



ASSAM ELECTRICITY GRID CORPORATION LIMITED

OFFICE OF THE MANAGING DIRECTOR

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CORRIGENDUM-I

BID IDENTIFICATION NO: AEGCL/MD/TL-76/PP&D/Traction Bay/IRCON/Gauripur/2023/BID

TENDER DETAILS/NAME OF WORK: Turnkey Construction of a 132kV Railway Traction Bay and associated works at 132kV Gauripur GSS, AEGCL

For the above referred bid, the following may please be noted by the bidders:

1. Drawings are uploaded with corrigendum for reference of interested bidders. However, the drawings provided are for indicative purpose only and may require modifications depending upon project, actual site conditions, exact equipment dimensions, etc. The contractor shall be required to prepare own drawings based on project with modifications as and if required and shall submit those for scrutiny and approval of AEGCL (As mentioned at **Clause No. 2.1.3, Section 2, Volume-II** and **Clause No. 3.8.1, Section 3, Volume-I** of the bid document).
2. Uploaded reference drawing of Auxiliary Earth Mat for 220 kV Isolator with earth switch shall also be applicable for 132 kV Isolator with earth switch.
3. Technical specifications for 132 kV Outdoor type cable end termination with composite insulators (sealing ends) with all materials are uploaded (For cable end termination & Jointing, refer to Clause no. 14.22, Technical Specification for XLPE cable with termination) for reference.
4. As per **clause 3.1.6, Section-3, Volume-I** of the bid document, it may be mentioned here that the integration of the newly supplied CRP to the **existing ABB make SAS at 132kV Gauripur GSS, AEGCL** has to be done by authorized representatives of the OEM only. Also, if the OEM of the supplied C&R Panel is different from the OEM of the existing SAS, then the integration of the supplied C&R Panel with the existing SAS has to be done by the authorized representatives of both the OEM. The arrangement for the integration of the C&R Panel with the existing SAS of AEGCL, as desired, shall be under the contractor's scope.
5. The tender submission end date and techno-commercial bid opening date is amended as below:

Tender submission end date and time: **12:00 Hrs., 03.10.2023**

Techno-commercial bid opening date and time: **16:00 Hrs., 04.10.2023**

All other terms and conditions of the bid document shall remain same.

Sd/-

Chief General Manager (PP&D)

Assam Electricity Grid Corporation Limited

Memo No: AEGCL/MD/TL-76/PP&D/Traction Bay/IRCON/Gauripur/20(a)

Date: 21.09.2023

Copy to:

1. IT Cell, O/o the MD, AEGCL, for publication of the corrigendum in AEGCL's Website

Sd/-

Chief General Manager (PP&D)

Assam Electricity Grid Corporation Limited

SECTION-14 TECHNICAL SPECIFICATION FOR XLPE CABLE WITH TERMINATION

14.1 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.

14.2 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 Tenderer along with the tender.

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 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
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)

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

14.4 Construction

For 132KV and above: 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 less than or equals to 800 sq.mm or segmental compacted circular (Milliken) Copper conductor in case of cross section over 800 sq.mm, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, crosslinked 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 corrugated & seamless or seam welded aluminum with asphalt coating & overall PE sheathed & graphite coated 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.

The construction of cable shall generally conform to the description mentioned above. Tenderer 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 Tenderer shall enclose with the TENDER, drawing showing cross section of the cable.

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.

The cables shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.

Progressive sequential marking of the length of cable in meters at every one meter shall be provided on the outer sheath of the cable.

The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.

Allowable tolerance on the overall diameter of the cables shall be plus or minus 2mm.

IS 7098 part III shall be followed for cable construction.

