq.mm cable at Thermal resistivity of soil at 120⁰C-Cm/watt and 150⁰C-Cm/watt. However the successful bidder has to measure the soil thermal resistivity along the cable route and the cable has to be designed suitably.

6. Formation	-	Trefoil Touching
7. Spacing between two circuits (if applicable)	-	800 mm (for 2 Circuits)
8. Sheath Bonding	-	Cross bonding.

Bidder shall recommend the type of bonding to be adopted with detailed calculation of sheath voltage, sheath current and current rating.

- | | | |
|--|---|--|
| 8. No. of cores | - | Single |
| 9. Conductor size | - | 1000 Sq.mm |
| 10. Rated continuous current (minimum) | | |
| i. In Air | - | 1000 Amps. |
| ii. In ground | - | 800 Amps. (after considering all derating factors) |
| 11. Conductor material | - | Annealed Copper |
- ii. TERMINATIONS:
- | | | |
|-----------------------------------|-----|---|
| 1) Installation | - | Outdoor type/GIS module Plugin Type in conformity with IEC 62271-209. |
| 2) Atmosphere | - | Polluted. |
| 3) Switchgear | - | SF6 Circuit breaker (AIS/GIS) |
| 4) Clearance (air) ph-ph | } - | 3650 mm |
| at 220kV (phase voltage) ph-earth | | 3350 mm |

5.00.0 TECHNICAL PARAMETERS OF CABLE:

TYPE OF CABLE:

127/220 kV single core, stranded, annealed, copper conductor, segmental compacted, circular (Miliken), XLPE insulated, lead sheath, copper wire screen, High Density Polyethylene outer sheathed cable (please see details under construction of cable).

The tests shall be as per IEC-62067 with latest amendments.

- | | | |
|--|---|--------------------|
| Voltage grade | - | 127/220 (kV rms) |
| Max. operating conductor temperature | - | 90 ⁰ C |
| Max. conductor temperature under short | | |
| Circuit for 1 sec. | - | 250 ⁰ C |

5.01.0 CONSTRUCTION OF THE CABLE:

Construction : 127/220 kV (Earthed), single core 1000 Sq.mm stranded, annealed, copper conductor, segmental,

compacted, circular (Milliken), conductor screen, cross linked polyethylene (XLPE) insulation, core screen, semi-conducting water swellable layer, lead alloy 'E' sheathed, semi-conducting bedding tapes, helically applied plain round copper wire screen, plain copper tape in open helix, water swellable tape with overall extruded High Density Polyethylene sheath coated with graphite.

Conductor : Plain, annealed, high conductivity copper wires stranded, segmental conductor (Milliken).

Conductor screen: Extruded semi-conducting layer.

Insulation : Dry cured cross linked polyethylene.

Nominal thickness 24.00 mm (min)
In any particular point, the thickness may differ from the nominal thickness, however, the measured thickness shall stay within the following limits.

Minimum thickness: $t_{(min)} \geq 0.9 t_{(nom)}$

And

$$\frac{t_{max} - t_{min}}{t_{max}} \leq 0.10$$

Where t_{max} , t_{min} and t_{nom} are respectively the minimum, maximum & nominal thickness.

The thickness of insulation mentioned is indicative only. However, the thickness of insulation shall be such that the maximum value of electric stress at the insulation screen shall be 4kV/mm, as indicated elsewhere in the specification.

**Core/insulation
Screen**

Extruded semi-conducting layer

**Longitudinal
Water barrier**

Semi-conducting water swellable tape/s.

Radial Moisture Barrier	Extruded lead alloy 'E'. (Nominal thickness not less than 3.0 mm) The minimum thickness of the metallic sheath shall not fall below the nominal thickness by more than 0.1 mm + 5.0% of the nominal thickness. $t_{\min} \geq 0.95t_{\text{nom}} - 0.1$
Bedding	Semi-conducting tape/s.
Armour/Screen	Helically applied non-magnetic plain copper wires.
Contact tape	Annealed plain copper tape in open helix.
Water swellable tape	Non-conducting water swellable tape.
Outer sheath	Extruded High Density Polyethylene type ST 7 (black), antitermite treated. Extruded outer conducting layer coated with graphite. Nominal thickness 3.5 mm

6.00.0 GENERAL TECHNICAL REQUIREMENTS OF THE CABLE:

The size of the conductors of the cable shall be sufficient to carry continuously **800 Amps** continuously without exceeding a maximum temperature of **90⁰C** under site conditions followed by a 20% overload for three hours without exceeding a maximum temperature of **130⁰C for emergency overload** under site conditions. The OWNER estimates that a cross section of 1000 sq.mm Compacted Segmental Circular Milliken conductor would be adequate to carry the stipulated load current.

The conductor size shall be based on loading of the circuit under the conditions indicated in Clause-3.00.00 & 4.00.00 above.

6.01.0 INSULATION CURING:

Dry curing process should be adopted in cross-linking the insulation.

6.02.0 TRIPLE EXTRUSION:

The conductor, screen, insulation and insulation screen shall be extruded in single process. The extrusion process shall be by **VCV method**. The same shall be confirmed in the GTP.

The Cross linked polyethylene insulated (XLPE) cable (Dry cured) shall be manufactured in accordance with the internationally accepted standard and also conform to the requirements of IEC: 62067 for rated voltages from 150KV to 500KV.

6.03.0 DESIGN STRESS AND INSULATION THICKNESS:

The recommended typical design stress values for insulation thickness are:

Design stress a.c. : 10 kV/mm

Design stress impulse : 40 kV/mm

The higher of the two values of the insulation thickness will be adopted but not less than the nominal value of 24.00 mm.

6.04.0 DIELECTRIC STRESSES:

The 220 kV cables shall be designed for continuous operation at a maximum line to earth system voltage of 127 kV. The maximum dielectric stress at the conductor screen and insulation screen shall not exceed the following:

For 1000 Sq.mm

a) At conductor screen 8 KV/mm

b) At the insulation screen 4 kV/mm

The dielectric stress at 127 kV shall be furnished by the bidder with calculation sheet.

6.05.0 The cable shall be designed to have a minimum useful life of not less than fifty years. The cable manufacturer should submit a graph showing the breakdown voltage with respect to time for the XLPE insulation compound used. In addition the type of XLPE semi-conducting compound used should be indicated i.e., whether super smooth and purity level.

6.06.0 Each cable length shall be provided with a pulling socket, pulling eye, which shall be fitted to pulling end to withstand the maximum pulling force.

6.07.0 Copper wire screening shall be preferably before the lead sheath to ensure specific water tightness of cable both transversely and longitudinally. However other types of placement of the copper wire screening is also acceptable if it meets the overall technical requirements. The same shall be established by way of Type Test Reports conducted on such cables.

The bidder shall indicate any specific construction features, which will be provided to ensure specific water tightness of cable both transversely and longitudinally.

6.08.0 CURRENT RATING:

The bidder shall furnish the continuous current ratings in ground, in air, in pipes and in

ducts at the maximum conductor temperature of 90°C with reference to the ambient site conditions on the guidelines of IEC 60287. Any additional data, other than furnished under climatic conditions and operating conditions may be suitably assumed. However, the same shall be furnished in GTP for reference. The ratings shall be for Trefoil touching formation when the sheaths are single point bonded and both ends bonded or cross bonded (without exceeding the stipulated sheath voltage of **65 volts** or undue high circulating currents).

The current ratings shall be for single circuit/double circuit in operation.

The bidder shall also furnish technical information on:

- i) Derating factors for various types of installation conditions in trefoil and flat (viz., depth of laying, varying ground temperatures, cables in ducts / pipes, cable spacings, circuit spacings, varying soil thermal resistivities etc.) shall be furnished by the bidder for the following conditions:
 - (a) Proximity to other 220 kV cables.
 - Variation of number of cables (max. 12 in number).
 - Variation in spacing.
 - Variation in loading of the cables (80% to 100%).
 - (b) Variation in depth of water table.
 - (c) Depth of laying cables in trenches and cable ducts.
 - (d) Depth of **Stabilised Thermal Backfill (STB)** below and above laid cables.
 - (e) Width of trench on either side of the cables in which **STB** will be put.
 - (f) Variation in STB effective thermal resistivity.
 - (g) Variation in soil thermal resistivity.
 - (h) Laying of cables in long lengths of HDPE pipe, 19 mm thick – Variation due to size and thickness of pipe and open space available in pipe – BIDDER shall suggest methods to improve the ratings.

ii) Short Time Current Loading:

The current loading permissible for a defined period of short time operation, over the cyclic load as under.

Cyclic loading over a 24 hour period.

2100	to	0600 Hours	(9 Hours)	50%
0600	to	0900 Hours	(3 Hours)	120%
0900	to	1800 Hours	(9 Hours)	100%
1800	to	2100 Hours	(3 Hours)	120%

Furnish short time loading for the following conditions.

- i) Only one circuit is live.
- ii) When both circuits are live.

When cables are laid in trefoil touching formation.

- i) Single point bonded.
- ii) Both end bonded.
- iii) Cross bonded.

The bidders should furnish GA drawing/other details with supporting calculations on charging current, capacitance, inductance, losses, sheath voltages, sheath currents, surge impedance, sequence impedance and screen factors, detailed drawings etc., along with the bidding documents.

6.08.1 MECHANICAL CHARACTERISTICS OF CABLE:

The cable shall withstand the electromechanical forces due to peak short circuit currents of **125KA** and shall withstand the stresses of thermal expansion in the insulation due to faults. The cable shall withstand the mechanical stresses during installation.

6.09.0 TEMPERATURE RISE:

The maximum conductor temperature shall not exceed 90⁰C during continuous operation at full rated current at 220 kV followed by 20% overload for three hours, maximum temperature not exceeding 130⁰C. The temperature after a short circuit for one second shall not exceed 250⁰C, with initial conductor temperature of 90⁰C.

6.10.0 EMERGENCY LOADING:

The BIDDER shall indicate the maximum percentage overload current that the cable can carry and its duration when operating initially at a conductor temperature of 90⁰C and the permissible final conductor temperature after overload. The total period during the lifetime of the cable when it shall be subjected to emergency loading without affecting the expected life of the cable shall also be indicated.

6.11.0 CYCLIC RATING:

The BIDDER shall also indicate the percentage overload current that the cable can carry and its duration, without the conductor temperature exceeding 90⁰C due to the time lag in conductor temperature change on account of the change in thermal characteristics of the mass of the soil surrounding the cable.

6.12.0 CABLE MATERIAL:

a)Conductor:

Plain annealed high conductivity copper wires, stranded, segmental conductor while conforming to IEC-60228. The Copper used for the conductor shall be of highest

purity. The minimum number of wires and conductors and DC resistance of conductor shall be as per IEC-60228.

b) Conductor Screen:

The conductor screen shall be provided over the conductor by extrusion of semi-conducting compound or by a combination of semi-conducting tape/s and extruded semi-conducting compound. The minimum thickness, excluding tape/s shall be 1.5 mm.

c) Insulation:

Cross-linked polyethylene insulation by dry curing process shall be provided over the conductor screen. The nominal thickness of 24.00 mm and subject to tolerance as per IEC-62067, Clause 10.6.2.

The insulation shall be of high quality, and shall be as far as possible free from contaminants, moisture and voids. The size of voids and contaminants shall be within limits of recognized National/IEC Standards.

The insulation shall be suitable for operation in wet or dry locations at conductor temperature not exceeding 90⁰C for normal operation, 130⁰C for emergency over load of short duration, and 250⁰C for short circuit conditions.

d) Insulation Screen:

Shall be by extruded semi conducting compound and of minimum thickness 1.0 mm. The semi conducting screens shall be suitable for the operating temperatures of the cable and compatible with the insulation.

e) Moisture Barrier (Longitudinal):

This shall be semi-conducting synthetic non-woven tape with suitable swellable absorbent for longitudinal water sealing covering the whole surface area of the non-metallic part of insulation screening. This barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water blocking tape shall not be less than 0.3 mm.

f) Metal Sheath/Moisture Barrier (Radial):

Shall be extruded lead alloy 'E' sheath.

The nominal thickness of lead alloy sheath shall be 3.0 mm and shall meet the Electrical and Mechanical properties as per standards. The minimum thickness shall be as per IEC-62067 (Clause 10.7.1).

g) Bedding Tapes:

Suitable semiconducting bedding tapes shall be used under metallic screen of approximate thickness 0.3 mm.

h) Metallic Screen (Armour):

The metallic screen shall be of non-magnetic plain copper round wires, helically applied over the semiconducting bedding tape/s.

A binder tape of suitable material/annealed plain copper shall be applied in the form of an open helix, over the metallic screen.

Note: Requirement of Metallic Sheath/Screen:

The metallic screen can be before or after the lead sheath. However, it shall be as per the manufacturer's type tested design.

The cross section of the metallic sheath that is lead sheath in combination with plain copper round wire screen shall be designed to meet the following requirements:

- i) Sustaining the system short circuit rating of **50 KA** for 1 Sec.

The temperature of metallic sheath at the time of short circuit (cable operating at maximum conductor temperature) shall be indicated in the short circuit calculations of the design of metallic screen/lead sheath.

- ii) Ensuring mechanical protection of the cable.
- iii) Ensuring radial water tightness of the cable.

Note: Test report ensuring the above compliance has to be submitted by the bidder along with the bid.

i) Outer Sheath:

The outer sheath shall be extruded Black colour High Density Polyethylene, type ST 7 conforming to requirement of IEC. The High Density Polyethylene compound used shall be brand new from a reputed manufacturer and in no case shall recycled material be used.

The outer sheath shall be designed for protection against termite and rodent attacks by adding suitable additives to HDPE compound and such additives shall be harmless to operating personnel. The minimum thickness of outer sheath shall be 3.5 mm.

j) Coating:

A hard baked on layer of graphite shall be applied over the sheath as outer electrode

for testing the sheath.

6.13.0 IDENTIFICATION:

The following information shall be embossed on the outer sheath of the cable continuously repeated throughout the length of the cable.

- i) Brand Name of Manufacturer:
- ii) Year of Manufacture:
- iii) Voltage rating / conductor cross section: 220,000V/1000 Sq.mm
- iv) K.P.T.C.L.
- v) XLPE

7.00.0 CABLE ACCESSORIES:

7.01.0 GENERAL:

Following are the accessories required.

(a) Straight through normal as well as cross bonded joints suitable for directly buried in ground conditions/RCC Cable Ducts.

(b) Outdoor type cable end terminations/GIS module plugin type.

The above accessories shall be suitable for the 127/220 kV, single core 1000 Sq.mm copper conductor lead sheathed cable. The detailed cable construction is given in these specifications under clause 5.01.00

7.02.0 TECHNICAL REQUIREMENTS:

The accessories should be compatible with the size of the conductor, the insulation and the voltage class of the cable. The components of the accessory shall not be affected by contact with the component materials of cable, and shall not corrode any metal, which they come in contact. The accessory, in the assembled condition, shall be capable of operating under the normal and fault temperature conditions of the cable.

The cable accessories should be procured only from reputed manufactures & type test reports shall be submitted along with the bid.

7.02.1 CABLE JOINT:

The Cable joints shall be suitable for 220 kV Single Core, 1000 Sq.mm copper conductor, lead sheathed XLPE cable and conforming to relevant IEC specification.

The joints shall be suitable for size of the conductor, the insulation, voltage and current ratings of the cable. The required service conditions are horizontal installation, directly buried in earth, laid in RCC cable duct and intermittently or continuously submerged in water.

