

# 132KV, 220KV & 400KV XLPE CABLE AND TERMINATION

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**November 2019**

## *Engineering Department*

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড  
( পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ )

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## 1.0 SCOPE

The specification covers Design, Engineering, Construction, Supply & Delivery, Erection, Laying, Testing & Commissioning including Transportation & Insurance, Storage of XLPE Cable of different ratings and their associated works.

## 2.0 STANDARD & CODES

The works covered by the specification shall be designed, engineered, manufactured, tested and commissioned in accordance with the Standards as specified in the table below.

Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted. Copies of such standards shall be submitted by the bidder along with the bid.

IS 7098 : Part 3 : 1993	Cross-linked polyethylene insulated thermoplastic sheathed cables: For working voltage from 66KV up to and including 220KV.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 1255 : 1983	Code of practice for installation and maintenance of power cables upto and including 33KV rating.
IS 3975 : 1999	Mild steel wires, formed wires and tapes for armouring of cables.
IS 5831 : 1984	PVC insulation and sheath of electric cables.
IS 6380 : 1984	Elastomeric insulation and sheath of electric cables.
IS 8130 : 1984	Conductors for insulated electric cables and flexible cords.
IS10418 : 1982	Drums for electric cables
IS 3975 : 1999	Mild steel wires, formed wires and tapes for armouring of cables.
IS 5 : 1994	Colours for ready mixed paints and enamels.
IS 617 : 1994	Aluminum and aluminium alloy ingots and castings for general engineering purposes (Superseded IS 20 : 1977)
IS 3043 : 1987	Code of practice for earthing.
IS 5578 : 1984	Guide for marking of insulated conductors.
IS 11353 : 1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
IS 5216 : Part I : 1982	Recommendations on Safety Procedures and Practices in Electrical Work.
IS 2071 : 1993	High voltage test techniques.
IEC-60540	Power cables with extruded insulation and their accessories and cords
EC 60060 : 1989	High Voltage Test Techniques
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1KV up to 30KV
IEC-60754 : 1991	Tests on gases evolved during combustion of electric cables
IEC-60183 : 1990	Guide to the Selection of High Voltage Cables.
IEC-60230 : 1996	Impulse tests on cables and their accessories.
IEC-60840 / IEC- 62067	Testing
IEC-60287 : 1995	Calculation of the continuous current rating of cables (100% load factor).
IEC-60304 : 1982	Standard colours for insulation for low-frequency cable and wires

IEC-60331 : 1970	Fire resisting characteristics of Electric cables.
IEC-60332 : 1992	Tests on electric cables under fire conditions.
BS-5468	Cross-linked polyethylene insulation of electric cables
IEC-60228 : 1978	Conductors of insulated cables
IEC-60332 : 1993	Test on electric cables under fire conditions
IEC-60066	Environmental Test
IEC-60117	Graphical Symbols
IEC-60270 : 2000	Partial Discharge Measurements
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements

### 3.0 COMPLIANCE TO SPECIFICATION & DEVIATION:

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidence. Such deviations suggested may or may not be accepted by the purchaser.

As a mark of technical conformance, all sheets of the specification shall be furnished by each bidder with the signature and company seal affixed thereon. In case of any deviations, the same shall be carried out in the deviation schedule only. Deviations not mentioned in Deviation schedule will not be considered.

The bidder shall also submit the GTP as per Annexure -1 duly signed with date & company seal for acceptance of the Technical Bid unless which the bid may be considered as non responsive.

### 4.0 SYSTEM PARAMETERS

SL NO	TECHNICAL PARAMETERS	400 KV SYSTEM	220 KV SYSTEM	132 KV SYSTEM
1	Rated Maximum Voltage	420 KV (rms)	245 KV (rms)	145 KV (rms)
2	Rated Frequency	50 Hz	50 Hz	50 Hz
3	Grounding	Effectively Earthed	Effectively Earthed	Effectively Earthed
4	Rated Power Frequency Withstand Voltage ( 1 min)	610 KV (rms)	460 KV (rms)	275 KV (rms)

5	Impulse withstand BIL (1.2/50/micro Sec) Line to earth	±1425 kVp	±1050 kVp	±650 kVp
6	Switching impulse voltage (250/2500 micro-sec)	±1050 kVp	X	X
7	Rated short time withstand current (1 sec)	40 kA (rms) for 1 sec	40 kA (rms) for 1 sec	31.5 kA (rms) for 1 sec
8	Rated peak withstand current (1 sec)	100 KA (peak)	100 kA (peak)	80 kA (peak)
9	Rated current normal (at 50 degree C design ambient temperature)	As per Price Schedule	As per Price Schedule	As per Price Schedule
10	Seismic level	Zone- IV, as per IS-1893 Year- 2002	Zone- IV, as per IS-1893 Year- 2002	Zone- IV, as per IS-1893 Year- 2002

## 5.0 CONSTRUCTION

1. The cable shall be of applicable EHV grade as per requirement according to price schedule , single core, unarmored stranded compacted circular Copper conductor in case of cross section is less than or equals to 800 sq.mm or segmental compacted circular(Miliken) Copper conductor in case of cross section is over than 800 sq.mm, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non woven tape with water swellable absorbent over insulation screen, followed by radial sealing of metal sheath of Lead alloy “E” as per IS 7098 part III & metallic screening by concentric layer of plain copper wire followed by open helix of copper & overall PE sheathed & graphite coated/semi conducting layer and conforming to the technical particulars of specification. **Cables used earlier or repaired after damaged shall not be accepted. IS 7098 part 3 shall be followed for manufacturing of cable along with technical specification.**
2. The construction of cable shall generally conform to the description mentioned above. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable. The bidder shall enclose with the bid, drawing showing cross section of the cable.

3. The cable shall be suitable for laying underground with uncontrolled back fill and chances of flooding by water and suitably designed by the addition of chemicals in the outer sheath to be protected against rodent and termite attack.
4. The cables shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
5. Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of the cable.
6. Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm

## **6.0 COMPOSITIONS OF CABLES**

### **6.1 CONDUCTOR**

The conductor shall consist of annealed copper stranded wires. The compacted circular conductor shall consist of segments wound up and then compacted. For the cable sizes having cross section over than 800 sq. mm the segmental compacted circular conductor having minimum four (4) segments should be constructed for the supply under the scope of bid. When the conductor's cross-section is less than 800 sq. mm, the compacted circular is applied generally.

### **6.2 CONDUCTOR SCREEN**

The conductor screen shall consist of extruded semi-conducting XLPE. Semi-conducting separator tapes may be applied between conductor and the extruded semi-conductor XLPE.

### **6.3 INSULATION**

The insulation material shall be extruded cross-linked polyethylene. In order to ensure that the screen and insulation are intimately bonded together and free from all possibilities of voids between layers, the conductor screen, the insulation and the insulation screen should be extruded simultaneously in one process. The extrusion process should be carried out under strictly controlled atmospheric conditions.