14.5 Compositions of Cables

- i. **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 800 sq.mm, the segmental compacted circular conductor having minimum four (4) segments should be constructed for the supply under the scope of tender. When the conductor's cross-section is less than 800 sq.mm, the compacted circular is applied generally.
- ii. **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.
- iii. **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 in single cross-head. 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 N₂ gas should be preferred instead of conventional cross-linking process by saturated steam.
- iv. **Insulation Screen**
The insulation screen shall consist of extruded semi-conducting XLPE. Suitable bedding tapes shall be applied over the extruded semi-conducting XLPE.
- v. **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.
- vi. **Metallic Screen:**
The metallic screen shall be of Lead Alloy 'E' as per IS 7098 Part III sheet with asphalt coating. The metallic screen shall be designed to meet the requirement of the system short circuit rating of 31.5KA for 3 sec (for 33KV) and 40KA for 3Sec (for 132KV).
- vii. **Outer Sheath**
The outer sheath shall consist of extruded black colored PE of ST2 grade as per IS: 5831 (1984). The outer sheath shall be designed for protection against termite and rodent attack and shall be coated with graphite.

14.6 Rating

The Tenderer 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.

14.7 Cable Drums

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 water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

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. A narrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

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.

The Tenderer 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. If any length of cable remains unused, the same shall be adjusted by the employer.

Embossing of outer sheet: the following details on the other sheet of cable at a regular interval of 1(one) meter.

Name of Customer i.e. AEGCL

Conductor size, type of insulation and voltage grade.

Manufacturer's name.

Year of manufacturing

14.8 Tests

All routine and acceptance tests shall be conducted as per IEC60840/IEC62067. 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 (Part3) 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/ Clause12.4.2 IEC62067:2001 & including amendments.

14.8.1 Following additional type tests shall be carried out on outer sheath of XLPE insulated HT cable.

Oxygen index and temperature index test as per ASTM D-2863.

Chemical composition test for verifying lead sheath composition.

All tests as prescribed in IEC-60840 shall be performed after installation of cable.

14.8.2 Tests After Installation

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

14.9 Technical Specification of 132KV UG 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, followed by radial sealing (metal sheath of Corrugated Aluminum), and over all extruded black HDPE Sheathed (Type ST 7).
2	Highest system voltage	145KV
3	Voltage Grade	76/132KV
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
8	Lightning impulse withstand voltage	±650 KV peak
9	No of phase per Ckt	3
10	Earthing system	Effectively earthed
11	Size of Cable	630 sq mm
12	Max. in Conductor Temp	90°C at maximum continuous current.
13	Fault level	40KA for 1 second
14	Maximum permissible short ckt temperature.	250°C for one second.
15	CABLE DETAILS: CONDUCTORS	
15.1	Conductor material	Plain un-tinned annealed copper.
15.2	Conductor Shape	Compacted circular.
15.3	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.
15.4	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
15.5	Insulation	
	a)) material	XLPE
	b) specified insulation resistance at 900 C	1x10 ¹² ohm cm
15.6	Insulation Screen: Type & Material	Extruded semi conducting compound.
15.7	Resistivity of the semiconducting compound	Max 500 Ohm-meter
15.8	Longitudinal water barrier Material	Layer of semi conducting tape with suitable water swellable absorbent with 50% overlap.
15.9	Radial moisture barrier Material	Seamless or seam welded Corrugated Aluminium sheath with anticorrosive material.
15.1	Overall sheath	Extruded black HDPE (Type ST 7) with anti-termite and anti-rodent treatment.
15.11	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.
16	Approximate Length of cable in a drum	500 metres with a tolerance range of ± 5% or as per requirement.
17	Bending Radius	The minimum bending radius of XLPE insulated cables as follows:
		Cable: Bending radius
		Single Core: 25xD
		D - diameter of overall conductor.

18	TESTS Applicable standards	IEC 60840 IEC 62067
19.1	Type Test	All tests as per specifications IEC Standards.
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.

14.10 Construction of cable trenches and cable trays:

The cable shall be laid in concrete cable trenches inside the substation from the line terminations and HV side of power transformers to the respective GIS bays inside GIS halls. The cable trench at road crossing within switch yard road must be designed as culvert for movement of vehicles. There shall be adequate slope for drainage purposes and must have sump pit with water pump at its lowest level and be connected to the substation storm water drainage system. The trenches must be sloped to prevent entry of water in GIS building. The typical cross section of various cable trenches Type A, Type B, Type C and Type D are given in the Volume-III of this tender document. However, tenderer have to submit design of the cable trench considering physical and electrical properties using applicable relevant standards and codes.