The BIDDER shall quote for the required quantity of prefabricated type Cable joints which shall comprise of a Factory Tested One Piece Pre Moulded Silicone Rubber joint body moulded from a special Silicone Rubber formulation to provide perfect compression force for optimized electrical performance and afford very simple, reliable, consistent installation. Conductor Jointing should be either with mechanical connectors or a proven crimping technique. Outer mechanical protection with integrated moisture protection must be provided and the manufacturer must provide a detailed description of this. Solderless Jointing technique for the lead sheath and copper wire screen must be provided. Further, the straight through joint shall be able to

- (i) Provide a seal against the entrance of moisture or external environment.
- (ii) The assembled joint should be resistant to corrosive agents present in the soil, should be mechanically strong to withstand pressure, bending, pulling fatigue. The joint should withstand temperature variations under normal load and fault conditions.

7.02.2 OUTDOOR CABLE END TERMINATION:

The cable end terminations shall be outdoor type suitable for 220 kV SC, 1000 Sq.mm copper conductor, lead sheathed XLPE cable and shall be designed to perform under severe environmental conditions and also conform to the relevant IEC Specifications.

The outdoor termination should have a pre moulded silicone rubber stress cone to provide the electrical stress control function at the end of screen/shield and should be easily applied without tools. It should avoid partial discharges and surface corona under severe service conditions. The cone should be placed on the cable terminated within a pressure tight composite housing made of glass fibre reinforced resin tube with silicone rubber sheds moulded to the tube. The interface between the stress cone, cable insulation and inner housing must be filled with a silicone oil poured from the top. No heating of the silicone oil prior to pouring should be required. It should seal any ingress of atmospheric elements. A flexible double sealing system which is installer friendly must be provided to provide protection against environmental influences. An oil resistant barrier must be provided over the conductor to prevent any oil migration the total creepage distance shall not be less than 6125 mm.

The outdoor termination shall be suitable for the insulation, voltage, conductor size and current rating of the cable.

The sealing ends shall conform to the latest International Standards and shall be of thoroughly proven design. The outdoor type sealing ends shall be suitable for installation in polluted atmosphere referred to in clause 4.00.00 and shall be completely weather proof. Each outdoor type-sealing end shall be supplied complete with four mounting plate insulators to insulate the sealing end from the supporting structures and to control the sheath current. All metallic fittings must be made of corrosion resistant aluminium alloy. Terminal connectors and bimetallic clamps shall also be supplied. Each sealing end shall be provided with consumable materials such as wipes and solvent for cleaning. A Cable Gland for the shield connection and lead sheath connection must be provided and this should be sealed from the external environment with a heat shrinkable sleeve. The power cable leading to sealing end shall be provided with proper sunshield cover.

The material for the housing of the termination should be resistant to tracking, ultra violet radiation (U.V. Exposure) weathering and should have stable hydrophobic properties.

The bidder shall provide necessary arrangement to limit flow of current in the structure supporting the sealing end.

The sealing ends shall withstand the power frequency, impulse and cable testing voltage after installation as specified.

The cable and accessories shall withstand all thermal and mechanical stresses under steady state and transient operating conditions.

7.03.0 TECHNICAL ASSISTANCE/TRAINING:

The successful bidder shall arrange with the suppliers of cable joints and / or terminations, the technical assistance in jointing / terminating the cable during installation at the site. The successful bidder shall arrange to train the owner's personnel in jointing and terminating techniques during the installation.

7.04.0 LINK BOXES:

7.04.1 Link Boxes along the run of the 220 kV Cable:

- a) Link boxes for grounding of the sheaths of single core cables along the run of the cables shall be made of cast iron/aluminium alloy/stainless steel, suitable for direct burial in the same ground conditions as the cable with anti-rust protection suitable for completely underground installation and for operation when immersed in water. The link box shall conform to IP-66 degree of protection for which the test reports shall be furnished.

The bidder shall furnish a copy of type tests certificates for the link box offered as

per the specification from any of the laboratories indicated in Cl.No. 10.02.10 or any other NABL Accredited Laboratories.

The design of the box must include a top Lid, which can be lifted vertically. BIDDER to submit the detailed drawing of these boxes along with the Bid. These Link Boxes shall be easily accessible from road surface in case of installation in joint pit. The box shall ensure complete water tightness.

- b) These Link Boxes shall be suitable for terminating the cable sheaths on either side of joint bays based on cable route for cross bonding at the box as well as for earthing at recommended locations.
- c) All accessories such as copper terminals, cable lugs, connecting links, disconnecting links, washers, gaskets, mounting arrangements, etc., shall be provided to make the system complete.
- d) The cross bonding link box shall be designed to be completely water proof and capable of immersion in water.
- e) The cable leads from sheath to link box, capable of withstanding 10 kV DC and cable leads from link box to earth shall also be in BIDDER's scope of supply. The BIDDER shall quote for the type of cable leads for the cross bonding system as per the following design:

Concentric bonding leads of suitable size corresponding to three-(3) nos. co-axial cable entries to the cross bonding box.

Non-linear resistor type surge divertors of metal oxide type, wherever required, shall be provided in the link box by the BIDDER.

- f) The BIDDER may quote for link boxes of suitable design in which the surge voltage limiters (SVLs) do not need to be disconnected when a routine 10 kV DC test on the cable outersheath is performed.

7.04.2 Link boxes at the circuit end:

The lead sheath shall be grounded through suitable disconnecting links at the base of sealing ends. The BIDDER shall clearly indicate whether the links are to be grounded directly or through SVLs (non-linear resistors). The links shall be housed in a weather proof, outdoor, galvanised sheet steel box or cast iron or aluminium alloy box with mounting brackets and provided with 'O' Ring gasketed door. The cable leads from the sheath to the link box, capable of withstanding 10 kV DC & cable leads from link box to earth shall form a part of the scope of supply of the BIDDER. The Bidder shall quote for the same.

7.04.3 Cross Bonding of cable sheath:

The BIDDER shall give his recommendations regarding cross bonding of cable sheaths for the flat formation of single core cables. The BIDDER shall clearly indicate the number of joints to be directly earthed and those to be earthed through zinc oxide (ZnO), non-linear resistors (sheath voltage limiters). The offer may indicate a suitable design whereby ZnO resistors need not be disconnected while conducting routine DC test on the over sheath.

The sheath standing voltage to earth for rated cable current shall not be in excess of 65 V RMS.

The sheath voltage, during an external three phase, symmetrical through fault as specified, should not be in excess of 3.3 KV for 3 sec.

The BIDDER shall indicate the arrangement considered by him in his proposal to meet the above requirements with suitable non-linear resistors, if required, to limit the sheath voltage.

Detailed calculations for sheath voltages as per recommended bonding methods shall be furnished along with the bid.

The BIDDER shall indicate permissible variation in the lengths of the 3 minor sections of a major section, which will not affect the efficacy of the cross bonding.

The BIDDER shall confirm that the cable can be continued in service in the event of a sheath fault and shall indicate the de-rating of the cable in case of an earth on the sheath at the link box earthed through SVLs.

Transposition of cables:

The BIDDER shall indicate and provide arrangement for transposition of cables if necessary along with cross bonding. The Details of the same shall be furnished alongwith the bids.

7.04.4 VOID

7.04.5 VOID

7.04.6 Partial Discharge (PD) Measurement System: VOID

7.05.0 DTS (Distributed Temperature Sensor) with RTTR: void

7.06.0 SHEATH BONDING CABLE AND EARTHING CABLE:

The sheath bonding cable shall be co-axial cable 6.6 kV and above grade with 400/400 Sq.mm (conductor/concentric conductor) stranded Copper conductor PVC insulated wire armoured and PVC sheathed. The earthing cable shall be 3.3kV & above grade with 400Sq.mm stranded copper conductor PVC insulated & PVC sheathed. However the rating and the size of sheath bonding cable and earthing cable mentioned are indicative and minimum values. The bidder may quote the actual rating and size of cable offered, to meet the requirement.

7.07.0 PIPE EARTH STATIONS:

The earthing shall be as per provisions of IS:3043, Code of practice for earthing and as per IE rules:1956 Or its Latest Amendments.

8.00.0 ELECTROLYSIS AND CORROSION:

The cable serving shall be designed such that the cable sheath and armouring are protected from electrolysis caused by stray currents, from galvanic action and from corrosion and microbiological attack. The design of accessories shall be such that the outer metallic coverings of cable joints, sealing ends and control points can be insulated from earth along the entire route so that cathodic protection, if needed can be applied and also periodic testing of the insulating resistance of the serving can be done. A set of links shall be provided at each end of cables to connect the cable sheath and armour to the respective station grounds. The sealing ends shall be suitably insulated from their supporting structures, to permit insulation test on the cable over sheath.

9.00.0 GROUNDING SYSTEM:

The BIDDER shall indicate his recommendations regarding the type of grounding systems for the lead sheath/armour. The scope of supply shall include ground rod or ground conductor as recommended. The grounding material shall be copper.

10.00.1 TESTS ON CABLES AND ACCESSORIES:

10.01.0 APPLICABLE STANDARDS:

The testing procedures and requirements shall conform to the latest edition of the following national and international standards, but not limited to:

- a) IEC publication 60540
- b) IEC publication 60228
- c) IEC publication 60229
- d) British Standard Specification 6622

- e) IEC publication 60840 (*only applicable Sections of the Standard*)
- f) IEC publication 60230
- g) IEC publication 60287
- h) IEC publication 60811
- i) IEC publication 60885
- j) IEC publication 62067

The IEC Standards shall prevail whenever the same tests are specified in other standards.

10.02.0 TESTS:

- 10.02.1 The Owner is keen to procure cables of highest integrity. To provide adequate confidence to the owner for the long term reliability of the cables, the manufacturer has to carry out the prequalification tests on cables and their accessories in accordance with IEC-62067:2011.

The prequalification tests should have been conducted on complete cable system as per clause 13 of IEC-62067.

Prequalification test report shall be furnished along with the bid documents, which is mandatory.

The prequalification tests are to determine long term reliability of a cables system. Hence it is necessary to carry out a long term accelerated ageing test. This test is to be performed as per clause no. 13.2 of IEC-62067 on the complete system comprising cables (specified in Tender) joints and termination in order to demonstrate the performance of the system.

The bidder shall enclose a detailed report of prequalification test as per clause No.13.2 of IEC-62067 along with the bid.

After qualification of these tests, regular routine, acceptance and type tests are to be conducted in any one of the approved labs as indicated in the clause 10.02.10 on the samples and cables manufactured for the Owner.

- 10.02.2 The bidder shall include the field test report of similar size and voltage class cables installed in actual service. The report shall include voltage class, size, actual voltage, actual load current data, sheath voltage, sheath/conductor temperature data and all events after installation during service of such cable till date etc.
- 10.02.3 Type tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this specification. These tests shall be carried out on samples prior to commencement of commercial

production against the order. The Bidder shall indicate his schedule for carrying out these tests in the activity schedule.

- 10.02.4 Acceptance tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of the lot.
- 10.02.5 Routine Tests shall mean those tests, which are to be carried out on each strand/spool/length of the cable to check requirements, which are likely to vary during production and to demonstrate the integrity of the cables to be delivered to the customers for use.
- 10.02.6 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Bidder to ensure the desired quality of the end product to be supplied by him.
- 10.02.7 The Standards and norms to which these tests will be carried out are mentioned elsewhere in these specifications. Where a particular test is a specific requirement of this specification, the norms and procedures of the test shall be mutually agreed to between the Bidder and the Owner in the Quality Assurance Programme.
- 10.02.8 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Supplier in the proforma for “Guaranteed Technical Particulars”, furnished in this Specification or acceptance value specified in this specification, whichever is more stringent for that particular test.
- 10.02.9 All tests – routine, acceptance and type tests shall be as per IEC-62067 and its Latest Amendments.
- 10.02.10 The adequacy of Partial Discharge detector used for Partial Discharge tests required for drum lengths of cables under routine tests must be demonstrated by performing tests as per IEC-60885 (3) – 1988.

The bidder shall furnish a copy of type tests certificates for the cable and accessories offered as per the specification from any of the following laboratory on similar cable and accessories as offered for this tender in compliance with IEC:62067, CL.No.12.2: Range of Type approval. The test should have been conducted within the last 10 years as on the last date of submission of bid. No charge is payable by the owner for the type tests.

a) For cables & accessories manufactured in India:

- i. The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

b) For cables & accessories manufactured Abroad:

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term “Purchasing Utility” covers the foreign Utility who has purchased that equipment.

Following are the type test reports which are to be enclosed/uploaded in the bid.

- 1) Prequalification test – (Cl. 10.02.1 of specification)
- 2) Electrical Type tests as per – (Cl. 10.03 (1)(a) to (j) of specification).
- 3) Non-Electrical Type tests as per – (Cl. No. 10.03 (2) (a) to(o) of specification).
- 4) Special test as per- (Cl. 10.06 (a) (i) & (ii) of specification)
- 5) Type test for Link box- (Cl. No. 7.04.1 of specification)

10.02.12 Tests to be conducted during the supplies/after completion of supplies for acceptance of cable and accessories will be at the discretion of the Owner.

1) CABLE:

The owner will select at random a test sample of cable from the lot and subject

it to **either a particular type test or** full range of type tests as per IEC-62067: 2011 at any reputed testing house or Laboratory or at manufacturer premises to be approved by KPTCL.

The bidder shall prepare the sample for tests and organize testing.

The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below). If the cable fails in any of the type tests, the entire lot of cable will be rejected.

2) JOINTS & TERMINATION:

Two Terminations and one joint will be selected at random out of the supplies and subjected to **either a particular Type test or** full range of type and other tests at any reputed testing house/laboratory to be approved by KPTCL as per Clause IEC 62067: 2011 and tests shall be carried out accordingly.

The bidder shall prepare the sample for tests and organise testing. The type test/s will be conducted at Owner's cost.

However, the bidder shall make arrangements for transportation of test samples from manufacturing unit to the Test Laboratory indicated by owner at his cost.

The applicable type test charges for only to such tests to be conducted as per owner's instructions will be payable by the Owner.(Refer Note (e) given below).

If the sample under test i.e., cable / joint / termination fails, the entire lot of cable / joint / termination will be rejected.

- 3)** The tests mentioned in (1) & (2) above are independent of the type test reports already furnished by the supplier.

NOTE: (a) The waiver of any type tests shall be at the sole discretion of the owner.

(b)The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.

(c) The cost towards **each** type test shall be clearly indicated **seperately** in the bid and the same will be included for bid evaluation.

(d) The owner may modify tests by including additional tests or delete certain tests at his discretion.

(e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected.

The type test charges shall be paid upfront by the firm/bidder even though the same is on the behest of KPTCL. However such type test charges as per actuals shall be reimbursed to the firm/bidder in case the cable passes the type tests successfully. Type test charges will not be reimbursed if the cable fails in the type test.

10.03.0 TYPE TESTS ON CABLE SYSTEM (CABLES & CABLE ACCESSORIES):

The following type tests comprising the electrical tests on the completed cable and the appropriate tests on the cable components shall be conducted in any of the laboratory to be approved by KPTCL in the presence of the owner's representative.

The owner may at his discretion, waive the type tests, modify the tests, request for additional tests.