The thickness of the insulation layer should be maintained as the maximum value figured out from the design of the impulse voltage and A.C. voltage. The cross-linking process by N<sub>2</sub> gas should be preferred instead of conventional cross-linking process by saturated steam.

### **6.4 INSULATION SCREEN**

The insulation screen shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE.

### **6.5 MOISTURE BARRIER**

The longitudinal water barrier shall be applied over insulation screen by a layer of non woven synthetic tape with suitable water swellable absorbent.

## 6.6 METALLIC SCREEN:

The metallic screen shall be of metal sheath of Lead alloy 'E' as per IS 7098 part-III. The metallic screen shall be designed to meet the requirement of the system short circuit rating of 31.5 KA for 1 sec for 145 KV grade considering parallel path between lead sheath and copper screen

## 6.7 OUTER SHEATH

The outer sheath shall consist of extruded black coloured PE having the grade as indicated below:

- a) ST7 grade while inside substation or buried underground running along/across/aside the road etc., or passing over Bridge etc. for any considerable length.

The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

## 7.0 RATING

The bidder shall declare current rating of cable for maximum conductor temperature of 90 degree C under continuous operation. A complete set of calculation made in arriving at the current rating shall be furnished for laying condition under present.

## 8.0 CABLE DRUMS

- 8.1 Cables shall be supplied in wooden or steel drums of heavy construction of suitable size and packed conforming to IS 10418 or applicable internationally accepted standards. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum. A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.
- 8.2 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
- 8.3 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with hermetically sealed by means of water blocking compound followed by heat shrinkable caps totally coated inside with mastic so as to prevent to cable for moisture penetration during transit, storage and laying.
- 8.4 The bidder shall consider supply of cable on returnable drums basis. Contractor shall take back all the cable drums from site after successful laying, testing and commissioning of cables. The bidder may quote the prices accordingly.
- 8.5 Embossing of outer sheet: the following details on the other sheet of cable at a regular interval of 1(one) meter.
  - (a) Name of Customer i.e. WBSSETCL
  - (b) Conductor size, type of insulation and voltage grade.
  - (c) Manufacturer's name.
  - (d) Year of manufacturing

## 9.0 TESTS

All Type, routine and acceptance tests shall be conducted as per IEC 60840/IEC 62067. All type tests conducted during last five years from the date of NIT as per IEC 60840:1999/IEC 62067:2001 including its amendments on the XLPE insulated HT cable should be submitted. The diameter of test cylinder during bending test shall be as per IS: 7098 (Part 3) or the diameter of drum barrel to be used for dispatch of cables whichever is lower. For accessories type test reports should be submitted as per Clause 11.3.2 IEC 60840:1999/ Clause 12.4.2 IEC 62067:2001 & including amendments.

### TESTS AFTER INSTALLATION

All tests as prescribed in IEC-60840:1999/IEC 62067:2001 shall be performed after installation of cable.

## 10.0 A) ROUTE SURVEY

The bidder shall fully familiarize himself with the site and route conditions etc. The bidders are advised to visit the site and acquaint themselves with the topography, infrastructure etc. The contractor shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the erection and successful commissioning of cable in all respects. All materials required for the Civil and construction/installation work shall be supplied by the Contractor. The complete design and detailed engineering shall be done by the Contractor. The survey shall be conducted in presence of WBSETCL officials for underground routes to finalize the route and paths for the underground cable.

The survey shall inter alia include the following minimum activities:

### B) RIGHT OF WAY:

(a) Any right of way, which may be required by the contractor for execution of cable line, shall be arranged by him. The approval from civil authorities, P&T authorities and other agencies / Government as required shall be arranged by the contractor. Statutory signature of WBSETCL officers for PTCC and other clearance shall have to be obtained by the contractor at appropriate time. Obtaining approval of the above proposal is the contractor's responsibility.

(b) For PTCC clearance, the contractor shall prepare all drawings including route map, obtain soil resistivity data as per requirement of PTCC and submit PTCC proposal to PTCC authority at appropriate time. The cost of compensation, if required for strengthening, protection of telecom lines from inductive interference from power lines will however be paid by WBSETCL to appropriate authorities at actual.

(c) Compensation of land for tower footing shall be paid by the contractor.

(d) Access road to the work site shall be arranged by the contractor at his own cost. Any compensation if needed to be paid for this purpose will be to the contractor's account.

(e) The compensation for trees, crops etc. (except Govt. forest) if required to be paid to execute the erection of the line and for getting corridor clearance shall be paid by the contractor.

(f) Identification and demarcation of forest-land plotting, preparation of necessary drawings / schedules is the responsibility of the contractor. Submission of the proposal to the state Govt. authorities will be sole responsibilities of the purchaser. The felling down of trees in the forest will also be done by the contractor at his

own cost. However, the necessary charges i.r.o forest land / forest clearance will be paid directly by the Employer to the concerned authorities.

## 11.0 SOIL DATA

The bidder shall be responsible for carrying out the required survey and should fully satisfy himself about the nature of soil expected to be encountered prior to the submission of bid.

The unit rate quoted by the Bidder shall be irrespective of soil type such as normal soil, soft rock, hard rock and crossings such as pavements, all types of roads, rivers, canals, drains, culverts, rail track etc. encountered during the actual installation. The bidders are required to make their own estimates and offer a single uniform rate applicable for all kinds of soil strata and crossings. The Employer shall not entertain any additional claims. Payments for any type of soil/crossings encountered during installation. Employer strongly recommends site visits/investigation by the Bidders (at their own cost) before submission of the bid for proper estimations. The contractor shall be required to carry out excavation and back filling in accordance with this specification and provide all additional items required at its own cost for proper installation not limited to those described in this specifications.

Unit rate for construction of buried cable trench and Back filling shall interalia include all related work/activities such as excavation, blasting of rocks and backfilling of trenches, fixing of gradient of trench, excavation of trial pits if required, clearing of bushes, roots of trees along the trenches, cutting of bushes, trees, shoring, dewatering, excavation and backfilling of any temporary manhole, support of the existing facilities/plant, removal of let out materials, breaking of pavement, clearing of obstacles, temporary reinstatement of footpath wherever required, providing all types of markers, warning bricks and tapes etc., suitable structure/techniques material for crossings (road, rail culvert, river, canal etc.) for installation of HDPE pipe and other installation materials etc.

A unit rate of laying of cable will be considered in all type of trenches, trench less laying, through air, through hangers while negotiating existing overhead road bridges etc. No separate rate for specified type of lying of cable will be considered. The BOQ in the bid proposal sheets indicates the total route length to be implemented under subject package.

**Map Study:** The Contractor shall arrange topographical maps and other maps of the concerned area in proper scale. All links shall then carefully be studied using maps. Various feasible alternative routes shall be identified on the maps and the Contractor shall shortlist most suitable route.