The space provided for cable racks has to be sufficient to carry the cables. The racks shall be generally fixed in the wall. The necessary size of the rack and associated structures has to be worked out taking into consideration of cable grouping and permissible bending radii. The vertical distance between the two racks should be 0.3 Mtr and clearance between the first cable and the wall (if the racks are mounted in the wall) should be minimum 25mm. The width of the rack should not be exceeding 0.75 Mtr in order to facilitate installation of cables. Each tray should contain one layer of cables. More than one tier trays are permissible if the cables present cannot be accommodated in a single rack. Cable racking/trays should be painted with a coat of primer and thereafter finished with suitable anticorrosive paint. Only single core cables laid on horizontal racks need be clamped at suitable intervals.

The places where cable trench cannot be constructed due to obstruction of existing trenches, overground cable trays shall be constructed to connect with the underground cable trenches. The locations of the overground 132KV cable trays are shown in the plan lay out diagram furnished in Volume III.

The requirement of bending radii transportation and cooling of cable as per IS 1255-1983. For fixing of cables the following has to be taking into consideration.

The cable trenches shall be properly earthed and connected to the main earth grid of the substation.

Cable fixing: After laying of three nos. of cable with one spare in each circuit, the cable shall be tied up with nonmagnetic material trefoil/single clamp depending on the laying configuration i.e., trefoil/flat.

Horizontal distance between cleats shall be at 1-2 mtr intervals or as per choice of purchaser.

Vertical distance: If the cable circuits between cleats are laid in tier, then the vertical distance between the cleats shall not be less than 300mm.

The civil part of the construction of cable trench shall be undertaken in consultation with DGM(Civil), AEGCL. All drawings of cable trenches, calculations of load bearing capacity of the cable trenches shall be submitted to DGM(Civil), AEGCL for approval.

14.11 Trenching

The cable trench work involves earth excavation for cable trench and removal of excess earth from site. The excess earth shall be transferred to an area as decided by the purchaser. Any damage to switchyard during excavation work shall be responsible of the contractor. 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 foot paths are encountered, the pavements 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 the other part of the switchyard to prevent accidents. 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 movement in the switchyard. 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.

14.12 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 seal 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.

14.13 Laying of Cables

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

- i. Route survey for the entire route length under the scope of work. This is also to finalize drum wise cable length with their tolerances.
- ii. Clearances from relevant authorities for laying of cables.
- iii. Formation of cable trenches for cables with cable trench top covers for entire route, construction of jointing bays, and restoration as per specification.
- iv. Crossings through HDPE pipe for each cable and restoration as per specification.
- v. 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.
- vi. Supply and installation of straight through joints for complete route.
- vii. Design, supply and installation of suitable hangers and other necessary structures for running the cable at overhead road bridge.

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.

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. Tenderer 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.

Design, fabrication, supply and erection of galvanized steel structures (including its civil foundation) for cable end terminations (with all necessary accessories) for cable at cable-conductor junction point. At cable-conductor junction point terminal connectors offered by Tenderer shall be suitable to terminate with ACSR conductors.

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.

Design, supply and installation of LA at cable-conductor junction point for both the circuits including its mounting structure and LA & Isolator at Sub-Station.

Termination, bonding, earthing etc. at GIS sub-station end is within the scope of this work.

14.14 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 IS1149-1984. Clamps shall be provided at every one meter of cable runs. The contractor shall submit drawings of trefoil clamps and arrangements for Employer approval.

14.15 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 IS1255- 1983 or its equivalent.

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 damages 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 using HDD technology.

14.16 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.

14.17 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.

14.18 Warning Tape

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

CAUTION: AEGCL 132 KV CABLES.

14.19 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.

14.20 Tools and Plants

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

The Tenderers are instructed to give all the details of equipment at their disposal to carryout the work successfully and speedily.

14.21 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.	

14.22 Cable End Terminations & Jointing

The cable jointing accessories shall include the end terminating kits, straight through joints and also any special tools and tackles required for making these joints.