- 1) The type tests and sequence of electrical test (as per following clauses of IEC 62067) on complete cable system shall be:
 - a) Bending Test on the cable (Cl.12.4.3) followed by installation of accessories and a partial discharge test at ambient temperature (Cl. 12.4.4)
 - b) Tan Delta measurement (Cl:12.4.5)
 - c) Heating cycle voltage test (Cl:12.4.7)
 - d) Partial discharge test (Cl:12.4.4)
 - at ambient temperature, and
 - at high temperature.The tests shall be carried out after the final cycle of item (c) above or alternatively, after the lightning impulse voltage test in item (f) below.
 - e) Switching impulse voltage test (required for $U_m \geq 300\text{kV}$ Cl.12.4.7.1)
 - f) Lightning impulse voltage test followed by a power frequency voltage test (Cl.12.4.7.2)
 - g) Partial discharge tests, if not previously carried out in item (d) above.
 - h) Tests of outer protection for joints (Refer annexure G):
 - i) Examination of the cable system with cable and accessories on completion of the above tests (Cl. 12.4.8)
 - j) The resistivity of the cable semi-conducting screens (Cl. 12.4.9) shall be measured on a separate sample.
- 2) The Non Electrical type tests (as per the following clauses of IEC 62067) on cable components & on completed cable shall be:
 - a) Check the cable construction (Cl. 12.5.1)
 - b) Tests for determining the mechanical properties of insulation before and after ageing (Cl. 12.5.2)
 - c) Tests for determining the mechanical properties of oversheaths before and

- after ageing (Cl. 12.5.3)
- d) Ageing tests on pieces of complete cable to check compatibility of materials (Cl. 12.5.4)
- e) Pressure test at high temperature on oversheaths (Cl. 12.5.6)
- f) Hot set test for EPR and XLPE insulations (Cl. 12.5.10)
- g) Measurement of density of HDPE insulation (Cl. 12.5.11)
- h) Measurement of carbon black content of black PE oversheaths (ST₃ and ST₇) (Cl. 12.5.12)
- i) Test under fire conditions (Cl. 12.5.13)
- j) Water penetration test (Cl. 12.5.14)
- k) Tests on components of cables with a longitudinally applied metal type or foil, bonded to the oversheath (Cl. 12.5.15)

Note: All the applicable tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

10.04.0 ROUTINE TESTS ON CABLE AND ON THE MAIN INSULATION OF PREFABRICATED ACCESSORIES:

The following tests (as per following clauses of IEC-62067) shall be carried out on each manufactured length of cable:

- a) Partial discharge test (Clause 9.2).
- b) Voltage test (Clause 9.3).
- c) Electrical test on over sheath of the cable (Clause 9.4).
- d) Conductor resistance test (Clause 10.5).

10.05.0 ACCEPTANCE TEST / SAMPLE TESTS ON CABLES:

The following tests (as per following clauses of IEC-62067) shall be carried out on samples.

- a) Conductor examination (Clause 10.4).
- b) Measurement of electrical resistance of conductor and of metal screen/sheath (Clause 10.5).
- c) Measurement of thickness of insulation and oversheath (Clause 10.6).
- d) Measurement of thickness of metallic sheath (Clause 10.7).
- e) Measurement of diameters, if required (Clause 10.8)
- f) Hot set test for XLPE and EPR insulation (Clause 10.9).
- g) Measurement of capacitance (Clause 10.10).
- h) Lightning impulse voltage test (Clause 10.12).
- i) Water penetration test, if applicable (Clause 10.13)

Note: All the applicable acceptance tests/sample tests as per IEC-62067 shall be conducted for the cable requirement of this specification.

Frequency of Acceptance Tests:

The acceptance tests shall be conducted on one drum length from each manufacturing series of the same type and size of cables, but shall be limited to not more than 10% of the number of drum lengths, rounded to upper unity. However, water penetration test & lightning impulse test shall be on one length for the order upto 20Kms and two lengths for more than 20kMs order.

10.06.0 (a) SPECIAL TESTS ON CABLES:

The following are the additional special tests:

- i) Short circuit test on metallic wire screen and lead sheath, in combination at 50kA for 1 Sec with conductor temperature during the test at 90⁰C.
- ii) Test for ovality of the core.
- iii)
 - (a) The waiver of type tests shall be at the sole discretion of the owner.
 - (b) The successful bidder/vendor shall provide the associated cable and testing material for tests at his own cost.
 - (c) The cost towards type tests shall be clearly indicated in the bid and will be included for bid evaluation.
 - (d) The owner may modify tests by including additional tests or delete certain tests at his discretion.
 - e) The test charges would be paid by the owner only for such tests that are, conducted successfully in a third party lab other than manufacturer lab. If the tests are conducted at Manufacturer lab no charges would be paid for such tests. However, the bidder has to quote for such tests. And in case of failure of the test material, the entire lot of cable/joint/termination will be rejected

10.07.0 SPECIAL TEST ON ACCESSORIES:

10.07.1 JOINTS

Cyclic ageing test under water.

The Test shall be conducted as per IEC 62067 Annexure – G

10.07.2 OUTDOOR TERMINATION:

The outdoor termination should meet the following additional test requirements

- (i) Power frequency voltage wet withstand test as per latest version of IEC-62067 standard.
- (ii) Salt fog test as per IEC.
- (iii) Material test (if applicable)
 - a) Tracking and erosion resistance
 - b) Thermal ageing
 - c) Weather resistance

10.08.0 ADDITIONAL TESTS:

Following tests shall be carried out as per IEC-62067: 2011, Cl. No. 16.0 on the complete installation after completion of cable laying, jointing and providing all necessary accessories.

- a) Insulation resistance test.
- b) DC voltage test of over sheath & AC voltage test of the insulation in accordance with IEC-62067: 2011 (Cl. No. 16.2 & 16.3).
- c) Site tests on non-metallic sheaths in accordance with latest version of IEC-60229.

The supplier shall also indicate any additional special test at site recommended by them to ensure satisfactory operation.

10.08.1 The Bidder shall furnish all the testing details in a compact disc (CD).

10.09.0 GUARANTEED LOSS:

Regarding guaranteed losses, measured losses and capitalization of losses for the purpose of evaluation of the offer refer respective clause in SCC of bid document.

11.00.0 IDENTIFICATION:

The Cable should be identified by embossed letters in English as per Clause 6.13 of technical specification.

The accessories shall be marked with voltage class, size of cable conductor, manufacturers name or trademark, date of manufacture and relevant technical information.

12.00.0 QUALITY ASSURANCE PLAN:

- a) The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.
- i. Structure of the organization.
 - ii. The duties and responsibilities assigned to staff for ensuring quality of work.
 - iii. The system of purchasing, taking delivery and verification of materials.
 - iv. The system for ensuring quality of workmanship.
 - v. The quality assurance arrangements shall conform to the relevant requirement of ISO-9001 or ISO-9002 as applicable.
 - vi. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of tests normally carried out on raw materials in the presence of suppliers representative, copies of test certificates.
 - vii. List of manufacturing facilities available.
 - viii. Manufacturing process shall be fully automatic with dust proof/Air conditioned working atmosphere.
 - ix. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
 - x. List of testing equipment available with the bidder for final testing of equipment specified and test plant limitation, if any vis-à-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the "Schedule of Deviations" from the specified test requirements.
 - xi. Level of automation achieved & test of areas where manual processing exists.
- b) The Successful bidder shall within 30 days of placement of order, submit the following information to the Owner.
- i. List of raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.
 - ii. Type test certificates of the bought out accessories if required by the Owner.
 - iii. Quality Assurance Plan (QAP) with holds points for owner inspection. QAP

and owners hold points shall be discussed between the owner and successful bidder before the QAP is finalized.

- iv. The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing if required by the owner and ensure that the quality assurance requirements of specifications are followed by the sub-contractor.
- c) The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details:
- i. Quality System
 - The Structure of the organization.
 - The duties and responsibilities assigned to staff for ensuring quality of work.
 - The system of purchasing, taking delivery and verification of materials.
 - The system of ensuring quality workmanship.
 - The system of control of documentation.
 - The system of retention of records.
 - The arrangement of successful bidder internal auditing.
 - A list of administrative and work procedures required to achieve successful bidder quality requirements. These procedures shall be made readily available to the Owner for inspection on request.
 - ii. Quality Plans:
 - An outline of the proposed work and programme sequence.
 - The structure of contractor's organizations for the contract.
 - The duties and responsibilities ensuring quality of work.
 - Hold and notification points.
 - Submission of engineering documents required by this specification.
 - The Inspection of the materials and components on request.
 - Reference to successful bidder work procedures appropriate to each activity.

- Inspection during fabrication/construction.
- Final inspection and test.

The Owner reserves the right to seek documentary proof of the source of material (insulation, outer sheath, and other cable components) and to cross check with the supplier.

13.00.0 INSPECTION:

Inspection may be carried out by the owner at any stage of manufacture. The successful bidder shall grant free access to the owner's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the owner informed in advance about the manufacturing programme so that arrangement can be made for inspection.

The owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa, to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the Contractor.

- 13.02.0 The owner reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.
- 13.03.0 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested in presence of the owner's representative and cleared for despatch.
- 13.04.0 The supplier shall give 30 days advance intimation to enable the owner to depute his representative for witnessing type tests, acceptance and routine tests.

14.00.0 PACKING AND MARKING:

14.01.0 DELIVERY LENGTH OF CABLE:

It is important to note that the correct delivery length on each drum and the total number of drums to be delivered shall be ascertained by the successful bidder before manufacture, by cable route survey and approval of the owner.

The inner diameter of the drum shall not be less than 20 D and the minimum delivery length of the cable on each drum shall be approximately 500 Mtrs (Five

Hundred) subject to approval of the owner.

- 14.02.0 The cable shall be wound on non-returnable strong steel drums. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks. The ends of the cable shall be sealed with good quality heat shrink sealing caps. The required additional sealing caps of sufficient quantity shall be supplied for use for testing during laying and jointing at site and to seal spare lengths of cable.

The packing should be able to withstand the rigors of transport.

The following information in bold letters in English shall be painted on the flanges.

- (i) Name and address of the Manufacturer, Trade name/Trade Mark/Brand.
- (ii) Size of cable (cross section) rated voltage, standard, insulation, cable code, drum number, year of manufacture.
- (iii) Length of cables (metres).
- (iv) Direction of Rolling.
- (v) Net weight (in Kg).
- (vi) Gross weight (in Kg).
- (vii) Purchase order reference.

- Note:**
- a. Economic drum length shall be got approved from the owner during the survey of route by the successful bidder and inner drum diameter shall not be less than 20 D.
 - b. Each cable end shall be hermetically sealed by means of metal cups using wiping lead so as to protect the cable from moisture penetration during transit, storage and laying. Pulling tension shall be furnished by the successful bidder.
 - c. The vendor shall be responsible for any damage to the cables during transit due to cable or reels not having been properly fastened, packed and secured.
 - d. Two Nos. of swivels of suitable capacity shall be supplied along with the first batch of cables free of cost.
 - e) The maximum weight of cable along with drum to be furnished by the successful bidder before execution of works.

Handling and Storage:

All accessories and spares shall have a minimum shelf life of 10 years, detailed instructions for storing accessories and all equipments which are supplied by the vendor shall be indicated.

15.00.0 DESPATCHES:

No dispatches shall be made without approval from the Owner to the test certificates. All dispatches shall be made to the consignees intimated by the owner.

16.00.0 CABLE LENGTHS:

The correct total quantity, the number of drums, the length of cable on each drum shall be ascertained by the successful bidder from the owner, at the time of manufacture. This is in view of any change in the already finalized route plan, profile which may arise due to any unforeseen circumstances between the period of placing the order and commencement of manufacture.

17.00.0 DELIVERY AT STORES/SITE STORES:

The stores / site is located at Bangalore. All regulations governing the transport of goods by various modes of transport shall be observed by the contractor.

It will be the sole responsibility of the successful bidder to deliver the goods safely at the owner's stores / site stores, including handling and unloading etc.,

18.00.0 INSTALLATION:

18.01.0 SURVEY - ROUTE PLAN:

18.01.1 The bidders are requested to fully inform and acquaint themselves on the local site conditions, which have a direct bearing on the cost estimates and execution of the work.

The tentative cable route plan is furnished to the bidder, indicating roads, position of road crossings, railway crossings, drainage crossings etc., in the drawing enclosed with the bidding document. In case of Variations during actual survey or any deviations in quantity, payment would be made as per quantities executed as per actuals.

The successful bidder shall make a detailed survey of the cable route, by excavating the trial pits as warranted by the local conditions and prepare necessary drawings. All relevant data, required shall be properly recorded and preserved for future use and to decide on requirements of:

- Cable delivery length per drum
- Proposed cable sections
- Location of joint bay positions
- Type and quantity of joints required
- Final cable route plans
- Design of cable ducts/trench for road crossings drainage crossings, railway crossings etc.
- Identify locations for bonding.
- Trench with brick masonry side wall and pre-cast reinforced concrete slabs.

The survey data on the cable route should also include recording of the information required for cable design, such as

- Type of soil along the cable route, soil resistivity
- Soil thermal resistivity, PH Value
- Sub soil water locations and other relevant information in designing the ducts and pipes for cable.

NOTE: The quantities executed will be paid at actuals.

18.01.2 LOCATION OF JOINT BAYS:

The location of the joint bays should be carefully decided to avoid, traffic hazards, collection of subsoil water and any possibility of flooding due to storm waters. The joint bays located should be easily accessible for inspection and tests.

18.01.3 CABLE LENGTH, SECTIONS:

The maximum and minimum delivery lengths of cable that can be supplied shall be furnished by the bidder in the tender.

The successful bidder shall carryout a final route survey, fix joint bay locations and finalize the sections and delivery lengths.

A tolerance of $\pm 1\%$ may be assumed while finalizing the actual cable length.

The work on installation and laying of cables will be taken up by the successful bidder only on approval of the route plans by the owner.

18.01.4 CABLE INSTALLATION RECORDS:

The route plan records / drawings, and the final route map drawings after installation and commissioning, should be furnished to the owner. Three transparencies and nine zerox copies each of route plan and 2) Final route map

after installation shall be furnished. Soft copy of the same shall be furnished in CDs.

- 18.01.5 For preparation of cable route plans and cable records, relevant sections of Indian standards publication IS:1255, "Code of Practice for installation and maintenance of power cable", or any other appropriate international standard may be referred for guidance.

18.01.6 SOIL THERMAL RESISTIVITY/ SOIL RESISTIVITY:

The successful bidder shall investigate the soil characteristics along the cable route, at the required laying depths to evaluate the parameters governing the cable design.

The thermal resistivity tests should be carried out at every 200M interval along the cable route and also at specified locations at the direction of the owner. At each location the thermal resistivity tests are to be taken at three different depths and two soil samples are to be taken for further laboratory analysis.

The laboratory analysis of the soil samples collected from the site should be conducted in detail, including soil identification, moisture content, density, organic content, critical moisture content of each soil type encountered along the route to arrive at the thermal resistivity values of the native soil.

These tests should be conducted by using reliable measuring instruments with fully automated thermal property analyser and thermal probes, through reputed agencies, like GEOTHERM, CPRI, Technical Institutions & any other competent organisations. KPTCL will depute its Engineers to witness these tests.

The generally assumed value of the soil thermal resistivity may be taken as 150°C Cm/w .

The OWNER anticipates the presence of soil strata at a few locations along cable routes with a soil thermal resistivity of more than 150°C Cm/w .

However, the successful BIDDER shall be responsible to ensure that no derating of the cable will take place on account of variation in soil thermal characteristics. In consultation with the OWNER, the BIDDER shall analyse and indicate the appropriate backfill (STB – Soil Thermal Backfill) recommended. Bidder will have to design the trench optimally to take care of local site conditions. The maximum permissible soil thermal resistivity shall be limit to 120°C Cm/w in fully dried condition out of the locally available materials to achieve maximum current capacity for the cable section used. BIDDER shall ensure that no derating of the cable takes place on account of soil/backfill thermal characteristics and that proper backfill is used.