**Collection of details of other utilities:** Contractor shall arrange information about existing underground facilities for the proposed routes. To do so as built drawing or route index diagram for various services viz. water works, electric supply utilities, telecom services providers, public health, gas/oil authorities etc. may be collected from the concerned authorities. **In case details are not available, the Contractor shall assess suitably by conducting enquiries and surveys with help of cable locator or same type of instrument.**

**Identification of underground cable route:** The Contractor shall propose most suitable route for link keeping in view the following broad criteria:



- 1) The route shall be as straight and as short as possible.
- 2) The route shall have minimum obstacle in order to minimize reinstatement cost.
- 3) Minimum clearances are required from other authorities/bodies and that the clearances can be obtained expeditiously.
- 4) Wet or unstable ground shall be avoided to the extent possible.
- 5) The route for the cables shall be away from the carriage-way of the road to the extent possible.
- 6) The route shall be suitable for placing manholes wherever required.
- 7) Future expansion of roads shall be taken into consideration.
- 8) Road, rail, canal, drain culvert crossing, trenchless digging shall be minimum.
- 9) As far as possible underground cable route shall be on the opposite side of the existing cables laid by DOT/BSNL or other utilities. Wherever both routes fall on the same side of the road, a spacing of about 2.0 mtr.horizontal and 1 mtr vertical spacing is to be maintained to the extent possible.
- 10) Care must be taken to avoid choosing routes, roads, areas that are prone to floods etc.
- 11) EHV cable crossing other EHV, HV,LT , communication cable or Gas, water, sewage line etc shall be placed in suitable distance according to guideline available (Indian/International or guide line of the concerned utilities).

After finalizing the best alternative route, some trial pits shall be dug at suitably selected locations to assess the obstacles. It is necessary to locate the trial pits at proposed manhole locations. They shall be dug carefully keeping watch for the existing underground facilities. The presence of each type of facilities shall be recorded in the inspection note of the trial pit along with their sites sketch are kept in record for future reference. These details shall be enclosed along with the survey report.

The Contractor shall submit the survey report with the most suitable route for cable link along with details above. Contractor shall submit the final survey report for approval before implementation. The final survey report shall include at least the following:-

- 1) A drawing of the proposed route indicating all details of the route including relevant details of soil strata, bridges, culverts, causeways, rail over under bridges, canal, defense area, underground gas/oil/water pipes line, power and communication cable routes, other important landmarks etc.
- 2) The distance of the cable route from the centre of the road/rail/canal/river/bridge/culvert etc. shall be indicated on the route maps as well as documented in table.
- 3) City/town/village/forest/defence etc. area coverage.
- 4) Sections of the links where Trenchless Digging may be required.
- 5) Location and number of permanent and temporary manholes.
- 6) Location of all turns, bends and major landmarks.
- 7) List of authorities from which clearance shall be required to be obtained from each relevant section.

The final survey report shall have to be approved by the Employer and requisite clearances need to be obtained before the cable installation work is commenced.

The contractor shall prepare and submit for approval by the Employer, specific construction drawings for all types of soil strata/crossings taking into consideration the guidelines given in this specification. The construction/implementation shall be carried out as per the approved drawings.

The construction drawings shall inter-alia include the longitudinal sectional diagram of the trench for different soil strata and detail arrangement of crossings, number of pipes, size of pipes, location and position of manholes, other details as per the technical specification.

Any other items not specifically mentioned in the specification but which are required for installation, testing, commissioning and satisfactory operation of the cable as per Indian Standards/IE Rules/IE Act and concerned authority regulations are deemed to be included in the scope of the specification and no deviation in this regard shall be accepted.

The contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, manpower, loading unloading, handling, moving to final destination for successful erection, testing and commissioning of the 132KV cable.

## **12.0 TRENCHING**

The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.

The trench shall be excavated using manual/mechanical modes as per field conditions.

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

The sides of the excavated trenches shall wherever required be well shored up.

Suitable barriers should be erected between the cable trench and pedestrian/motorway to prevent accidents. The barriers shall be painted with yellow and black or red and white coloured cross stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights.

The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

The bottom of the excavated trench should be levelled flat and free from any object which would damage the cable. Any gradient encountered shall be gradual.

## **13.0 PAYING OUT**

The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paying out the cable. The cable shall be rolled in the trench on cable rollers, spaced out of uniform intervals. The paying out process must be smooth and steady without subjecting the cable to abnormal tension. The cable on being paid 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 meters 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.

## 14.0 LAYING OF CABLES

The installation, testing and commissioning work for laying of cable in the entire route outside or within the substation, through the outside cable laying corridor as per designated approved route shall mainly consist of :

- a) Route survey for the entire route length under the scope of work. This is also to finalize drum wise cable length with their tolerances.
- b) Clearances from relevant authorities for laying of cables.
- c) Formation of buried cable trenches for cables as per specification including supply and installation of warning tape, protective tiles/ bricklayer of minimum class designation 50 (50 kg./sq. cm.) cable protection covers for entire route, construction of jointing bays, backfilling of trenches and restoration as per specification.
- d) Road, rail and canal crossings through HDPE pipe for each cable and restoration as per specification.
- e) Cable markers as per statutory requirements shall be provided all along the route at a maximum distance of 500 meters and other important locations. Also the location of underground cable shall be clearly indicated on the marker.
- f) Supply and installation of straight through joints for complete route.
- g) Design, supply and installation of suitable hangers and other necessary structures for running the cable at overhead road bridge.
- h) Supply and installation of all critical installation materials like trefoil clamps, neoprene cushions, support brackets etc. as required for complete route to avoid damages of the cable. Neoprene cushion shall be provided at road and rail bridge crossings to avoid damage of cable due to vibrations during movement of trains and vehicles.
- i) Termination of cables, bonding of screen/sheath to the earth station through disconnecting type link boxes and SVL (sheath voltage limiter) at cable conductor junction - point etc. Bidder shall adopt ends bonding for route under scope as per STP or as per detailed Engineering. Earthing stations/Earthing pits, earthing materials and earthing conductors wherever applicable for complete route including outdoor equipment, structure, cable terminating structure and earth link box at the locations mentioned above shall be in contractors' scope.
- j) Design, fabrication, supply and erection of galvanized steel structures (including its civil foundation) for cable end terminations (with all necessary accessories) for cables at cable-conductor junction point. At cable-conductor junction point terminal connectors offered by bidder shall be suitable to terminate with ACSR conductors.
- k) For termination at GIS substation end the cable should be laid up to GIS building. Necessary design construction of cable duct etc. in the GIS Sub-Station including all supply is within the scope of this contract.
- l) Design, supply and installation of LAs at cable-conductor junction point for both the circuits including its mounting structure and LAs & Isolators at Sub-Station.
- m) Termination, bonding, earthing etc. at GIS sub-station end is not within the scope of this work.
- n)

## 15.0 LAYING OVER PRE CONSTRUCTED TRENCH

For lay of the cable on a pre-constructed trench below the road in any planned township area, Bridge, switch yards etc., cable shall have to be accommodated in the space allotted in the trench for laying the cables. Sufficient clamping arrangement shall have to be done for fixing the cable properly. Cables may be placed in

arrangements or flat arrangements as per allotted width of the trench. Any damages occurred in the trench during lay of the cable shall have to be repaired properly.

## **16.0 CLAMPS**

Clamps shall be pressure die cast aluminium (LM-6) or Nylon-6 or fiber glass and shall include neoprene rubber lining wherever the cable touches the clamps and below the clamp base and necessary fixing nonmagnetic nuts, bolts, washer etc. The thickness of neoprene rubber shall not be less than 10 mm inside around the inner surface of the trefoil clamp and minimum 20 mm thick below the base of trefoil clamp. The neoprene shall be tested as per IS 11149-1984. Clamps shall be provided at every one meter of cable runs. The contractor shall submit drawings of trefoil clamps and arrangements for Employer approval.

## **17.0 CABLE HANDLING**

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

## **18.0 DAMAGE TO PROPERTY**

The contractor shall take all precautions while excavation of trench, 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 Employer.

- The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.
- At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes of adequate strength.

## **19.0 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 supplied by Employer.

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

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

## **20.0 DEPTH OF LAYING OF CABLES**

Depth of lay shall be normally at 1.5 m. below ground but variation of depth of lay to 1 meter may be considered at the time of detailed engineering on the characteristics of the laying zone.

## **21.0 SAND BEDDING**

The cable shall be completely surrounded by well-compacted cable sand to such a thickness and of such size that the cable is protected against damage. The thickness of the cable sand should normally be a minimum of 10 cm in all directions from the cable surface.

## **22.0 THERMAL BACKFILL**

Based on the evaluation of soil thermal resistivity along the cable route and after approval from the Employer the contractor shall design, specify, supply, lay and monitor the installation of thermal backfill surrounding the cables.

## **23.0 IMMEDIATE ENVELOPE TO CABLE**

The option on the use of the material that immediately envelopes the cable viz., thermal backfill or sand or sieved native soil rests with the Employer. The contractor shall seek prior approval on the use of the envelop material from the Employer before execution of the works.

## **24.0 BACK FILLING**

Normally back filling shall consist of the material earlier excavated. However, bigger stones or pieces of rock should be removed.

## **25.0 WARNING TAPE**

A pre-warning, Red colour plastic/PVC tape, 250 mm wide 100 microns thick, shall be laid at approx. 0.4 m above the cable specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION: WBSETCL xxxxxxV CABLES.

## **26.0 PREVENTION OF DAMAGE DUE TO SHARP EDGES**

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

Straight and curved 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.

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

## **27.0 ROAD, RAIL & CANAL CROSSINGS**

The road cutting, whether cement concrete asphalt or macadam road surface, road crossing and canal crossing shall be taken after obtaining approval from the concerned authorities i.e. Railway authorities, irrigation deptt., civic authorities traffic police, telephone authorities etc. and work should be planned to be completed in the shortest possible time. Where necessary, the work shall be planned during night or light traffic periods. HDPE pipes shall be used for cable. HDPE pipes diameter should not be less than 1.75 times the cable diameter.

### **27.1 TRENCHLESS DIGGING**

It is envisaged that trench less digging shall be used for crossing National highways, Rail line and canal and this shall be in the scope of bidder. Trench less digging shall also be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of underground cables. The trench less digging methods shall generally conform to ITU-T 1.38. The various methods of trenchless digging such as hand/manual auguring (up to 15m.) impact moulding (from 16m to about 40-50m.). HDD (above 40-50m) shall be adopted based on the soil/site conditions and the requirement and exact method for trench less

digging shall be finalized during detail engineering as per actual site/soil condition. The equipment used for HDD shall be capable of drilling at least 100m at one go. The contractor shall propose the exact methods and procedures for implementation of trench less digging at various crossings taking into consideration the following guidelines, for approval by the Employer.

- a) Excavation and backfilling of trial pits and verification of soil condition.
- b) Excavation of entry and Exist pits.
- c) Erection of drill machined. Drilling of pilot hole.
- d) Placement and driving hand augur.
- e) Placement and carrying out impact moling.
- f) Reaming and widening of bore holes in steps (if required).
- g) Pulling of product pipe.

## **28.0 FOOTPATH CUTTING**

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

## **29.0 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 energized and taken over by the Employer. 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 the 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.

## **30.0 MANHOLES**

Manholes shall be provided at every proposed joint location for jointing bays. The 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 Contractor shall get inspected by a representative of the Employer, all manholes before carrying out the backfilling. Pipe and cable sealing, installation of joint bus and cable service loops as per approved drawings shall be visually inspected and checked for tightness.

The contractor shall submit design and drawing of Jointing bay including manholes in the buried cable trench portion for withstanding a live load of 20 tons vehicle plus 30% for impact from moving vehicle. The Contractor shall propose a suitable procedure for testing the manhole for approval by the Employer. Manholes type approved by the Employer only shall be acceptable. The manhole shall include sufficient number of suitable entries.

All works shall be carried out under supervision of the engineer in charge of his representative.

### 31.0 TOOLS AND PLANTS

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.

### 32.0 BENDING RADIUS :

The minimum bending radius of XLPE insulated cables are as follows :

Cable	Bending radius
Single Core	25 X D
"D" means the overall diameter of the completed cable.	

### 33.0 CABLE END TERMINATIONS & JOINTING

**33.1** The cable jointing accessories shall include Outdoor & Indoor the end terminating kits as per price schedule, straight through joints and also any special tools and tackles required for making these joints. **For cable jointing & terminating purpose only certified (certification from cable accessories manufacturer or some reputed agency) jointer shall be employed.**

#### The outdoor end termination

- a) Outdoor termination at substation shall be oil type as mentioned below.
- b) It shall be anti-fog, pre-fabricated type. The termination base plate and the cable's metallic sheath shall be electrically insulated from the supporting structure by means of self-supporting stand-off insulators or any other self-supporting means designed to withstand both mechanical and electrical stresses in services. The stress cone shall inhibit possible mechanical stress and deformation of the cable insulation surface during operation and also shall be capable of accommodating minor radial and longitudinal movement without detriment to the dielectric stress in the insulation shield
- c) For OD Termination at substation, the termination shall be within polymeric or porcelain hollow insulator in brown or grey colour as per S.T.P and standard practice of manufacturing in addition upon, arcing horn and shield ring shall have to be supplied wherever required. The termination shall be filled with an insulating compound up to a level where the electric field is substantially reduced and shall be offered from reputed vendor as per Maker's list. Oil filled termination should have silicon oil as di-electric medium. Silicon oil should not be subject to any heating at site prior to filling.
- d) For composite tower oil type outdoor termination shall be used for 220 KV and for 132KV dry type termination to be used as per Maker's list.
- e) The outdoor terminal should be suitable for very heavily polluted atmospheric conditions with total creepage distance of 31 mm/ kV and protected creepage distance of not more than 50% of the total Creepage distance. The cable end terminals for terminating the cables shall be fully compatible with the cables to be supplied.