In conformity with the above requirement, the BIDDER shall determine and advise on the following:

- Optimum design of trench to take care of local hot spots and methods to reduce effective Thermal resistivity value.
- The type of graded sand to be utilized by sieve analysis as one of the components of the STB backfill to obtain tight fit soil.
- The optimum Kaolinitic clay content in the soil to make it less porous and of high specific surface area for optimum moisture retentivity suitable for areas prone to moisture migration on account of low water table.
- The material and composition of thermal backfill will be finalized during detailed Engineering. Bidder shall be responsible for ensuring the best “effective” thermal resistivity.

Subsequent to completion of backfilling, in-situ measurements of soil thermal resistivity, dry cured density, void ratio, moisture and clay contents of the soil shall be carried out by the BIDDER along the cable routes at regular intervals mutually agreeable to the BIDDER and PURCHAER, using his own instruments as a quality check on the backfill employed and method of back-filling and detailed report shall be submitted by BIDDER.

However, the successful bidder shall carry out the required investigation and tests to evaluate and determine the soil resistivity and soil thermal resistivity along the cable route, at cable laying depth, to the satisfaction of the owner.

18.01.7 THERMAL BACKFILLS:

The successful bidder shall design, specify supply formulate, test and lay a suitable backfill, only if the owner desires and with the prior approval of the owner, if found necessary after the receipt of the route survey report for thermal characteristics of the soil.

18.02.0 Laying and installation of Cables:

18.02.1 General

The successful bidder shall carry out all activities connected with the laying and installation of the power cables, and completion of the work for which the project is intended and to the full satisfaction of the owner.

Notwithstanding subsequent changes/alterations in route/design, the bidders shall

quote in their bid proposals for carrying out the cable installation work as per the specifications of the owner, which will be considered for bid evaluation.

However, alternate route/installation arrangements offered from the bidders, with clear justification for these alternatives, will be considered by the owner, if they prove to be of a better and economical design and also the quoted bid value is the lowest.

18.02.2 Scope

This scope covers the proposed method of cable laying, in ground i.e., directly buried in ground with laying in ducts, pipes and in air. The excavation and construction of R.C.C., stone masonry, brick masonry ducts, laying of pipes for installing cable and also for the construction of jointing bays as per requirement of the field conditions.

The scope also includes supply of all requisite materials, labour, tools and plant like sand, brick, stones, steel, cement aggregate for reinforcement, pipes, joint and route markers and all other consumables required for the completion of this work.

The bidder shall insure for materials. The bidder shall handle, load, transport, unload and store all materials at site and arrange for security, till commissioning and handing over to the owner.

18.02.3 Drawings

The bidder shall prepare the drawings for the applicable field conditions of cable installation, like cables directly buried, in ducts, in road crossings, on drainage crossings, railway crossings, cable jointing bays, manholes if any, and furnish 6 copies of each to the owner for approval.

All works are to be executed only after due approval of the competent authority and under the supervision of the engineer in-charge.

18.02.4 Specifications

These specifications are intended for general description of quality, of materials and workmanship of finished work.

They are not intended to cover the minute details. The work shall be executed in accordance with the best modern practices, Indian standards (I.S.) and other relevant codes.

The specifications, referred to above are I.S. Standards relevant to Civil Engineering works and cable laying works.

The specifications shall be read in conjunction with the other parts of the bid documents.

The owner's decision shall be final on any issue in respect of installation.

18.02.5 Installation of U.G.Cables

Installation: The cables shall be laid generally in "directly buried in ground/in RCC cable duct in Trefoil touching formation to form 220 KV 3 single core, single circuit system. However, as per requirement of the field, the cables may also have to be laid;

- in ducts/trenches.
- in HDPE pipes in trefoil/horizontal formation (pipes to be filled with sand/suitable material after cabling).
- in Air at terminations.
- At varying depths due to obstructions.
- As per approved drawings.
- In HDPE pipes for railway crossing

18.02.6 Inspection, Storage and Handling

The successful bidder should take all necessary precautions for inspection of cables on receipt, and for the proper handling and storage. The successful bidder shall have his own arrangement for transporting the cables, materials, equipment to site and back to store.

The cables shall be stored on hard packed surfaces and protected from harmful weather conditions.

The cable drums shall be mounted and transported on only approved type cable drum conveyors. The cable should not be bent beyond permissible limits of the bending radius while laying and jointing.

18.02.7 Statutory Clearances

The installation of cables shall be as per established code of practice and fulfill the

requirements of statutes. Obtaining all statutory clearances from other utility services, like telephones, water supply, power supply, Railways, National highways, Bengaluru Mahanagara Palike and other Local Administrative Authorities for road cutting etc., for laying the cable will be responsibility of the successful bidder.

All necessary approvals of the concerned authorities to be obtained before execution of the works by the successful bidder and necessary assistance will be rendered by the owner.

Charges to the civic/national highways/traffic/defence authorities/Railway/Telephones/Water supply/Power supply/MahanagaraPalike and other Local Administrative authorities etc., as per their standard schedule of rates for grant of permission/approvals for trenching/laying pipes/laying cables etc., are to be paid by the successful bidder. These charges are reimbursable by the owner as per actuals, on production of valid vouchers.

Restoration of the surface to its original condition as per the requirements of the concerned authorities is also included in the scope of the work. (Necessary specification of Bengaluru MahanagaraPalike is included in the Annexure).

The Restoration of the surface shall be carried out as specified in Annexure -1 of the technical specifications (Volume-II) of the tender document.

It is the responsibility of the bidder to ensure the restoration of the surface in complete in all respect before handing over to KPTCL.

18.02.8 Trench/RCC Cable duct

The cable trench/RCC cable duct work involves earth excavation for cable trench/Excavation and Construction of RCC cable duct, back filling and removal of excess earth from site. The work site shall be left as clean as possible after completion of the work.

The earth for construction of trench/RCC cable duct shall be excavated using manual and mechanical modes as per field conditions. Most of the roads are of asphalt surface and some are with cement concrete surface.

An air compressor with pneumatic drill or equivalent mechanical tool will be essential for the road crossings and railway crossings involve horizontal drilling i.e., Trench-less cutting wherever necessary.

Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly restored.

The sides of the excavated trenches/RCC cable duct shall wherever required, be well shored up with timber and sheeting.

Suitable wooden barriers should be erected between the cable trench and pedestrian / motor way/railway to prevent accidents. The barriers could be made out of Jungle Wood / Deal Wood Planks. These could be portable types of size 1.5M (long) by 1.2M (Height). These barriers should be painted with yellow and black or red and White coloured cross stripes. Warning and caution boards should be conspicuously displayed. Red lights as warning signal should be placed along the trench during the nights and any other requirements as per the traffic authorities directions.

The excavated material shall be properly restored immediately after laying the cable by mechanical compactness to avoid obstruction to public and traffic movement.

The cable shall be laid immediately after formation of trenches. The bottom of the excavated trench should be levelled flat and free from any object, which would damage the cables. Any gradient encountered in trench/cable duct shall be gradual.

18.02.9 Cable Handling

The inspection of cable on receipt, handling of cables, paving out, flaking, cushioning with sand or sieved compacted native soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, preparation of all chambers, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to latest edition IS 1255 - 1983 or its equivalent.

18.02.10 Damage to Property

The successful bidder shall take all precautions during excavation of trench/RCC cable duct trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the owner.

The successful bidder shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

18.02.11 Cable over bridges:

Wherever the cable route crosses the bridges, the cables shall be laid in ducts.

18.02.12 Cable crossing open drains with long span

- 1) Wherever the cable route has to cross an open drain, with a long span, the cable shall be laid in suitable size ducts, or pipes, suitably jointed with collars. The entire

duct system shall be designed as per civil engineering practice and shall be got approved by the concerned authorities and owner.

- 2) At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes.

18.02.13 Cable route markers/ cable joint markers.

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per drawings approved by owner.

Markers provided shall be as per the field requirement. If the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information: The name of the owner, voltage, circuit and distance of cable from the marker.

18.02.14 Laying of Power Cables

The 220 KV, single-phase cables shall be laid in Trefoil formation, forming one circuit laid in the trench/duct complying with all applicable standards as per drawings approved by the owner.

The cables shall be laid wherever required in HDPE pipes of ISI approved quality. When cables are laid in RCC hume pipes, the following points shall be taken care of.

If one cable (single phase) is laid through the Cement Concrete pipe, the CC pipe should not have reinforcement of steel rods.

The cable should occupy only 30-40 % of the area of the cross section of pipe.

The CC pipes shall be backfilled by sand after installing the cable.

The cables shall be protected by covering with a pre-cast RCC slab of approved design and marking throughout the length of the route.

18.02.15 Identification

An identification marker/Tag of lead of size 50 mm x 25 mm x 2mm shall be provided at 2.5 meter intervals throughout the route length of the cable and fastened with a suitable nylon string. The marker shall be embossed/punched on both sides with the letters, KPTCL, 220 KV, CKT-1, Phase identification by coloured PVC tape shall be at 1M interval. Alternatively plastic tags may be used. These tags should also be fixed, at the cable inlet and outlets of a duct, tunnel, manhole and joint bays.

18.02.16 **Warning Tape:**

A prewarning, Red colour plastic /PVC tape, 150 mm wide 100 microns thick, shall be laid at specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION; KPTCL, 220000V CABLES.

18.02.17 **Paving out the cable**

The excavated cable trench/RCC cable duct shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paving out the cable. The cable shall be rolled in the trench/RCC cable duct on cable rollers, spaced out at uniform intervals. The paving out process must be smooth and steady without subjecting the cable to abnormal tension. For this power winch, power roller – both straight and angle roller, may be used. The cable on being paved out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed not exceeding 600 to 1000 mtrs per hour.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores, for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct.

18.02.18 **Flaking:**

The cables shall be flaked and left with slight extra lengths at jointing bays for expansion and flexibility.

18.02.19 **Sand Cushion:**

The sieved sand cushion for the cables shall be provided as per the drawings. Sand covering shall be done by hand and in such a manner as to provide complete envelope for the cables and a good bedding for protection covers

18.02.20 **Thermal Backfill:**

Based on the evaluation of soil thermal resistivity along the cable route and after

approval from the owner the successful bidder shall design, specify, supply, lay & monitor the installation of thermal backfill surrounding the cables.

18.02.21 Immediate Envelope To Cable

The option on the use of the material, which immediately envelops the cable viz., thermal backfill or sand or sieved native soil rests with the owner. The successful bidder shall seek prior approval on the use of the envelope material from the owner before execution of the works.

18.02.22 Prevention of damage due to sharp edges

After the cables have been laid in the trench/RCC cable duct and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench/RCC cable duct or placed in such a position that may fall into the trench/RCC cable duct.

Straight and curved (angle) rollers used shall have no sharp projecting parts liable to damage the cable.

While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. Bell mouth shall be used whenever the cables are drawn inside HDPE pipe, duct..

The cables shall never be bent, beyond the specified bending radius.

18.02.23 Road Crossings:

The road cutting work for cable trench/RCC cable duct whether cement concrete, asphalt or macadam road surface shall be taken after obtaining approval for cutting from the civic authorities, traffic police, telephone authorities and work should be planned to be completed in the shortest possible time. Wherever necessary the work shall be planned during night time or light traffic periods.

In the excavated trench across the road, the cables shall be laid in HDPE pipes, pipes are embedded in RMC (Ready mixed cement concrete) 1:2:4 proportions, excavation backfilled, compacted and the surface shall be redone in the shortest possible time as per the requirements of the civic authorities.

18.02.24 Footpath Cutting:

The slabs, kerbstones, on the roads shall be removed and reinstated without damage.

18.02.25 Reinstatement:

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energised and taken over by the owner. The protective covers shall then be provided, the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required, then temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

In case of the road surface being cement concrete, asphalt or tarred macadam, resurfacing shall be done as per the requirements of the civic authorities.

18.02.26 Jointing Bays:

The successful bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The joint bays shall be of sufficient size to accommodate jointing of cables and constructed with RCC M20 Grade and Fe 415 Steel. It shall consist of RCC raft laid over PCC 1:4:8, RCC Retaining walls/Side walls and RCC cover slab with an inspection chamber. All exposed faces of raft, slab and side walls shall be plastered with 12mm thick Cement Mortar 1:4. At the bottom in a corner, a sump pit shall be made for bailing out water.

After completion of all the works, viz., construction of Jointing Bay, laying of cables, testing of cables/jointing etc., the jointing bay shall be backfilled with riddled sand.

The successful bidder shall submit an economical design and drawing of joint bay for approval of the owner.

All works shall be carried out in presence and supervision of the owner's engineer.

18.02.27 Railway Crossing:

The earth shall be excavated using an air compressor with pneumatic drill or equivalent mechanical tool for laying pipes for crossing of railway track after obtaining prior approval of railway authority. The work shall be planned to be

completed within shortest possible time. The work shall be carried out as per the standard practice suggested by railway authorities.

18.02.28 Tools and Plant

The successful bidder shall have all necessary tools, plant and equipment to carry out the survey and cable installation work.

The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

18.03.0 JOINTING AND TERMINATING:

18.03.1 Jointing Of Cables

General: The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriageways, driveways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables, and water mains should be avoided wherever possible.

Sufficient over lap of cables, shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed.

The joints of different phases shall be staggered in the jointing bay.

The cable jointing work should be necessarily got done only through well trained professional jointers.

Jointing work details

- i) Uncoiling, cleaning, straightening and trimming of 220KV cable as required for jointing.
- ii) Checking the cable inside the joint bay before cutting the cable, for any accidental damages due to re-excavation.
- iii) Providing the joint tent, tools etc., at the site by the vendor.
- iv) Erection of joint tent, (joint tents should be of metallic housing.
- v) Electrification of the joint bay, arranging and fixing of air conditioners and maintaining them for the entire period of jointing (temperature inside the

- joint tents should be maintained below 25 deg C.)
- vi) Transporting the required quantity of jointing kits from stores to site (Including link boxes)
 - vii) Dismantling the wiring, air conditioner etc.
 - viii) Dismantling the joint tent.
 - ix) Devolution of cable cut bits to departmental stores including transportation.
 - x) Providing security guards for joint bay.
 - xi) Cost of power for the entire period of jointing.
 - xii) Providing 2 Nos. 2 HP Diesel Dewatering pumps.

18.03.2 Sumpholes:

While jointing cables in water logged ground or under unforeseen rainy conditions, a sumphole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or bailed out by buckets, without causing interference to the jointing operation.

18.03.3 Tents/Covers

Erection of Joint tent (Joint tent shall be of metallic housing) Electrification of Joint bay, arranging and Fixing of Air conditioners and maintaining them for entire period of jointing (Temperature of Joint tent should be maintained below 25 deg. C)

Providing sheath protection for earthing wherever necessary. All accessories and spares required shall be of satisfactory operation for 10 years and furnish the details of maintenance.

18.03.4 Precautions before making a joint:

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

18.03.04A PERT CHART

Indicating time schedule for supply of cable and accessories and supervision of cable laying, testing and commissioning shall be furnished by successful vendor in consultation with the purchaser and should be got approved along with drum length approval. The schedule should be kept up by the vendor. Any delay in completing the work will attract penalty.

18.03.5 Measurement of Insulation Resistance:

Before jointing, the insulation resistance of both sections of cables shall be checked.

Before laying cable in the ground, the insulation resistance of each section shall be measured.

18.03.6 Identification:

The identification of each phase shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

18.03.7 Making a Joint

Comprehensive jointing instructions should be obtained from the manufacturer of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs, etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing EHV XLPE cables.

18.03.8 Cable Terminations

The cable terminations used are outdoor type/GIS plugin type.

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures.

The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included.