#### The Indoor Termination at GIS SF6 Housing

### 33.2 The Indoor Termination at GIS SF6 Housing

It shall be dry type without insulating oil. There shall be mechanical devices to maintain the interface pressure if requires.

It shall be based on the EPR (Ethylene-Propylene Rubber)- based or silicon based stress relief cone. Termination shall be dry type without insulating oil. Stress relief cone and mechanical devices shall be designed to fit with controlled interference over the cable insulation and shall follow the cable's diameter variations still guaranteeing under any service condition a sufficient positive pressure to control the electric field concentration. Plug-in type leading conductors shall be supplied though at the time of detailed engineering confirmation shall be given for selection of normal type, blind type or plug-in type. Design and scope of delivery shall be fully complying with IEC-60859, IEC-62271-209 and possibly adjusted the various needs of project. The main insulation components shall be fully examined and tested in the factory.

The bidder shall furnish the detailed description on jointing procedure during detailed engineering.

33.3 The cable jointing accessories shall include Outdoor & Indoor the end terminating kits as per price schedule, straight through joints and also any special tools and tackles required for making these joints.

### 33.4 The straight through joints

It shall be either pre-molded type or heat shrinkable type complete with accessories. The joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical climatic conditions.

### 33.5 PERFORMANCE OF TERMINATION KITS

The details of the offered end termination/ straight through joints with the period in service shall have to be furnished.

### 33.6 WORKING PROCEDURE FOR TERMINATION

- (i) At cable terminating end sufficient length of spare cable shall be left in the ground and at cable tray also at GIS, for future needs.
- (ii) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
- (iii) The cable shall be properly fastened using non-metallic 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 end 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 fiber shroud.
- (vii) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS-3043:1987 (Code of practice for earthing).

### 33.7 WORKING PROCEDURE FOR JOINTING

- (i) The cable jointing personnel shall have good experience in the type of joint and termination that are used. The jointing works shall commence as soon as two or three lengths of cable 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.

- (ii) Jointing of cables in carriage ways, drive ways under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and was mains should be avoided wherever possible.
- (iii) Sufficient over lap of cables shall be allowed for making the joints.
- (iv) The joint bay should be 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.
- (v) The joints of different phases shall be staggered in the jointing bay.
- (vi) Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.
- (vii) The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs etc. shall be of good quality and conform to standards.
- (viii) The jointing tools shall be appropriate and as per the requirement of jointing HV XLPE cables.
- (ix) **SUMPHOLES**

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

- (x) **TENTS/COVERS**

An enclosure or suitable protection cover shall be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The joint shall be made in dust free, moisture free and clean atmosphere.

- (xi) **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 of cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

- (xii) **MEASUREMENT OF INSULATION RESISTANCE**

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

- (xiii) 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.

#### **34 BONDING OF SCREEN/SHEATH**

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

On the basis of the length of the cable and rise of sheath Voltage the bonding may be required as follows:

1. Single End Bonding
2. Double End Bonding

3. Cross Bonding
4. Mid point bonding

All accessories and consumables used in the termination should be of good quality and compatible with the cable. At the time of single end bonding parallel copper conductor along the length of the cable shall have to be provided between the two ends of the cable. Bonding cable of 6.6 KV/3.8KV copper shall be provided for bonding of metallic sheath/Screen.

### **35 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.

### **36 ENGINEERING DATA AND DRAWINGS**

The Bidder shall necessarily submit all the drawings/documents unless anything is waived. The Bidder shall submit 4(four) sets of drawings/design documents/data/test reports as may be required for the approval of the Employer.

All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal and the external connections, fixing arrangement required and any other information specifically requested in the specifications.

All engineering data submitted by the Bidder after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

### **37 INSTRUCTION MANUAL**

- (i) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (ii) If after the commissioning and initial operation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated by the bidder in the final submission.
- (iii) The Bidder shall furnish to the Employer catalogues of spare parts.

### **38 QUALITY ASSURANCE PROGRAMME**

- a. To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Bidder's Works or at his sub-bidder's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Bidder shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Bidder and shall be finally accepted by the Employer after discussions before the award of Contract.
- b. Quality Assurance Documents

The Bidder shall be required to submit the following Quality Assurance Documents within three weeks before laying/erection of the equipment.

- (i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- (ii) Welder and welding operator qualification certificates.
- (iii) Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.
- (iv) Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- (v) Stress relief time temperature charts/oil impregnation time temperature charts.
- (vi) Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
- (vii) The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

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#### **ADDITIONAL EQUIPMENTS & STRUCTURES FOR CABLE TERMINATION**

1. The terminating structure being provided should be designed as per the requirement of the cable end sealing, porcelain bushing etc. The mounting structure shall be fixed on the cement concrete foundation, the design and drawings of which shall be submitted to Employer for review and acceptance during the course of detailed engineering.
2. After fixing the end termination, the cable shall be fixed to the support, with non-magnetic material clamps to the required height securely. The mounting structure includes 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 Employer.
3. Suitable fencing should be provided at the cable terminating yard at cable conductor junction point. The fencing will consist of galvanized steel XPM structure over a brick wall of 2(two) feet meeting electrical requirement (IE). A suitable entry point (gate) has to be provided.
4. Outdoor type 120KV lightning arresters for each cable of both the circuits are to be provided at cable-conductor junction point. The technical specification of lightning arresters is given separately in this volume.
5. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals

meet the specified designs, standard and performance requirements and are acceptable to the Employer. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule will not be considered as valid deviation.

6. Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the work unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided shall be inter-changeable with one another.

#### **7. STEEL STRUCTURES (GANTRY, EQUIPMENTS ETC.):**

- A) The contractor shall assume full responsibility for supply, fabrication and detailing, if required of the steel structures and for their satisfactory performance. All detail drawings for the structures shall be supplied to the successful bidder by the Employer/Engineer. However, the contractor shall have to submit the construction drawings to the Engineer/Employer solely prepared on the basis of these supplied drawings. Equipment Structure drawings, supplied by the employer, shall have to be modified to suit to the approved GA drawings of the equipment and electrical layout drg. and to be submitted to Engineer for approval. Employer/Engineer shall have the right to instruct the contractor to make any changes in details necessary to make the construction conform to the requirement of the Contract Document.
- B) The contractor shall supply all materials, deliver the same to site, and provide all labour, erection plant and equipment, fixtures, fitting and all temporary and permanent works necessary for satisfactory completion of the job in all respects.
- C) No omissions or ambiguities on the drawings or in specifications will relieve the contractor from furnishing best quality of materials and workmanship. Should any inaccuracies be found, the contractor shall promptly notify the Employer/Engineer without carrying out the job and no further work shall be done before these discrepancies are corrected. Continuation of further work shall be done only after such discrepancies are rectified at contractor's risk and responsibility.
- D) MATERIALS: The materials shall conform to the following requirements:
  - D.1 All Structural Steel Materials to be used in construction within the purview of the specification shall comply with:IS:2062 - Structural Steel (Grade-A) (fusion welding quality) and manufactured by Prime Rollers e.g. SAIL/TISCO/IISCO/RINL. In case of MS sections not manufactured by prime rollers or such sections are not available with prime rollers the same is to be procured from approved conversion agents of prime manufacturer(s). In such case, prior approval of the Engineer is to be obtained by the contractor.
  - D.2 Successful bidder on receipt of structural drawing from department shall submit within 15 days, a detailed raw material procurement plan indicating MS section wise producers name to the Engineer for approval. On according approval in this aspect, work for fabrication protos shall be taken up in hands.

- D.3 Entire fabrication job of MS structural shall not be entrusted to more than two sub-vendors. Further, a list of bonafide fabricators, not exceeding 6 (six) shall be furnished to the Engineer for according approval within 15 (fifteen) days from the date of handing over of drawings.
- D.4 All electrodes to be used under the contract shall comply with any of the following Indian Standard Specifications as may be applicable.
- i) *IS:814 : Covered electrodes for metal arc welding of Structural Steel.*
  - ii) *IS:815 : Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.*
  - iii) *IS:144 : Covered electrodes for the metal arc welding of high tensile structural steel.*
- D.5 All bolts and nuts shall be of grade 5.6 HRH and shall conform to the requirements of IS:6639 and IS:1367 and galvanizing quality shall be as per IS:1367. All bolts and nuts shall be of minimum diameter of 16 mm unless otherwise stated. All mild steel for bolts and nuts when tested in accordance with the following Indian Standard specification shall have a tensile strength of not less than 44 Kg/Sq.mm. and a minimum elongation of 23 percent on a gauge length of 5.6 A, where 'A' is the cross sectional area of the test specimen -
- i) *IS:1367 : Technical supply conditions for threaded fasteners.*
  - ii) *IS:1608 : Method for tensile testing of steel products other than sheet, strip, wire and tube.*

Washers shall be made of steel conforming to IS:226, IS:961 as may be applicable under the provisions of the contract and shall be electro galvanized.

## **8 FASTNERS & CONNECTIONS:**

- a) **BOLTS:** All connections shall be bolted with 16 mm bolts.
- b) **SPLICES:** Splicing shall be avoided unless the length of a member exceeds 6.0m or so. The number of splices shall be limited to a practical minimum. No credit shall be allowed for bearing on abutting areas. Lap joints in leg members shall be preferred to butt joints.
- c) **STEP BOLTS:** Step bolts shall be of 16 mm diameter and shall have round or hexagonal head. Each step bolt shall be provided with two hexagonal nuts. The minimum bolt length and length of unthreaded portion shall be 180 and 125 mm respectively. Step bolts shall not be used as connection bolts the step bolts shall be spaced alternately on the inner gauge line on each face of the angle about 40 cm center. They shall be furnished for one leg of each steel structure column from its base elevation.
- d) **U – BOLTS:** U-Bolts shall be suitable furnished for steel structures to suspend or terminate insulator strings or ground wire assemblies. Size of U- bolt shall withstand all loads acting on it.
- e) **BILL OF MATERIAL:** Bill of material shall give the size, length and weight of each member and the total weights of steel structures. It shall also include the number of bolts, nuts and washers per structure.

## **9 MATERIAL/WORKMANSHIP**

1. Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new of highest grade of the best quality of their kind conforming to best engineering practice and suitable for the purpose for which they are intended.
2. In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer the Bidder shall submit, for approval, all the information concerning the materials or components to be used in manufacture, Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Bidder.
3. The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.
4. Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
5. All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification.
6. Provision for Exposure to Hot and Humid climate: Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew.

## **10 PACKAGING & PROTECTION**

- a. All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Bidder shall also submit packing details/associated drawing for any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper

packing. Any demurrage, wharfage and other such charges claimed by the transporters, railway etc. shall be to the account of the Bidder. Employer takes no responsibility of the availability of the wagons.

- b. All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damaged. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

## **11 FINISING OF METAL SURFACES**

- a. All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized to service condition. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.

- b. **HOT DIP GALVANISHING**

The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6 mm. For items lower than 6 mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface, which shall be embedded in concrete the zinc coating shall be 610 gm/sq m minimum.

The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

c. **PAINTING**

All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment.

The surfaces, which are to be finished painted after installation or require corrosion protection until installation shall be shop painted with at least two coats of primer. Oil, grease, dirt shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphate thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

The exterior colour of the paint shall be as per shade no : 697 of IS-5 and inside shall be glossy white for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Each coat of primer and finishing paint shall be slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

In case the Bidder proposes of follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids of Employer's review and approval.

**12 HANDLING, STORING AND INSTALLATION**

- a. In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Bidder shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.
- b. Bidder may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Bidder shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- c. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instruction, necessary clarifications shall be obtained from the Employer. Bidder shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- d. Where material/equipment is unloaded by Employer before the Bidder arrives at site or even when he is at site. Employer by right can hand over the same to Bidder and there upon it will be the responsibility of Bidder to store the material in an orderly and proper manner.
- e. The Bidder shall be responsible for making suitable indoor storage facilities to store all equipment, which require indoor storage.
- f. The words 'erection' and 'installation' used in the specification are synonymous.
- g. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.



- h. The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances as given in clause 4.7.1 the Bidder shall immediately proceed to correct the discrepancy at his risks and

### **13 QUALITY CONTROL:**

The contractor shall establish and maintain quality control procedures for different items of work and materials to ensure that all work is performed in accordance with the specifications and best modern practice.

In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer. As far as possible all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at site or elsewhere. The contractor shall cooperate with the Engineer in permitting access for inspection to all places where work is being done and in providing free of cost of all necessary help in respect of tools and plants, instrument, labour and material required to carry out the inspection. Materials or workmanship not in reasonable conformance with the provisions of this specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work :

- i) Steel: Quality, manufacturer's test certificates, test reports including procurement in-voice of representative samples of materials from unidentified stocks if permitted to be used.
- ii) Bolts, nuts & Washers: Manufacturer's certificate, dimension check, material testing
- iii) Electrodes: Manufacturer's certificate, thickness and quality of flux coating.
- iv) Welds: Inspection, X-ray, ultrasonic test, magnetic particle tests asrequired
- v) Paints: Manufacturer's certificate, physical inspection reports.
- vi) Galvanizing: Tests in accordance with IS:2633 - Method of testing uniformity of coating on zinc coated articles and IS:2629 Recommended practice for hot-dip galvanizing of iron and steel. Raw zinc & samples collected from bath shall be tested at third party laboratory as per direction of the Engineer.