- i) A sufficient length of spare cable shall be left in the ground, for future needs
- ii) The rise of the cable, immediately from the ground shall be enclosed in minimum dia of 250 mm HDPE pipe to protect against direct exposure to the sun.
- iii) The cable shall be properly fastened using nonmetallic clamps.
- iv) Appropriate labels shall be fixed identifying the phase, circuit, Voltage and date of commissioning etc., on the cable supporting structure.

- v) The sealing ends shall be mounted on pedestal insulators to isolate them from their supporting steel work.
- vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.
- vii) Providing earth stations with all required materials like leads, connectors, earthing rods/pipes etc.

ACCESSORIES

Dust and humidity free enclosures complete with air conditioners and material handling equipment shall be used by the vendor.

All special tools including a set of jointers hand tools that are necessary to complete the joint/termination works shall be arranged by the vendor. Necessary power supply for jointing and termination works shall be arranged by the vendor.

The cost of consumables which are essential for satisfactory erection and commissioning shall be included.

Adequate quantity of consumable shall be supplied for completing the entire cable laying and jointing works.

Termination Work details:

- 1) Erection of termination structure.
- 2) Removal of cable from the trench, rerouting, cleaning straightening and trimming if necessary, checking the exposed cable before cutting the cable for any accidental damages due to re-excavation.
- 3) Providing of scaffolding pipes, clamps, wooden planks and tools for erection of termination.
- 4) Erection of scaffolding pipes/ providing crane for lifting 220KV cable and termination.
- 5) Lifting the cable up the terminal structure and positioning.
- 6) Transporting the termination kit from departmental stores (including link boxes)
- 7) Dismantling scaffolding work.
- 8) Transporting the above item back.
- 9) Devolution of cable cut bit to departmental stores including transportation.
- 10) Provision of security guard for the cable end/ termination.
- 11) Providing fire retardant paint for exposed portion of the cable and other

related works.

12) Cost of power for the entire period of work.

18.03.9 Bonding of screen/sheath

The type of bonding i.e., single end bonding/both end bonding/cross bonding as recommended by the successful bidder, shall be adopted.

For one/both end bonding:

The screens at one/both ends, shall be brought out and solidly bonded/ or through SVL to the earth station through disconnecting type link boxes.

The link boxes, single-phase outdoor type with SVL at receiving end (with bye-pass arrangement for SVL) and without SVL at sending end shall be provided.

All accessories and consumables used in the termination should be of good quality and compatible with the cable.

For cross bonding:

Shall be executed as recommended in Clause No.7.04.03.

18.03.10 Connection of Radial Water Barrier and Cable Screen

If the metallic radial water barrier is insulated from the metallic wire screen a connection suitable to carry the currents occurring during operation must be

installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

18.03.11 Erection of Cable Terminating Structure.

The terminating structure should be designed as per the requirement of the cable end sealing, offered by the bidder.

The mounting structure shall have good cement concrete foundation as per civil engineering norms/ Approved drawings.

After fixing the end termination, the cable shall be fixed to the support, with nonmagnetic material clamps to the required height securely. The drawings of station structure and equipment for connection of cable will be furnished by the

owner.

18.03.12 Surplus Cable

The wastage of cable beyond practically required permissible limits should be avoided.

For any valid reason if there is a surplus cable, it shall be returned to the owner's store.

Approved good quality sealing caps, heat shrinkable type of the correct size, shall be supplied for spare cut lengths of cable exceeding 100 M length, to enable them to be properly stored for future maintenance purposes. The successful bidder shall be responsible for the immediate sealing of such cut lengths and the cost of the sealing end etc., thereof shall be deemed to have been included in the contract price.

The successful bidder shall clean the completed cable route and shall remove all surplus and waste materials, empty cable reels etc., preferably the same day but not later than the next day after the particular work is completed.

18.04.0 CIVIL AND STRUCTURAL WORKS:

General : This specification deals in brief with the civil and structural works for cable laying.

- a) The scope of civil works include earth excavation for cable trench & RCC cable duct and cable laying, removal of excavated earth, design, supply and provide plain & reinforced cement concrete for foundations of equipment, support structures, back filling, dewatering of trenches. Design, supply and providing cable jointing bays. The design of RCC cable duct for laying the cable along the route and cable duct/pipe ducts for crossing drains, roads, railway lines etc., shall be suitably done and rates quoted, making provision for complete supplies and erection as per relevant schedules. It includes all connected civil works.
- b) Design, fabrication and supply of galvanised steel structures for cable end terminations, mounting of earthing link boxes.
- c) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

18.04.1 Codes And Standards

Unless otherwise stated, latest Editions of the following standards are applicable.

IS:1255	:	Installation and Maintenance of Power Cable.
IS:5820	:	Specification for pre-cast concrete cable cover.
IS:209	:	Quality of Zinc for galvanising.
IS:226	:	Structural Steel.
IS:456	:	Plain and Reinforced Cement Concrete.
IS:800	:	Use of structural steel in general building construction.
IS:2016	:	Plain washers.
IS:2633	:	Zinc coating on Galvanised Steel.
IS:3063	:	Spring washers.
IS:5358	:	Hot Dip Galvanised coating on fasteners.
IS:6639	:	Hexagonal Bolts for steel structures.
Any other equivalent International/National Standard.		

18.04.2 **Excavation**

The specification covers excavation for cable trenches, ducts, structural foundations, jointing bays.

The successful bidder shall control the grading in the vicinity of all excavations so that the surface of the ground will be properly sloped or diked to prevent surface water from running into the excavated area during construction.

The excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance to permit the placing,

inspection and setting of forms and completion of all works for which the excavation is done.

The sides and bottoms of excavation shall be cut sharp and true. Under cutting shall not be permitted. Earth sides of excavation shall not be used in lieu of form work for placement of concrete unless authorised by the Engineers of the owner where the limitations of space for large excavation necessitates such decision.

18.04.3 **Quantities**

The bidder shall indicate the ceiling volumes/quantities for excavation and RCC works and Steel structure works, wherever specifically indicated.

18.04.4 The bidder shall quote unit rates for the items of works. He shall also quote the total price for each of the works.

18.04.5 The quoted price shall also include supply of all material, transportation charges, taxes, duties, octroi and toll, labour, construction plant and equipment and fixtures, fittings and all temporary and permanent works necessary for satisfactory

completion in all respects.

- 18.04.6 The measurements of various civil works shall be jointly recorded; by the successful bidder and the Engineer-in-charge of the owner and duly certified.
- 18.04.7 When machines are used for excavation the last 300mm. before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at required final level in its natural condition.
- 18.04.8 The bottom of the excavation shall be trimmed to the required level and when carried below such level by error, shall be brought to level, by filling with lean concrete of 1:4:8 mix, at successful bidder cost.
- 18.04.9 If the successful bidder is directed by the Engineer-in-charge of the owner to excavate to a lower level than that indicated on the drawing, such additional excavation shall be paid for at the applicable unit rates provided in the tender.
The rates shall be firm irrespective of increase in quantities to any extent. The bidder is bound to carryout any Non-tendered items of work required for completion of the task. For such items of work the applicable KPWD /MWSR schedule of rates, Data rates or derived rates whichever found appropriate will be allowed.
- 18.04.10 The successful bidder shall be responsible for his estimates, assumptions and conclusions regarding the nature of the materials to be excavated and difficulty of making and maintaining of required excavations and performing the work

required as shown on the drawing and in accordance with these specifications. Cofferdams, sheeting, shoring, bracing, draining, dewatering etc., shall be furnished and installed as required and the cost thereof shall be included in unit rate quoted for the item of excavation. The successful bidder shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavation. The materials can be salvaged if it can be done with safety for the work and structure and as approved by the Engineering-in-charge.

However, no extra claim shall be entertained for material not salvaged or any other damage to successful bidder property as the results of the collapse. He shall not be entitled to any claim for redoing the excavation as a result of the same.
- 18.04.11 All excavation for installation of underground facilities shall be open cuts.
- 18.04.12 The excavation for foundation where specified shall be carried out atleast 75mm. or as specified in relevant drawing below the bottom of the structure concrete and then be brought to the required level by placing lean concrete of 1:4:8 Mix or as specified with aggregate of 40mm. nominal size.

18.04.13 When the excavation requires bracing, sheeting, shoring, or strutting etc., the successful bidder shall submit to the Engineer-in-charge drawings showing arrangement and details of proposed installation and shall obtain the approval from the Engineer-in-charge before proceeding with the work.

18.04.14 The successful bidder shall have to constantly pump out the water collected in the pits, trenches, due to rain, sub-soil, springs etc., and maintain dry working conditions at no extra cost to the owner.

18.04.15 Classification of soil:

For purpose of excavation, the soil is classified as ordinary soil, Hard soil, Ordinary rock and Hard Rock. The details of classifications are given in Annexure - TS-I.

18.04.16 Measurement Of Excavation:

The measurement, for the payment of earth excavation will be based on volume calculations of pit/trench. The unit of measurement shall be cubic meters. Nothing extra would be payable for slopes, shoring, strutting, etc., irrespective of whatever is provided. If directed by the Engineer-in-charge, the excavation shall be done on the slopes from slope stability point of view at no extra cost to the owner.

18.04.17 Carriage of excavated soil beyond a lead of 50 mts per lift of 1.5 mts.

18.04.18 By manual labour:

The excavated earth for disposal purpose beyond 50 mts and upto 300 mts shall be carried by manual labour. If directed by the Engineer-in-charge, this earth shall be used for back filling purpose. The rate for disposal of earth by manual labor upto 300 Mtrs shall be included in the excavation item and no extra rate for the same is admissible.

18.04.19 **By Mechanical Transport:** The successful bidder shall arrange to transport the surplus earth and soft/hard rock, left over after back filling the trench up to the required level (with watering and compaction) and disposal of earth by manual labor, by Mechanical means, to the disposal point of the local bodies with all leads and lifts and as directed by the Engineer-in-charge. It shall however be ensured that no soil is stacked in excavated area. Location where the soil is to be stacked/disposed shall be as directed by the Engineer-in-charge. However the successful bidder shall take all precautions at the site of excavation, for keeping the free flow of vehicular and human traffic and to avoid inconvenience in general.

The soil transported for disposal, shall be stacked and leveled neatly and dressed.

The rate for this item shall include loading, carriage, unloading, stacking and dressing etc., complete.

- 18.04.20 In no case the excavated soil shall be stacked upto to the distance of 1.5 mts from the edge of excavation or one third the depth of excavation whichever is more.

18.04.21 Lead And Lift:

The rates quoted for all items of work shall include all lifts and leads whenever applicable unless otherwise specified.

18.04.22 Excavation and measurement in Hard Rock:

Blasting in hard rock shall be done as per IS: 4081 (latest Edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Premeasurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

At locations where, open blasting can not be taken up due to site conditions, controlled blasting or removal of rock by chiseling & wedging shall be resorted to. The rate for excavation of hard rock shall include its removal by all the types referred to, appropriate to the site conditions.

18.04.23 Backfilling Materials:

The backfilling of excavated trenches/RCC cable duct & around foundation shall consist of one of the following materials as the Engineer-in-charge may direct in each location.

- i) Selected sieved earth from excavated soil.
- ii) Selected sieved earth brought from borrowed area.
- iii) Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.

Filling shall be done after the concrete or masonry work has fully set and its curing completed.

The successful bidder shall fill in and around any work untill it has been properly reinstated and approved by the Engineer-in-charge.

18.04.24 Backfilling for cable trench:

Backfilling shall be done in horizontal layers of thickness not exceeding 300mm thickness, free from pockets with careful watering where necessary for compaction. The backfill shall be riddled earth free from materials likely to cause damage to the cables.

The thermal backfill surrounding the cable shall be as per the design approved, by

the owner.

18.04.25 **Measurements:**

Payments for back filling shall be based on the volume of consolidated fill. This volume shall be derived from the difference between the volume of excavation and that of the structure (Concrete work, sand filling), or trench as the case may be.

18.04.26 **Specification For Cement Concrete:**

For the cement concrete, plain or reinforced for general use, requirement of concrete for nominal mix, strength and quality, pouring at all levels, form works, protection covering, finishing, add mixtures, inserts, curing etc., the provisions of the latest revision of IS:456 shall be complied with, unless permitted otherwise by any other Indian Standard Codes, shall form the part of the specification to the extent applicable within specification. The cement used shall comply with IS:269. The metal (Jelly) used in PCC/RCC shall be properly graded and machine mixed.

18.04.27 **Curing And Protection Of Concrete:**

All fresh concrete shall be covered with the layer of an absorbent material and kept constantly wet for a period of seven days or more from the date of placing concrete. The immature concrete shall be protected from the damages and contamination, that would impair the strength of the concrete.

18.04.28 **Precast RCC Items:**

The concrete mix for the various types of precast units shall conform to IS:456. The aggregate shall be mixed by weight and water cement ratio shall be controlled to obtain the dense concrete and the strength required. The reinforcement shall be as per the design approved. The curing shall be carried out for the period of seven days from the date of casting, and the precast element shall be cured by flooding with water of minimum 25mm. depth over the element for the period mentioned above.

All the precast element shall be marked, appropriately as specified.

18.04.29 **Masonry Work:**

Stone masonry and Brick (Table mould) masonry work wherever required shall be carried out by the contractor. The associated materials for masonry work like stones, bricks, sand etc., shall be of approved quality. The construction shall comply with accepted norms and standards.

18.04.30 **Plaster:** Plastering shall be done with cement and sand mortar, 1:4 by volume with

clean sand. All plaster work shall comply with IS:1661.

Materials for plaster such as cement, sand, water shall conform to standards.

18.04.31 Mounting Structures:

The mounting structure include the supports for cable end boxes, link boxes and any other structure required for the intent of the contract.

All steel sections used shall be free from all imperfections, mill scales, slag intrusions, laminations, fillings, rust etc., that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the owner. The structures shall be fabricated by the contractor.

18.04.32 Foundation:

Foundations for mounting structures in cement concrete shall be provided as per approved drawings by the Engineer-in-charge.

18.04.33 Bolts Nuts and Washers:

Standard bolts, nuts and washers shall be used in all works. These should be galvanised in accordance with IS:5358.

18.04.34 Painting:

Outdoor Kiosk for link boxes etc., shall be painted with anticorrosive paint and red oxide as primer and two coats of enamel paint. the boxes should be appropriately labelled as per installation at site regarding the Sl. No. location, type caution board/Danger Board. etc.

18.04.35 Materials Used In Cable Laying:

Specification in brief on the materials used in installation of the 220 kV underground cables, like RCC precast cable protection covers, precluded cement concrete blocks for cable route/joint indication, cable and mounting structures, joint bays, earthing and other miscellaneous materials are given below. All materials shall conform to relevant standards, and shall be approved by the Engineer.

18.04.36 RCC Precast Cable Protection Covers:

These should be pre casted as per the approved design and drawing. The reinforced cement concrete should be M20 grade (1:1.5:3 proportion) with 20 mm. and down size coarse aggregate and steel reinforcement (Fe 415 grade) shall be used and cured as per civil Engineering Standards. The covers should carry the legends KPTCL 220 kV CABLES, CKT-1. The covers should be free from burrs and projecting edges so that they may be easily laid to butt. The average breaking load shall be 450 kgs for the cover slabs.

18.04.37 Cable Route Markers/Joint Markers:

Permanent and durable type, cable route markers/ joint indicating blocks should be provided as per the design supplied by the owner.

The cement concrete block should be made by the wet process and the concrete shall consists of one part cement two parts sand four parts aggregate of size 20mm. and down.

The marking block should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5mm. deep engraved on them as "KPTCL 220 KV CABLE CKT-1", "KPTCL 220 KV CABLE JOINT CKT-1".

18.04.38 Pipes:

HDPE pipes of ISI Mark, 250mm dia and above, 20 mm thickness approximate, of good quality shall be used for formation of cable ducts. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided.

Hume pipes and accessories conforming to IS shall be used if required. Reinforced hume pipe shall not be used for laying single core power cable, in one cable per pipe arrangement.

Stoneware pipes, salt glazed of good and approved quality shall be used.

Hume pipes without steel reinforcement, stoneware pipes, HDPE pipes can also be used where the cable passes through the passage or drive ways of public and private buildings.

In case of pipe – the size of the pipe shall be at least 30 to 40% more than size of cable. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable.

18.04.39 Supporting Structure For Cable And Cable End Terminations:

The bidder shall quote for unit prices for support structure for each single core cable to suit the end termination supplied by him. The bidder shall design and furnish the details and drawings.

These support structures shall be fabricated out of galvanised steel pipe to IS:1239 or they shall be fabricated out of galvanised mild steel sections, such as channels, I-beams etc., conforming to IS:226, pipes if used for fabrication of the structure shall not have any joints.

The height of the structure shall be such that the terminal connection to receive the owner's ACSR Double Drake/Moose conductor/63 mm. Diameter, IPS aluminium pipe is approximately at a height of 4.5 meters. The successful bidder shall be furnished with relevant drawings by the owner.

18.04.40 The supporting structure shall be suitable to withstand, the wind pressure, seismic forces and the short circuit forces, etc., and the design shall be with an adequate factor of safety as specified in I.E. rules 1956.

18.04.41 The bidder shall furnish the design and fabrication drawings, foundations, foundation anchor bolts, design calculations etc., of these structures.

18.04.42 Terminal Connectors:

The terminal connector/clamps shall be suitable for connection to 63-mm diameter IPS aluminium pipe or double Drake/Moose ACSR conductor. The terminal connector shall be of bimetallic type to connect the terminal of the cable end to the aluminium bus pipe or ACSR conductor.

The type and size of the connector will be confirmed to the successful bidder.

The connector/clamp shall be designed to overcome:

- i) Galvanic Corrosion.
- ii) Thermal Cycling.

The current carrying capacity of the connector/clamps shall be greater than the maximum capacity of the power cable.

The terminal clamp shall be free from burrs, voids and blowholes.

The terminal clamps shall have passed tests for short circuit current capability and temperature rise.

18.04.43 Sand:

Sand supplied for backfill shall be river sand, free from flakes, dust, earth, organic matter and large pebbles and stones and should be free from any chemical contaminants likely to have corrosive action on the cable coverings.

The sand should be sieved through a mesh to remove all large stones and pebbles.

The sand shall be properly graded and shall conform to IS:383 for concreting work. The owner will decide on the requirement of the use of sand depending on the availability of the excavated earth to be used for backfill.

The sand should be used with the approval of the owner as a backfill.

18.04.44 Earthing:

The earthing system required is for the

- i) Earthing of all non-current carrying metal parts and
- ii) Earthing system for cable screens/sheath bonding at terminations and at all others places wherever required.

The latest editions of the following standards and codes are applicable.

- i) IS:3043 : Code of practice for earthing.
- ii) IS:2309 : Code of practice for the protection of building and allied structures against lightning.
- iii) Indian Electricity Rules 1956 : Provision of Rules on EHV systems.
- iv) IEEE-80 : Guide for safety in sub-station grounding.

All equipment, supporting and mounting structures of the installation shall be bonded together and connected by separate and distinct conductor to earth electrode.

18.04.45 Earth conductor:

The earth conductor shall be of GI flat, of size 50 x 6 mm. size and shall be protected against mechanical damage and corrosion. The connection of the earth continuity conductors to earth bus and earth electrodes shall be strong, secure and sound and shall be easily accessible.

18.04.46 Pipe Earth Stations:

The pipe earth electrodes shall be of cast iron in conformity with IS:3043, buried vertically and the pit filled with alternate layers of charcoal, salt and earth. The earth lead shall be properly fastened with brass bolts nuts and connection shall be enclosed in a masonry chamber. The chamber shall be provided with a RCC inspection cover.

- 18.04.47 The connection between the earthing terminal of equipment and earth electrode shall be made by short and direct earthing lead, free from kinks and splices.

- 18.04.48 The distance between any two electrodes shall not be less than, twice the length of the electrode.
- 18.04.49 All joints shall be covered with suitable compound to protect against corrosion.
- 18.04.50 Earthing connections with equipment earthing terminals shall be of bolted type. The contact surfaces shall be free from scale, paint, enamels, grease, rust or dirt. Two bolts shall be provided for making each connection. The bolted connections after being checked and tested shall be painted with anticorrosive paint or compound.
- 18.04.51 Welds and brazed joints shall be treated with red lead and afterwards coated with bitumen compound to prevent corrosion.
- 18.04.52 Steel to copper connection shall be brazed type and shall be treated to prevent moisture ingress.
- 18.04.53 The resistance of the welded joint shall not be more than the resistance of equivalent length of the conductor.
- 18.04.54 All welded joints shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature.
- 18.04.55 Arc welding with large diameter conductor shall be done with low hydrogen content electrodes.
- 18.04.56 Bonding Of Cable Screens/Sheath:
- Each single phase cable shall have a separate earth for the screen earthing.
- The system short circuit level is 50 kA for 1 Sec. The earthing lead at solid earth positions shall be single core, 240 sq.mm copper conductor, PVC insulated 6.6 KV voltage grade Cable.
- 18.04.57 Earth Tests:
- Tests on earths shall be carried out by the successful bidder for testing the effectiveness of earth resistance of electrodes and the results furnished to the owner.
- 19.00.0 TESTING COMMISSIONING, TYPE/ROUTINE TESTS ON CABLES AND ACCESSORIES**
- 19.01.00 General**

- 19.01.01 The material and equipment covered under this contract are subject to strict codes of owner approved Q.A.P., inspection, and tests.
- 19.01.2 The Engineer or his authorized representative shall have, at all reasonable times access to the contractor's premises to inspect and examine the materials during manufacturer and if part of the equipment is being manufactured or assembled on other premises or works, the bidder shall arrange and obtain permission for the purchaser as if the equipment/material is manufactured at the bidder's own premises. The Owner can depute upto Five Engineers from KPTCL for inspecting the equipments/materials. The Visa to and fro travel expenses from the place of working of officials deputed for inspection, boarding charges, lodging charges and other incidental expenses of the inspecting Engineers for inspections to be carried out outside the country are to be borne by the contractor.
- 19.01.3 The inspection requirement for material shall conform to the design, assembly fabrication and tests defined in the reference code of standards.
- 19.01.4 Approval or passing of any such inspection by the owner, shall not however, prejudice the right of the owner to reject the material or equipment, if it does not comply with the specification when installed and or fails to give the intended service.
- 19.02.0 Notice of Inspection :**
- 19.02.1 The successful bidder shall give the owner thirty days written notice of any material being ready for inspection and tests.
- 19.02.2 The Engineer shall, within fifteen days of the inspection, give notice in writing to the successful bidder of any defects noticed during inspection. The successful bidder shall take corrective measures and shall confirm in writing, of the compliance or otherwise, with due reason.
- 19.02.3 The Engineer shall issue a certificate for having inspected the material/equipment within thirty days of inspection. The issue of the certificates does not bind the owner to accept the material should it on further tests on installation be found not to comply with the contract specification.
- 19.02.4 In the case of stage inspection, the successful bidder shall proceed from one stage to another only after the component is inspected by the owner and permission given to proceed further. The same procedure shall apply for any rectification or repairs suggested by the owner.

- 19.02.5 The owner or the Engineer, shall have the right to inspect any machinery, material, structure, equipment, plant or workmanship, furnished or used by the contractor, and may reject any or all which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the specification.
- The successful bidder on demand by the owner shall remedy or replace, at his expense, such defective material/plant equipment. In the event of the failure by the successful bidder for correcting the defect or replacement of the material / equipment plant, the owner may take such remedial measures necessary, at the expense of the contractor.
- 19.02.6 On the material to be supplied under this contract, it is to be noted that it shall not relieve the successful bidder of his responsibility for supplying material conforming to requirement of the contract, nor prejudice any claim right or privilege which the owner may have because of the use of defective material.
- Should the owner waive the inspection, any item of the material, such waiver shall not relive the successful bidder in any way from his obligation under the contract.
- In the event of inspection by the engineer, and the inspection revealing goods/materials not in conformity with the standard/specification, the owner shall specify additional tests/inspection procedures, if required, to ascertain compliance with specifications.
- 19.02.07 A set of latest relevant approved drawings/data /applicable Reference Standards shall be made available to the Engineer during inspection.
- 19.03.0 TEST ON MATERIALS SUPPLIED BY SUB-SUCCESSFUL BIDDER:**
The plant or equipment supplied by the sub-successful bidder of the successful bidder shall comply in every respect to the specification and applicable tests.
- 19.04.0 TEST MATERIAL:**
The successful bidder shall provide test pieces, as required, in quantity, to determine the quality of material supplied under this contract. If any test piece fails to comply with the requirement the Engineer may reject the whole material represented by the test pieces.
- 19.05.00 TESTS AT MANUFACTURER'S WORKS:**
- 19.05.01 The test at works shall include the electrical, mechanical and hydraulic and other special tests in accordance with the relevant standards.

A complete test schedule/programme shall be furnished by the contractor.

The successful bidder shall carry out all the tests as specified by the owner, under tests for relevant material.

- 19.05.2 Test certificate include, test records and performance graphs, drawings, which shall be supplied to the owner. All tests shall be carried out in accordance with the provisions of the contract.

All test certificates must be endorsed with sufficient information to identify the material or equipment to which the certificate refers, and must carry in the top right hand corner the identification of the owner and the contract.

20kV DC voltage test between the metallic sheath and the outer sheath for each and every length of the cable delivered should be conducted and the sheath leakage at 10kV, 15kV and 20kV are to be furnished and got approved before dispatch of cable drums. The leakage current shall be within limits of 5.0mA for 500mtrs at 20kV Dc and 2.0mA for 500mtrs at 10kV DC.

- 19.05.3 The routine, acceptance and type tests conducted in the presence of the Engineer, and the test certificates shall be approved before the materials are dispatched.

19.06.0 MANUALS & LITERATURE ON MATERIAL/EQUIPMENT

The bidder shall enclose with his offer all literature and manuals relevant to the contract and in particular

- i) On cable offered.
- ii) On cable jointing and terminating techniques.
- iii) Instructions on cable installation, storage, handling, maintenance, fault finding, repairs, preventive maintenance etc.
- iv) Literature on special Tools & plant.
- v) Literature on sheath bonding, maintenance of link boxes.
- vi) Any other relevant literature/manual

19.07.0 TESTS:

- 19.07.1 The successful bidder shall make available to the Engineer a complete set of detailed data, required for inspection and tests.
- 19.07.2 Routine & acceptance Tests shall be conducted at the factory by the successful bidder in accordance with the relevant standard code to determine the performance and characteristics of material equipment/ accessory and to determine whether or not the guarantees of quality have been met.

19.07.03 Routine & acceptance Tests shall be conducted in accordance with the relevant IEC-62067: 2011

19.07.4 TYPE TESTS:

The Successful bidder shall indicate that the equipment/material offered has successfully passed the type tests as required by the relevant standard.

Relevant type test certificates shall be furnished along with the bids to prove the quality of the material/equipment including those of the accessories.

The successful bidder shall agree to conduct all tests or repeat the tests already conducted, for the satisfaction of the owner.

19.08.0 ELECTRICAL TESTS AFTER INSTALLATION:

19.08.1 The Successful bidder shall conduct the following tests during and after installation as per IEC 62067: 2011.

19.08.2 In the event of the installation failing the tests, the successful bidder shall at his own expense, identify the cause and rectify the defects, and render the installation serviceable.

19.08.3 DC Voltage Tests of the Over sheath:

- a) After the cables have been laid and the trench partly filled and before joints are made a 20KV DC voltage is applied to the over sheath of cable, between the metallic sheath and earth for 15 minutes.
- b) The test should be repeated when all the accessories have been installed, before commissioning.
- c) The above tests shall be carried out by the vendor in the presence of owners' representative.
- d) Should a breakdown of the sheath occur during these tests, the vendor shall locate the fault and repair the cable(s) after owner's agreement until the retests give satisfactory results for the total link.
- e) All expenses in connection with the civil works which are made necessary for faults location and repair shall be borne by the vendor including additional costs for the services rendered by the owner

19.08.4 A.C. TESTING:

The installation shall be tested with AC voltage.

(A voltage equal to $1.7 U_0$ or 180Kv applied for One hour between each conductor and metallic sheath as per Cl. No. 16.3 of IEC-62067: 2011, where U_0 is the RMS rated voltage between the conductor and the earth or the metallic sheath. The waveform shall be sinusoidal and the frequency shall be as per Cl. No. 16.3 of IEC-62067.

The installation shall withstand for One hour with the phase to phase voltage applied between the conductor and metallic screen/sheath

OR

Test for 24 hours with the normal operative voltage of the system.

19.08.5 TEST ON NON METALLIC SHEATH:

The non-metallic sheath shall be subjected to test as per IEC publication 60229.

19.08.6 The bidder can recommend any other test, for satisfactory performance of the installed system.

19.08.7 PRE- COMMISSIONING - ELECTRICAL TESTS AFTER INSTALLATION:

On completion of cable laying, jointing and termination works the complete installation will be tested with.

DC Voltage test on over sheath as above for complete installation.

Sheath fault occurring during laying, testing after laying and during pre-commissioning should be rectified by the vendor free of cost (including civil works) Necessary sheath repairing kits with heat shrinkable materials are to be supplied as per the site requirement during execution of works.

The following pre-commissioning tests shall be carried out by the VENDOR after installation.

1. Electrostatic capacitance of the cable
2. Resistance of the cable conductor.
3. Resistance of the Sheath.

These tests should be got done by CPRI.

The vendor is requested to quote testing charges.

The owner reserves the right to witness all the tests and the vendor shall provide all facilities to the owner in this regard. The date of testing will be informed by the owner

sufficiently in advance to the vendor's supervising engineer, to enable the vendor to carry out the tests.

The vendor should furnish (5 copies) of the test results for calculating the total losses.

The observation period shall be one month of operation after energizing of the cable. For this period of one month the cable circuits will be operated by KPTCL under normal conditions.

If a breakdown occur on the cables or accessories during this period, all repairs shall be made by the vendor at his own expenses including civil works and road cut restoration charges. Owner reserves the right to request to change the full length of cable between the two joints chambers, free of charge including duties and taxes etc., this shall not apply for injuries of external origin.

After the verification is done, field tests shall be carried out again according to site tests specified in the tender clause.

The observation period shall be 3 months of operation after repairs and re-energisation. No breakdown shall occur. If breakdown occurs again on the cable & accessories during this period, all repairs & replacement shall be made by the vendor as given in the above para. When the observation period is completed, the guarantee period will start.