The contractor shall submit a detailed material inspection plan on the basis of various IS codes & standard practices in respect of structural fabrication, galvanization, bolts, nuts, anchor bolts etc. much prior to commencement of the job.

### **14. FABRICATION WORKMANSHIP:**

All workmanship shall be equal to the best practice in modern structural shop and shall conform to the provisions of IS:800 / IS:802.

Rolled materials before being laid off or worked, must be clean free from sharp kinks, bends, or twists and straight within the tolerances allowed by IS:1852. If straightening is necessary it may be done by mechanical means or by the application of a limited amount of localised heat not exceeding 600°C.

Cutting shall be effected by shearing, cropping or sawing. Use of mechanically controlled Gas Cutting Torch may be permitted for mild steel provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge.

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without cleats shall not be more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed clearance shall be provided.

All members shall consist of rolled steel sections.

Holes for bolts shall not be more than 1.5 mm larger than the diameter of the bolt passing through them unless otherwise stated.

All members shall be cut to jig and all holes shall be punched and drilled to jig. All parts shall be carefully cut and holes accurately located after the members are assembled and tightly clamped or bolted together.

Drifting or rimming of holes shall not be allowed. Holes for bolts shall not be formed by gas cutting process.

Punching of holes will not be permitted for M.S. members upto 8 mm thick and in no case shall a hole be punched where the thickness of the material exceed the diameter of the punched hole.

Minimum bolt spacing and distances from edges of members shall in accordance with the provisions in the relevant Indian Standard Specification.

Built members shall, when finished, be true and free from all kinds of twists and open joints and the material shall not be defective or strained in anyway.

All bolts shall be galvanized including the threaded portion except the foundation bolts for which galvanizing work shall be done for a length of 100mm (min) to 175mm (max) measured from the tip of the treaded portion. The threads of all bolts shall be cleared of smelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the Engineer. All nuts shall be galvanized with the exception of the threads which shall be oiled. In case of foundation bolts the same shall be galvanized excepting the length of embedment.

When in position all bolts shall project through the corresponding nuts but not exceeding 10 mm. The nuts of all bolts attaching insulator sets and earth conductor clamps to the structure shall be carefully positioned as directed by the Engineer.

Bolts and nuts shall be placed in such a way so that they are accessible by means of an ordinary spanner.

Foundation bolts shall be fitted with washer plates or anchor angles and flats, nuts etc. and shall be manufactured from mild or special steel.

Washers shall be tapered or otherwise suitably shaped, where necessary to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least by 3 mm. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut. In addition to the normal washer, one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified in the drawings.

The thickness of spring washer shall be 3.5 mm for bolt diameter 16 mm and 4 mm for bolt diameter 20mm.

## 15 CLEANING & GALVANIZING:

### CLEANING:

After fabrication has been completed and accepted, all materials shall be cleared off rust, loose scale, dirt, oil grease and other foreign substances.

### GALVANIZING:

All materials shall be hot-dip galvanized after fabrication and cleaning. Retapping of nuts after galvanizing is not permitted.

Galvanizing for structural mild steel products shall meet the requirements of IS:4759. All holes in materials shall be free of excess spelter after galvanizing.

Galvanizing for fasteners shall meet the requirements of IS:1367. The spring washers shall be electro galvanized as per IS:1573.

Finished materials shall be dipped into the solution of dichromate after galvanizing for white rust protection during transportation.

All galvanizing shall be uniform and of standard quality. Quantity of zinc shall meet the requirement of IS:209.

### Mass of Zinc Coating:

The mass of zinc coating for different class of materials, as given in Table below, shall be followed:

MASS OF ZINC COATING

Sl. No.	Product	Electro meter reading ( micron )	Minimum Value of Average Mass of Coating
i)	Casting - gray iron, malleable iron		610 (gm/m <sup>2</sup> )
ii)	Fabricated steel articles :		
a)	5 mm thick and over	86	610
b)	Under 5 mm, but not less than 2 mm	65	460
c)	Under 2 mm, but not less than 1.2mm	48	340
iii)	Threaded work other than tubes and tube fittings :		
a)	10 mm dia and over	43	300
b)	Under 10 mm dia	39	270

### STRAIGHTENING AFTER GALVANIZING:

All plates and shapes which have been warped by the galvanizing process shall be straightened by being rerolled or pressed. The materials shall not be hammered or otherwise straightened in a manner that will injure the

protective coating. If, in the opinion of Employer / Engineer the material has been forcibly bent or warped in the process of galvanizing of fabrication, such defects shall be cause for rejection.

#### **REPAIR OF GALVANIZING:**

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized, unless, in the opinion of Engineer, the damage is local and can be repaired by zinc spraying or by applying a coating of galvanizing repair compound. Where regalvanizing is required, any member which becomes damaged after having been dipped twice shall be rejected.

#### **SHOP ASSEMBLY:**

One of each type of steel structures shall be assembled in the shop to such an extent as to ensure proper field erection in order to facilitate inspection by the Engineer.

#### **SHOP TEST:**

The following shop tests shall be performed with relevant provisions of I.S.Codes :

- a) *General Inspection*
- b) *Material test.*
- c) *Assembly test.*
- d) *Galvanizing test.*

The contractor shall furnish four certified copies of reports of all tests to the Engineer.

### **16 FOUNDATION WORKS:**

#### **GENERAL REQUIREMENT:**

The design of RCC foundation for gantry and other equipment structures to be constructed shall be the responsibility of the contractor. All design of RCC foundation works shall conform to IS:456 (2000) unless otherwise mentioned herein. All designs and details shall be subject to approval of the Engineer. Effect of additional surcharge due to earth filling shall duly be taken into account during design.

However, detailed foundation design shall be based on the actual soil parameters which shall be ascertained by the intending bidder. Any variation in design of foundations due to change in soil parameters during execution of work shall not affect the terms of the Contract. No extra payment on account of any change whatsoever in soil parameters will be entertained.

### **17 DESIGN OF FOUNDATIONS:**

#### **A) STEEL STRUCTURE FOUNDATIONS :**

The foundations shall be designed such that the upper structure shall be securely supported. Any unequal displacement that may cause harmful effect to the upper structures shall not be allowed. The safety factors for strength and stability of the foundations shall be as per relevant code.

The overload factor shall be taken as 1.1 for designing foundations of all gantry and equipment. The loads, shear and moment values shall be multiplied with this overload factor, so as to obtain the design values.