20.00.0 DOCUMENTATION

The following documents should be furnished

a) Along with the bid:

- 1) Dimensioned cross sectional details of the cable.
- 2) Current carrying capacities "with supporting calculated data" of the cable and derating factors.
- 3) Manual of instructions on cable handling and cable laying.
- 4) Type, acceptance and routine test certificate on the cables as per relevant IS, IEC or other national standards to be furnished by the bidder. For accessories test certificates shall be furnished along with the bid.
- 5) GA drawing of Dimensioned cross sectional details of the straight through joint kit furnished along with the bill of material.
- 6) Detailed drawing of the straight through joints to be furnished by the bidder.
- 7) Type, acceptance and routine test certificate on the straight through joints shall be furnished by the bidder.
- 8) OGA drawing of the cable end termination furnished along with the offer.
- 9) Dimensioned cross sectional details of cable end termination with bill of materials to be furnished by the bidder.
- 10) Manual of instructions on the method and formation of the cable end termination to be furnished by successful bidder.
- 11) Type, acceptance and routine test certificate on the cable end termination to be

- furnished by the bidder.
- 12) OGA drawing of the cable termination structure along with the bill of materials-to be furnished by the bidder.
 - 13) Foundation drawing of the cable terminating structure.
 - 14) Civil Engineering details of jointing bays with cross sectional elevation and plan.
 - 15) Dimensioned cross sectional details and plan of cable trench/duct/road crossing /drain crossing showing the position of cable.
 - 16) Dimensioned cross sectional drawing of the pipe electrode earthing along with bill of materials.
 - 17) Drawing showing the method of bonding of the cable screen/sheath and the earth connection to be furnished by successful bidder.
 - 18) Drawing of RCC cable protection cover.
 - 19) Calculation of induced voltages in the sheath and the recommended method of bonding.
 - 20) The Successful bidder shall submit 10 sets of cable installation records giving all the details sought by the owner along with the routes map.

b) On award of the contract:

- 1) The successful bidder shall prepare all relevant and associated drawings of the route layout plan indicating the road crossing, crossing across drains, nallahs, railway lines etc., and location of the straight through joints.
- 2) The owner will communicate approval to the drawings furnished in respect of the supply as well as for the installation portion within one month from the date of submission.

ANNEXURE - TS 1

CLASSIFICATION OF SOIL STRATA

1.0 Ordinary Soil:

This shall comprise of vegetable or organic soil, turf, sand, sandy soil, silt, loam, clay, mud, red earth, suade, peat, black cotton soil, soft shale, loose murrum, mud debris, concrete below ground level, a mixture of all these and similar material which yields to the ordinary digging implement. Removal of gravel or any other modular material having diameter in any one direction not exceeding 75 mm, such occurring strata shall be deemed to be covered under this category.

2.0 Hard soil

This shall include :

- (1) Stiff heavy clay, hard shale or compact murrum requiring digging tool or pick or both and shovel closely applied.
- (2) Gravel, soft laterite, kankar and cobble stone having maximum diameter in any one direction between 75 mm and 300 mm.
- (3) Soling of road paths, etc., and hard core.
- (4) Macadam surfaces such as water bound and bitumen/tar bound.
- (5) Lime concrete, stone masonry in lime/cement mortar below ground

level.

- (6) Soft conglomerate, where the stones may be detached from the matrix with picks.
- (7) Generally any material which requires the close application of pick or sacrifices to loosen and not affording resistance to digging greater than hardest of any soil mentioned in item (1) to (6) above.

3.0 Ordinary Rock :

- (1) Ordinary rocks comprising of limestone, sand stone, hard laterite, fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars.
- (2) Unreinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level.
- (3) Boulders, which do not require blasting having maximum diameter in any direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus slope wash and terrace material of dissimilar origin.

NOTE : Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

4.0 Hard Rock :

This shall comprise :

- (1) Any rock or cement concrete or RCC for the excavation for which the use of mechanical plant or blasting is required.

Hard rock shall be removed by blasting where the same is permitted/allowed. In restricted places hard rock shall be removed by chiseling and wedging/ controlled blasting without causing inconvenience to the free flow of vehicular and human traffic and also without endangering the human life, property etc.

SECTION - DRS

DATA REQUIREMENT SHEETS

(TECHNICAL DATA SHEETS/GUARANTEED TECHNICAL PARTICULARS)

NOTE: Please furnish Technical Data Sheets duly filled in, with each set of Technical bid.

Design, Manufacturer, Testing at works, supply, Civil Engineering works, installation, testing, commissioning of 127/220 kV Single Core, 1000 Sq.mm XLPE underground cable and accessories.

CONTENTS

Sl.No.	DESCRIPTION	ANNEXURE
1	Schedule of Guaranteed Technical Particulars of Cable.	Annexure-I
2	Schedule of Guaranteed Technical Particulars of Accessories (Outdoor type termination).	Annexure-II
3	Schedule of Guaranteed Technical Particulars of Normal Straight Joint.	Annexure-III
4	Schedule of Cable Covering Protection units/surge voltage limiters & link box.	Annexure-IV
5	Schedule of Drawings/Graphs	Annexure-V

ANNEXURE-I

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF CABLE

The bidder shall furnish the following information, in addition to any other relevant data, for laying conditions specified, for 127/220 kV E 1000 Sq.mm, Copper, Single Core, XLPE insulated, lead sheathed Cable. The Technical parameters shall be supported with the calculations data sheets.

1	Name of Manufacturer	
2	Country of Manufacturer	
3	Type of Cable/ Cable Code	
4	Applicable standard	
5	Voltage a) Rated Nominal Voltage b) Rated Maximum Voltage	
6	Continuous current carrying capacity in Amps (Calculation to be shown separately)	
7	Permissible voltage & frequency variation for satisfactory operation	
8	Suitability for a) Earthed System b) Unearthed system	

9	Type of process of manufacturing of cable (a) Triple Extrusion (Yes/No) (b) Whether VCV method (Yes/No)	
10	Conductor – Construction details a) Nominal Cross section (Sq.mm) b) Material c) Shape d) Diameter of Conductor (mm) e) Number of wires per conductor (Nos.) f) Nominal diameter of wire in conductor (mm)	
11	Conductor screen a) Material and type (extruded) b) Thickness (mm) c) Maximum volume resistivity at $90 \pm 2^{\circ}\text{C}$ before and after ageing (ohm-cm)	
12	Maximum value of Electric stress at a) Conductor screen kV/mm b) At the insulation kV/mm (Calculation to be shown separately)	
13	Insulation XLPE a) Curing process (furnish details separately. b) Material/Composition c) Dia over insulation d) Radial thickness i. Nominal (mm) ii. Average (mm) iii. Minimum (mm) iv. $t_{\text{max}}-t_{\text{min}}/t_{\text{max}} \leq 0.1$ e) Specified insulation resistance at 90°C f) Insulation resistance at 20°C	
14	Insulation screen (Non metallic) a) Material & type (extruded) b) Nominal thickness (mm) c) Maximum volume resistivity at $90 \pm 2^{\circ}\text{C}$ (ohm-cm) d) Maximum dielectric stress (calculation to be provided)	
15	Tape Swellable	

	(Longitudinal Water/Moisture Protection) a) Material b) Thickness c) Tolerance	
16	Radial Water Barrier (lead sheath) a) Type/Composition b) Material c) Nominal Thickness d) Tolerance on Thickness e) Diameter of cable over metallic sheath (mm)	
17	Bedding Tape Over Inner Sheath i) Material ii) Dimension (Wxt) (mm) x (mm) Nom. Min.	

18	Concentric Screen/ Armour of Stainless steel/Bronze/Plain Copper Wires a) Material b) Diameter Nom. (mm) Min. (mm) c) Whether screen is to be earthed at both terminations (Yes/No) d) Screen Voltage/KM corresponding to rated current of cable with one end of screen unearthed (Volts). e) Screen current corresponding to rated current of cable with both ends of screen earthed (Amps) f) Screen Loss/KM corresponding to rated current of cable with both ends of screen earthed (Watts) g) Screen voltage/KM corresponding to short circuit current in cable for 3 phase fault with one end of screen unearthed (Volts) h) Screen current corresponding to short circuit current in cable for 3 phase fault with both ends of screen earthed (Amps) i) Current rating of screen under short circuit	
----	--	--

	duty (Amps) j) Separation between armour wires (mm) k) Direction of lay l) Thickness of tape (mm)	
19	Binder Open Helix, Contact Copper Tape Over Screen/ Armour Wires a) Material b) Dimension (Width x thickness) Nom. (mm) Min. (mm)	
20	Non-woven Water Swellable Tape Over Binder Tape a) Material b) Dimension	

21	Overall Sheath i) Material & Type ii) Thickness Nom. (mm) Min. (mm)	
22	Conductive Coating on Outer Sheath a) Material b) Thickness	
23	Anti-termite treatment to outer sheath a) Material	
24	External Overall diameter of Cable	
25	Weight of cable/mtr(Kgs)	
26	Short Circuit rating of conductor 90 ⁰ C Operating Temperature for 1 Sec.	
27	a) Minimum Cable Bending Radius (in terms of Cable Diameter) b) Recommended minimum installation radius	
28	Permissible Maximum Tension	
29	Continuous Current Rating Under specified	

Installation Conditions at Conductor Temperature of 65 ⁰ C & 90 ⁰ C		Details to be furnished as per the table given below for thermal resistivity of soil of both 120 ⁰ C Cm/watt and 150 ⁰ C Cm/watt
Ground Temperature	30 ⁰ C	
Thermal resistivity of soil	120-150 ⁰ C CM/W	
Depth of laying	1500 mm	
Ambient Air Temperature	50 ⁰ C	
No. of Circuits	1	
Formation	Trefoil touching	

TABLE

		Single Bonded	Point/Cross	Both End Bonded	
		65 deg. C	90 deg. C	65 deg. C	90 deg. C
		Amps	Amps	Amps	Amps
Current Rating conductor size 1000 sq.mm.					
a) In Ground/Trench					
b) In RCC Duct					
c) In HDPE (250 mm dia) pipe,					
i) one cable per pipe					
ii) Three cable per pipe					
c) In air					
30	Maximum Permissible Conductor Temperature for continuous operation under specified installation conditions (°C)				
31	Conductor temperature at rated current (°C)				
32	Temperature rise for 20% over current				
33	Emergency overload rating				

34	a) Basic impulse level at conductor temperature of 90 ⁰ C (kV) b) Impulse wave shape	
35	Ionisation factor at 50 Hz	

36	Power frequency withstand voltage (kV)	
37	Tan Delta at 50 Hz (at U ₀ kV and 90 (-5/+10) ⁰ C	
38	Sheath voltage at max. load in single point bonded, Trefoil touching formation (V/KM) Amps:	
39	Withstand voltage of sheath on spark test	
40	Permissible short circuit current ratings of conductor i) 0.1 Sec KA ii) 0.2 Sec KA iii) 0.5 Sec KA iv) 1.0 Sec KA	
41	Short circuit capacity of conductor for one second at 90 ⁰ C prior to short circuit and 250 ⁰ C during short circuit (KA)	
42	Maximum conductor resistance DC & AC a) at 20 ⁰ C (d.c)/A.C. ohm/KM b) at 90 ⁰ C (d.c)/A.C. ohm/KM c) at 105 ⁰ C (d.c)/A.C. ohm/KM (over load temp) a.c. (ohm) d) at rated continuous current in ground as per Cl. No. 4.00.00 B(i) 10(ii) of Technical specification (dc)/AC ohm/Km	
43	Equivalent star resistance at 50 Hz of 3 phase current a) at 20 ⁰ C ohm/KM b) at 90 ⁰ C ohm/KM c) at 10% continuous over load temperature	

	(ohm/KM)	
44	Star reactance at 50 Hz (ohm/KM)	
45	Approximate impedance at 50 Hz per KM a) at 20 ⁰ C ohm/KM b) at 90 ⁰ C ohm/KM c) at 10% continuous over load temperature (ohm/KM)	

46	Self electrostatic capacitance per phase (Micro farad/KM)	
47	Maximum Power factor at Charging KVA of cables when laid direct in ground at normal voltage & frequency a) at ambient Temperature b) at Maximum Conductor Temperature	
48	a) Positive and Negative sequence Impedance (Ohm/Km) b) Zero Sequence Impedance (Ohm/KM)	
49	Zero Sequence Data a) Series Resistance (ohm/Km) b) Series Reactance (Ohm/Km) c) Shunt Capacitive Reactance (Ohm/Km)	
50	a) Sheath Resistance at 20 ⁰ C Ohm/Km b) Screen Resistance at 20 ⁰ C Ohm/Km c) Combined Resistance at 20 ⁰ C Ohm/Km	
51	Sheath voltage under maximum operating conditions, assuming all circuits connected KV per KM	
52	Potential gradient at conductor surface KV/Cm - Maximum - Minimum	
53	Surge Impedance of Cable (ohm/km)	

54	IR value at ambient Temperature per Km	
55	Maximum magnitude of partial discharge at 1.5 U _o . At Ambient Temperature (P _c) At High Temperature (P _C)	
56	Guaranteed losses per Km (Calculation sheet to be furnished) For details such as current rating, AC resistance to be considered etc., Refer Guaranteed losses clause no.10.09 of technical specification & respective clause of SCC of bid documents	
57	a) Dielectric Loss per phase at rated voltage and rated current b) Copper Loss per phase at rated voltage and rated current. c) Sheath / screen loss per phase at rated voltage & rated current. d) Other losses due to reinforcement e) Total Losses at rated continuous current Charging Current at rated Voltage per Km (Amps)	
58	Circulating Currents Under BEB Condition in i. Lead Sheath Amps: ii. Copper Wire Screen Amps: iii. In Both Amps: When current in conductor is 800A	
59	Circulating current in lead sheath armouring / Cu screen (when the conductor is carrying 50 KA S.C. Current) KA	
60	Combined Short Circuit Capacity of Metallic Sheath and Screen for 1 Sec, at metallic sheath / screen temperature of 75 ⁰ C (conductor temperature 90 ⁰ C before S.C. & 250 ⁰ C during S.C.) KA	
61	Screening factor of cable for calculating interference on control and communication cables:	
62	Approximate Value of attenuation of carrier current signals operating over a frequency range i. 50 KC/s - dB/KM ii. 100 KC/s - dB/KM	

	iii. 150 KC/s - dB/KM	
	iv. 200 KC/s - dB/KM	
63	Shipping Weight and size of cable drum. a) Size of Drum i. Dia of Drum(M) ii. Width of Drum(M) iii. Gross Weight(Kgs) iv. Length of Cable Per drum(M) v. Weight of Cable(Kg/M) vi. Weight of copper (Main conductor excluding copper wire screen) (Kg/M) vii. Weight of copper (Copper screen excluding main conductor)(Kg/M) viii. Weight of lead(Kg/M)	
64	Guaranteed maximum life in years	

TABLE - II

65. DERATING FACTORS

a) VARIATION IN GROUND TEMPERATURE:

Ground Temperature : 15 20 25 30 35 40 45

Rating Factor :

b) VARIATION IN DEPTH OF LAYING:

Depth of Laying (Meters) : 0.7 0.9 1.0 1.2 1.3 1.35 1.5 1.8

Rating Factor :

c) VARIATION IN THERMAL RESISTIVITY OF SOIL:

**Thermal Resistivity of Soil: 100 120 150 200 250
(⁰C cm/watt)**

Rating Factor :

d) VARIATION IN AIR TEMPERATURE:

Air Temperature (⁰C) : 25 30 35 40 45 50 55

Rating Factor :

e) VARIATION DISTANCE (mm):

**Axial Distance (mm) : 100 200 300 400 600 800
Between Circuits**

Rating Factor :

ANNEXURE-II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES Outdoor Type Cable end Termination (Sealing End)/ Plugin type for GIS Modules

1. Manufacturer's Name :
2. Country of Manufacture :
3. Class and Type :
4. No. of years the design in commercial use :
5. Rated Voltage Kv :
6. Rated Continuous Current Amps :
7. Size of sealing end termination :
8. Total Creepage Distance (mm) :
9. Maximum Conductor Size, Cu (Sq.mm) :
10. Details of Terminal Connector :
11. Power Frequency Voltage 1 Min Dry withstand :
Test kV. rms
12. Power Frequency Voltage Wet withstand :
Voltage kV
Time: Sec.
13. Power Frequency Voltage Dry withstand :
Voltage kV. rms
14. Flashover voltage Dry KV rms:
 Wet KV rms
15. Radio Interference Voltage (R.I.V.) Test :
(Micro Volts)
16. Partial Discharge (corona) extinction Test :
a) Extinction Voltage kV rms :