## **B) ELECTRO-MECHANICAL EQUIPMENT FOUNDATIONS :**

The foundation shall be so designed that the upper equipment shall be securely supported. The effect of vibration of the equipment, impact load when in operation and overturning force due to abnormal condition of equipment shall be considered in foundation design. The safety factor for stability of the foundations shall be as per relevant code with an overload factor of 1.1.

Following minimum values shall be used while designing foundations :

- i) Minimum base slab thickness of footings : 200 mm
- ii) Minimum bar dia for foundation : 10 mm TOR
- iii) Minimum bar dia for columns : 12 mm TOR with binderspacing limited to 190 mm c/c.
  
- iv) Clear cover to :
  - Main bars in base slab : 50 mm
  - Main bars in columns : 40 mm
  - Main bars of beams : 40 mm
  
- v) Minimum reinforcement for base slab shall be 0.2 percent of cross sectional area, depth to be considered as effective depth and where beam slab mechanism will be deployed 0.12 percent of gross cross sectional area shall be considered.
  
- vi) Plinth height for structures & equipment's foundation a) 132 kV – 200 mm

## **18 OTHER DETAILS**

### **A) DETAIL DESIGN CALCULATION :**

Detail design calculations for each type of foundation shall be submitted for approval of Engineer. Such details shall show the following requirements.

- i) *Detailed calculation of loads acting on foundation under different loading conditions.*
- ii) *Calculated safety factor for each type of stability and other conditions.*
- iii) *Maximum stresses in concrete and in steel reinforcement at any critical section.*

### **B) LINE AND GRADE :**

The contractor shall set all lines and grades or elevation of the ground at all footings and set the necessary stakes that are required for the work and will be responsible for their accuracy. Employer/Engineer may check lines and levels set by the Contractor from time to time, and inadequacies if any, shall be rectified by the contractor as per the direction of the Engineer, but the responsibility for their accuracy shall rest entirely with the Contractor.

### **C) DETAIL DRAWINGS :**

Details of each type of foundation submitted for Employer's/ Engineer's approval shall be as shown on the approved design drawings and shall conform to the requirements described hereafter. No change shall be made

without the written approval of Employer/Engineer. The detail drawings shall include but not limited to the following:

- i) Detail dimensions of foundation.
- ii) Details of setting dimensions of foundation.
- iii) Details of placing of all reinforcing steel which shall conform to the Building Code Requirements for Reinforced Concrete (IS:456) and the Manual of Standard Practice for Detailing Reinforced Concrete Structure unless otherwise specified herein.
- iv) Details of type size and length of each reinforcing steel including schedule of bar bending to be submitted to the Engineer at site

**18 WEIGHT OF SUB-STATION STRUCTURES:**

Self-weight of line tower, A-frame and equipment structures for different gantry and equipment structures shall be provided at the time of detail engineering.

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**SPECIFIC TECHNICAL PARTICULARS FOR 132 KV & 220KV XLPE CABLE**

SL	ITEMS	PARTICULARS
1	Description of Cable	Stranded single core compacted copper core screening by a layer of semi conducting tape followed by a layer of semiconducting compound as conductor screen, XLPE insulation, insulation screening with semiconducting compound extruded directly over the insulation,(semiconducting conductor screen, XLPE insulation, semiconducting insulation screen-all in one triple extrusion process), longitudinal sealing by a layer of water swell able semi conducting non woven tape over insulation screen, Metal sheath of Lead alloy 'E' as per IS 7098 part-III, metallic screening by concentric layer of plain copper wire followed by an open helix of copper and over all extruded black HDPE Sheathed (Type ST 7).
2	Highest system voltage	145KV/245KV
3	Voltage Grade	76/132KV 127/220KV
4	Voltage variation	+10% and -12.5%
5	Frequency	50 Hz
6	Frequency variation	±3%

7	Power frequency withstand voltage	190 KV rms for 30 minutes 318KV for 30 minutes
8	Lightning impulse withstand voltage	±650 KV peak      1050 peak
10	No of phase per Ckt	3
11	Earthing system	Effectively earthed
12	Size of Cable	<b>AS per requirement</b>
13	Max. in Conductor Temp.	90°C at maximum continuous current.
14	Fault level	31.5 KA for 1 second      40KA for 1 second
15	Maximum permissible short ckt temperature.	250°C for one second.
<b>16</b>	<b>CABLE DETAILS : CONDUCTORS</b>	
16.1	Conductor material	Plain un-tinned annealed copper.
16.2	Conductor Shape	Compacted circular.
16.3	Conductor Screen	Extruded, Cross-linked, semi conducting compound of suitable thickness. Semi conducting separator tapes with 50% overlap to be applied between conductor and conductor screen.
16.4	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16.5	Insulation	
	a)material	XLPE
	b)specified insulation resistance at 90°C	1x10 <sup>12</sup> ohm cm
16.6	Insulation Screen : Type & Material	Extruded semi conducting compound.
16.7	Resistivity of the semiconducting compound	Max 500 Ohm-meter
16.8	Longitudinal water barrier Material	Layer of semi conducting tape with suitable water swellable absorbent with 50% overlap.
16.9	Radial moisture barrier Material	<b>Metal sheath of Lead alloy 'E' as per IS 7098 part-III.</b>
16.10	Overall sheath	Extruded black HDPE (Type ST 7) with anti termite and anti rodent treatment.
16.11	Coating of outer sheath	A hard baked layer of graphite or semi conducting layer shall be applied over the outer sheath as outer electrode for testing the sheath.
17.	Approximate Length of cable in a drum	500metres with a tolerance range of ± 5% or as per requirement.

18	Bending Radius	The minimum bending radius of XLPE insulated cables as follows:  Cable: Bending radius  Single Core: 25xD  D – diameter of overall conductor.
19	<b>TESTS</b> Applicable standards	IEC 60840 IEC 62067
19.1	Type Test a) whether previous test reports will be sufficient b) whether sample to be Type tested against this order.	All tests as per specifications IEC Standards Yes, if done on identical cable.  No, if done on identical cable.
19.2	Routine Test	All tests as per specifications IEC Standards.
19.3	Acceptance Test	All tests as per specifications IEC Standards.
19.4	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
20	<b>INSTALLATION, TERMINATION AND JOINTS</b>	
21	Ambient temperature	45°C
	Ground temperature	30°C
	Thermal resistivity of soil	150°C cm/Km
22	Laying Configuration	Trefoil formation.
23	Depth	1.5 m below ground level.
24	Termination	
25	Type	<b>AS per requirement</b>
26	Joints Required	<b>AS per requirement</b>
27	Earth Link Boxes Required	<b>Yes. In both end and at joints for cross bonding.</b>
28	Surge Suppressor Required	<b>AS per requirement</b>
29	Bonding Type	<b>To be finalized at the time of detailed engineering if not mentioned otherwise.</b>