- b) Minimum Detector Sensitivity PC :
- 17. Impulse Voltage Lightning Voltage Dry :
Withstand kV (Crest)
- 18. Direct Voltage 15 Min Dry withstand kV :
- 19. Description of Materials Used in the ter-
minations with electrical & mechanical :
Particulars
- 20. Mounting Structure Details for termination :
- 21. Electrical & Mechanical Particulars of
 - a) Heat Shrinkable Tubing :
 - b) Heat Shrinkable Moulded Parts :
 - c) Heat Shrinkable adhesives/sealents :
- 22. Type Tested to [Standard (s)] :
- 23. Other Details :

Please Enclose complete Technical literature :

ANNEXURE-III

Normal Straight Joint (Earthing Type) And (Straight Joint Insulated)

1. Name of Manufacturer :
2. Country of Manufacture :
3. Type (Design) of Joint :
4. No. of years the design is in commercial use :
5. Rated Voltage kV :
6. Rated Current Amps :
7. Suitable for cable Conductor Sq.mm :
8. Connector, Type, Material :
9. Partial discharge test 245 kV PC :
10. A.C. Withstand Voltage kV :
11. Impulse withstand voltage +ve& -ve 10 times kV :
12. Load Cycling 90⁰C + 5⁰C (No. of Cycles) :
13. Load Cycling as above under Water at
----KV (No. of Cycles) :
14. D.C. Withstand ---- kV Hrs :
15. D.C. Withstand Voltage 15 Min :
16. Conductor thermal short circuit 250⁰C For 1 Sec :
17. Shield thermal short circuit 250⁰C for 1 Sec :
18. Type Tested to Standard (S) :
19. Maximum conductor temperature in joint at rated current.
20. Additional Information :

ANNEXURE-IV

I. Cable Covering Protection Units / Surge Voltage Limiters:

1. Manufacturer's Name :
2. Country of manufacture :
3. Type of Material :
4. Dimensions / Weight mm/Kg :
5. Rated Voltage Kv :
6. Characteristics :
7. Nominal discharge current KA :
8. Power frequency withstand voltage KV :
9. Power frequency spark over voltage kV :
10. Reseal voltage :
11. Pressure relief class :
12. Impulse high current short duration
Discharge (Amps) :
13. Additional Requirements :

II. Link box details and other accessories:

Sl. No.	Technical Particulars	
1.	Details of Link Box	
a)	Material.	
b)	Type of Application	
c)	Drawings	
d)	Accessibility	
e)	Suitability	
f)	At Circuit end	
g)	Option	
h)	Special arrangement	
i)	Accessories	
2.	Cross-bonding Link Box (CBB) Concentric bonding leads of suitable size to suit 3 Nos of Co-axial cable entries to CBB	

3.	Sheath Bonding Cables	
4.	Cross Bonding of Cable Sheath	
5.	No Of Joints	
6.	Sheath standing voltage to earth for rated cable current	
7.	Sheath standing voltage to earth when an external 13-symmetrical through fault	
8.	Transposition of cables: No. of Cable Transpositions and other details.	
9.	Details of Distributed Temperature Sensing (DTS) system such as make, No. of Channels, Distance covered, components of Hardware, List of Softwares, Industrial PC, DTS Cofigurator, Protocol adopted, applicable standards etc.	

III. List of consumables to be supplied by the vendor

Sl. No.	Description	Quantity

ANNEXURE - V
SCHEDULE OF DRAWINGS/GRAPHS

The bidder shall furnish the following drawings along with the graph.

Sl. No.	Description	
1	Cross section and dimensional drawings of the cable with weight	
2	Detailed drawings of the straight through joint.	
3	Detailed drawings of the direct earthing link boxes. a) Weather proof type b) Structure mounted type	
4	Detailed drawings of sheath earthing link boxes weather proof type	
5	Detailed drawing of the cable earthing arrangement	
6	Detailed drawing of the cable protection unit (S.V.L)	
7	Outline dimensional and assembly drawings of cable sealing end.	
8	Outline dimensional and assembly drawings of a) Normal straight joint	
9	Detailed drawings of cable termination supporting structure and foundation.	
10	Schematic drawings of cables installation a) Cable screen earthed at both ends. b) Installation of cables in trench(direct buried) c) Installation of cables in RCC ducts d) Installation of cables in RCC through/over open drains e) Installation of cables in pipes f) Plan and cross sectional drawings of cable jointing bay in detail, with transposition of cable with cross bonding of cables. g) Plan and cross sectional drawings of cable jointing bay in detail, without transposition of cable with cross bonding of cables.	
11	Detailed drawing of RCC cable protection Covers.	
12	Detailed drawing of cable reel/drum.	
13	Characteristics of cable temperature Vs current	
14	Characteristics of cable and sealing end-power factor Vs temperature.	
15	Characteristics of cable and sealing end-power factor Vs voltage.	
16	Characteristics of cable and sealing end-partial discharge	

	magnitude v/s temperature.	
17	Characteristics of cable covering protection unit (S.V.L)	
18	Foundation drawing of a) Cable end termination structure b) Special link box mounting structure	
19	Arrangement of joint chamber with dimensions	
20	Arrangement of terminal structure for outdoor sealing end with civil designs with earthing arrangement cable	
21	Cross section of sheath bonding cable	
22	Drawing of straight rollers and angle rollers	
23	Trefoil clamp	

ANNEXURE-VI

Schedule of instruction manuals/catalogues/calculations/certificates etc.

Sl. No.	Description	Quantity
1	Description of extrusion, curing and cooling processes	
2	Transport, storage and handling practices for cables and accessories	
3	Electrical characteristics (conductor resistance, capacitance, electrical stress etc.) of the cables	
4	Characteristics of sheath voltage limiters and surge arresters	
5	Manning schedule for one set of three straight through joints and one set of three sealing ends	
6	Design calculations - wherever called for against respective clause of specification and GTP	
7	Type test certificates issued by a recognised institution	

NOTE: Not exhaustive. Bidders may furnish additional documents as required.

ANNEXURE-VII

1) Schedule of tests and charges for tests

Sl. No.	DETAILS OF TEST	CHARGES PER TEST
I-A	Type Tests	
B	Routine Test	
C	Site Tests	
D	Special Tests (Specified)	
E	Other tests at works/Site Recommended by the tenderer	
II	Total cost towards inspections and tests (special routine and acceptance tests) included in the price bid (if chargeable to owner) (break-up details to be furnished separately)	
	Note: Details have to be furnished for tests on cables as well as accessories, each separately.	

ANNEXURE-VIII

Test Data on the 220 KV XLPE cable and accessories

Sl. No.	DETAILS REQUIRED	STANDARDS AS PER WHICH TESTED	DATA/TEST RESULTS TO BE FURNISHED
1	FOR IMPULSE TEST (HOT CONDITIONS): i. Number of samples tested. ii. Cable cross section and insulation wall thickness iii. Type of terminations iv. Type of joints v. Basic impulse level (wave form and peak voltage) vi. Breakdown level		
2	FOR POWER FREQUENCY TEST (COLD/HOT CONDITIONS): i. Number of samples tested ii. Cable cross section and insulation wall thickness iii. Type of terminations iv. Type of joints v. Voltage applied and duration vi. Breakdown level		
3	FOR LONG TERM TESTS: i. Length of the cable loop ii. Cable cross section and insulation wall thickness iii. Number and type of terminations & joints iv. Installation conditions (air, buried) v. Voltage applied and duration vi. Conductor temperature at the end of heating cycle vii. Breakdown conditions (if any)		

NOTE: Details should be furnished for each and every sample for item (1) and (2) and for each and every long term test for item (3).

ANNEXURE-IX

SCHEDULE OF DOMESTIC VALUE ADDED COMPONENTS

Sl. No.	ITEM	QUANTITY (EX-WORKS)	UNIT PRICE (EX-WORKS)	TOTAL PRICE
	Total Ex-works bid price (X)			

Total Ex-works bid price (X) =

Domestic value added component =

Domestic value added component =

(as percentage of total Ex-works bid price)

*** To be furnished for each category separately**

SECTION – DRS

DATA REQUIREMENT SHEETS

ANNEXURE TS-II

Turnkey Package for supply, installation of 220 KV cables with all associated accessories and materials at various locations in Bangalore City.

List of drawings enclosed with the Bid Document

Sl. No.	DESCRIPTION	DRAWING No.
1.	Proposed Cable Route	Uploaded in website
2.	Single Line Diagram	Uploaded in the website
3.	Sheath Bonding System	
4.	Cable Construction	
5.	Cable Trench	
6.	Cable Trench for Road Crossing	
7.	Cable Duct	
8.	Precast RCC Tile	
9.	Reinforcement Details of Precast RCC Tile	
10.	Cable Route/Joint Marker	
11.	Pipe Earthing	

ANNEXURE-I

PROCEDURE AND SPECIFICATION TO BE FOLLOWED BY UTILITY AGENCIES FOR RESTORATION OF FOOTPATH

- 1 Removing footpath slabs if any and stacking at a designated place with all lead and lifts of 50 mtrs. and Earth work excavation for leveling and lowering the footpath to the required depth and slope, as directed. Removal of roots and other organic materials including consolidation with watering to get the required density to the satisfaction of BMP Engineer incharge of work.**
- 2 Providing polythene sheet of 300 micron thick over the prepared surface adequately stiffened to prevent distortion during handling in order to prevent the slurry entering the sub soil.**
- 3 Refixing the stone slabs longitudinally at the outer edge with a projection of 2.00 cms. above the concrete surface and cutting the edges to regular shape and with pointing in CM 1:3.**
- 4 Removing and refixing in position available Kerb stones of granite, dressing the top surface and neatly rounding of the edges and fixing in ground with excavation to the required depth in all soils and pointing in CM:1:3 and providing painting to kerb stones with Black and yellow Japan paint alternatively and as directed by BMP Engineer incharge of work.**
- 5 Providing and fixing precast fiber reinforced semicircular shoulder drains of 0.60 m. dia in CC M20 grade with necessary earth work at an interval of 30mtrs. or less as per site conditions including fixing, laying, curing, with all lead and lifts etc., complete as per the direction of Engineer incharge and providing and fixing recast RCC covering slab of 100 mm thick over shoulder drain flushing with concrete surface.**
- 6 Formation of footpath surface to a width of 0.450mtr. at an interval of 30mtrs. and covered with precast covering slab of 10 cms thick in blend with RMC concrete to facilitate drawing of underground cable whenever necessary.**
- 7 Providing necessary catch drain in front of shoulder drains, of size 0.23 x 0.60 x 0.40 mtr. clear with necessary grating over catch drain with one end of the grating fixed with hinges for easy operation.**
- 8 Providing CI/ precast grating at the mouth of the shoulder drain and suitably and firmly fixed with the kerb.**
- 9 Supplying and fixing necessary edge stones or suitable protective measures around to the existing trees/poles etc.**

- 10 Providing and laying 100mm thick ready mixed cement concrete M25 over the prepared surface covered with polythin sheet using 20mm and down size granite jelly with necessary form work including vibrating groom finishing and curing etc., with all lead and lifts etc., complete to a width of 2 mtrs with proper expansion joints at an interval of 6 mtrs etc., complete as per drawing.**
- 11 Restoration of road cross cuttings to be done by refilling the excavated trench with available soil in layers of 15 cms. With watering and compacting, over which to be filled with good quality of sand to a minimum depth of 0.30 mtr and the top surface to be provided with 20 Cm thick ready mixed cement concrete (RMC) of M25 grade to the full width of the trench, including vibrating, compacting, curing etc., complete with all leads and lifts and in level with the existing road surface.**
- 12 Providing mountable kerb to the approaches wherever necessary with necessary pointing and painting.**
- 13 Conveying the surplus earth, debris or any other unwanted loose materials at the works spot to the designated dumping yard with all leads and lift as directed by BMP, Engineer incharge of the work.**

GUARANTEED LOSSES:

- i) The bidder shall clearly indicate the guaranteed value of the losses (at a maximum of two decimal places only) which **shall be firm and without any tolerance limit** in respect of under mentioned types of losses, as required in Schedule-14 at rated current, voltage & frequency **per circuit KM (all 3 phases put together in one KM length of cable) in KW only.**

- (a) Dielectric losses
- (b) Conductor/Copper losses.
- (c) Sheath losses.

- ii) The Guaranteed values of these losses quoted by the bidder will be taken for capitalizing the losses at the rates indicated below wherein the quoted prices shall be loaded by the differential capitalized loss amount for the purpose of bid comparison. For fraction of a KW quoted, capitalized cost of losses shall be calculated on pro-rata basis.

1	Capitalized Cost of Dielectric Losses	Rs.4,53,000/- per KW.
2	Capitalized Cost for Conductor/Copper loss and sheath loss.	Rs.1,85,000/- per KW.

- iii) For the purpose of evaluation of the offer, the lowest individual losses/CKM quoted for each type of losses by any bidder shall be taken as the basis to work out the deviation in quoted losses by any particular bidder. No rounding-off of any value will be done and Loss values will be reckoned up to TWO decimal places only. The bid price would then be enhanced by the differential capitalized amount for the purpose of comparison of bids.

- iv) The cable losses guaranteed in the bid are to be supported by design calculations along with documentary evidences if any, as per procedure & formula stipulated in IEC 60287-1-1 with latest amendments thereof. The reference of the same along with an extract of applicable IEC Standard shall be clearly furnished along with the GTP.

- v) The value of loss factor of the XLPE insulation ($\tan \delta$) shall be as per IEC 60287-1-1 i.e., 0.001. This value shall be taken for calculation of dielectric losses/evaluation. No upper

tolerance limit would be allowed for this value. However bidder can supply cables of tan delta values lesser than 0.001

- vi) The current in the conductor (I), for computation of conductor/copper loss shall be the rated continuous current in ground, as per clause no. 4.00.00 BI (11) (ii) of Technical specification of cable. The AC resistance of conductor (R_{ac}), at the **said rated continuous current in ground** shall be considered for calculation of copper losses. All cable parameters considered for loss calculation shall be as per the values declared by the bidder in the GTP. Any assumptions/ Omissions in the Formula used for detailed loss calculation as per the above IEC shall be invariably indicated in the GTP.
- vii) In case the declared guaranteed/quoted losses are in deviation to the losses arrived as per calculation, the higher of the two would be considered for evaluation of the offer and the lower of the losses would be considered for acceptance of the cable.
- viii) On testing, if it is found that actual losses are more than the values guaranteed/quoted in Schedule-14, penalty shall be recovered from the bidder at the rates **triple the capitalisation cost** indicated under sl. no. (ii) above. However, no incentive would be allowed if the actual losses are found to be less than the guaranteed/quoted values.
- ix) The cable would be accepted only if the measured values/test values/actual values on the finished product (on testing) is found to be within +5% of the guaranteed/quoted values for each type of losses subject to recovery of penalty as stated in sl. no (viii) above. In case the measured value is exceeding the limit of 5% in any type of these losses, the cable would be out rightly rejected.
- x) The guaranteed values of the losses quoted by the successful bidder will be verified at the time of final acceptance of the material after conducting necessary Tests on a random sample/s of the material taken from the finished product. The Tests shall be conducted in the laboratories as per terms and conditions as noted elsewhere in the tender documents.