The straight through joints shall be either Pre-molded Heat Shink type complete with all accessories. The joint shall preferably be built up as per the construction of 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.

The outdoor end termination up to 132 KV XLPE Cable shall be Anti-fog, Pre-molded type Silicon Rubber stress cone. Torque controlled mechanical shear head bolted connector with polymeric composite housing (resin cast body with silicon shed housing), dry/fluid filled type self-supporting with Plug-in / Plug-out facilities. The termination base plate and the cable's metallic sheath shall be electrically insulated from the self-supporting structure by means of stand-off epoxy insulators designed to withstand both mechanical and electrical stresses in services. The Polymeric insulator in grey colour shall be used.

The outdoor terminals should be suitable for 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 shall be based on the Silicon Rubber based stress relief cone and the epoxy resin housing. There shall be mechanical devices to maintain the interface pressure. 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. There shall be epoxy insulating plate to isolate between cable sheath and GIS chamber. The SVLs (Sheath Voltage Limiter) shall be installed to protect epoxy insulating plate from switching impulse. Plug-in type leading conductors shall be supplied though at the time of detailed engineering confirmation shall be given for selection of plug-in type. Design and scope of delivery shall be fully complying with IEC-60859, IEC-62271-209 and possibly adjusted to various needs of project. The main insulation components shall be fully examined and tested in the factory.

The detailed description on jointing procedure shall be furnished during detailed engineering.

The details of the performance of end terminations / straight through joints as offered with the period in service in reputed Indian Utility should be furnished for 145 KV Cable accessories for evaluation of the techno-commercial offer.

The accessories shall be Type Tested as per relevant IEC 60840 & Type test report shall have to be furnished for technical evaluation.

14.22.1 Working Procedure for Termination

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.

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.

The cable shall be properly fastened using non-metallic clamps.

Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.

The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.

Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fiber shroud.

Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS-3043:1987 (Code of practice for earthing).

14.22.2 Working Procedure for Jointing

The cable jointing personnel and his crew shall have good experience in the type of jointing and terminations 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.

Jointing of cables in carriage ways, driveways under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and power mains should be avoided wherever possible.

Sufficient overlap of cables shall be allowed for making the joints.

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. 3 ph link box for cross bonding to be placed inside the bay with provision for easy access for maintenance purpose.

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

Comprehensive jointing instructions should be obtained from the manufacture 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 HVXLPE cables.

i. **Sump holes**

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.

ii. **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.

iii. **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.

iv. **Measurement of Insulation Resistance**

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

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.

14.23 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:

Single End Bonding

Double End Bonding

Cross Bonding

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 6.6KV copper shall be provided for bonding of metallic sheath/ Screen.

14.24 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.

14.25 Statutory Approval of Works

Contractor shall make an application on behalf of the owner for submission to the Electrical Inspectorate along with copies of required certificates complete in all respects and submit to the engineer-in-charge for onward transmission well ahead of time so that the actual commissioning of system/ equipment is not delayed for want of inspection by the Inspector. Contractor shall arrange the actual inspection of work by the Electrical Inspector. Necessary coordination and liaison work in this respect shall be the responsibility of the contractor.

The Inspection and acceptance of work as above shall not absolve the Contractor from any of his responsibilities under this contract.

Any other statutory approval of works required for the electrical installation (such as Factory Inspector, CCOE, etc.) is also included in contractor's scope.

Supply & execution of job is subjected to regulations time to time framed by the AERC; approval Govt. of Assam, and NOC from Assam Pollution Control Board. Contractor shall complete the entire job in compliance with the same.

14.26 Inspection, Testing and Commissioning

Inspection of Supplied materials and Site works time to time during execution: Inspection of AEGCL and clearance from AEGCL will be in Contractor responsibility. Expenditure related to this inspection will be in contractor account. Site inspection, testing and commissioning of electrical installation shall be carried out as per enclosed Specification and Inspection and Test Plans included or referred in this tender. All the equipment installed by the contractor shall be tested and commissioned, as required and no separate payments shall be made unless otherwise specified in the Schedule of Rates. Contractor shall carefully inspect all equipment and submit the manufacturer's Certificate before installation. Any damage or defect noticed shall be brought to the notice of the engineer-in-charge at that time and same shall be rectified or replaced by contractor on his **own risk and cost within time frame**. Complete testing of power transmission system would be carried out under the supervision of the Employer.

Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at his own cost.

The contractor shall carry out all the tests as enumerated in the tender and technical specifications and technical documents which may be furnished to him during performance of the work.

Before the electrical system is made live, the electrical contractor shall carry out suitable tests to establish to the satisfaction of the Employer that the installation of equipment, cabling/ wiring and connections have been correctly done and are in good working condition and that the system/ equipment will operate as intended.

All tests shall be conducted in the presence of Employer/ Engineer-in-Charge or his authorized representative unless he waives this requirement in writing. Contractor shall arrange testing equipment, as required to carry out the tests. Test results shall be recorded on approved Performa and certified records of the tests shall be submitted to the Employer/ Engineer-in-Charge.

Prior intimation to be given to the Employer before finalizing of date of scheduled inspection at least 15 days in advance.

Clearance in favour of contractor for dispatch of equipment/material from respective works of manufacturer will be covered by the Employer after physical inspection and witnessing satisfactory routine and acceptance tests. Contractor will have to arrange physical inspection and witnessing of Routine and Acceptance Test of materials/equipments at respective manufacturer's works by two engineers of the Employer and cost of such

inspection shall have to be borne by contractor. Clearance for dispatch of equipments & materials from respective works of manufacturers will be conveyed by the Employer after verification and acceptance thereafter. After the completion of all tests and rectification of all defects pointed out during final inspection, plant start-up trials shall commence. During the start-up trials, contractor shall provide skilled/ unskilled personnel and supervision round the clock at his own cost. The engineer-in-charge/Employer will decide the number and the category of workmen and their duration. Any defects noticed during the start-up trials relating to the equipment supplied and work carried out by the contractor, shall be rectified by the contractor at his own cost.

The Employer shall have the right to get the defects rectified at the risk and cost of the contractor if he fails to attend to the defects immediately as desired.

Contractor shall also inform the Employer/ Engineer-in-charge, well in advance in case services of any OEM (Equipment manufacturer) are required and same shall be arranged by Contractor at the time of commissioning on his own cost.

Contractor shall furnish site acceptance test (SAT) procedures from the equipment supplier and get it approved from the Employer/ Engineer-in-charge before carrying out the same at site.

Contractor shall prepare detailed testing, pre-commissioning and commissioning procedures for the entire installation. These shall include Performa for defining activities and recording of test results.

It is the responsibility of the contractor to coordinate and provide all necessary assistance to other contractors / agencies/ vendors involved in the complex for proper and timely execution of the works. Further contractor shall do all the liaisoning, documentation or other related formalities with respective authorities/agencies for successfully charging/commissioning of system.

The following equipment/ items as included in Contractor's scope of supply shall be tested and inspected by the Employer or his authorized representative before dispatch at the manufacturer's works. Test certificates duly signed by the Employer or his authorized representative shall be submitted by the contractor as part of the final document:

- a) EHV cable & optical fiber cables.
- b) Jointing & termination kits for above items

14.27 Engineering Data and Drawings

The Tenderer shall necessarily submit all the drawings/ documents unless anything is waived. The Tenderer 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 Tenderer including those submitted at the time of TENDER 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 Tenderer 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.

14.28 Instruction Manual

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.

If after the commissioning and initial operation, the instruction manuals require any modifications/ additions/ changes, the same shall be incorporated by the Tenderer in the final submission.

The Tenderer shall furnish to the Employer catalogues of spare parts.

14.29 Quality Assurance Programme

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

Quality Assurance Documents

The Tenderer 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.

14.30 Equipments & Structures for Cable Termination

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.

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.

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.

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.

It is recognized that the Tenderer 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

Tenderer 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 tender, if not clearly brought out in the specific requisite schedule will not be considered as valid deviation.

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.

14.31 Steel Structures (Gantry, Equipments Etc.):

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 Tenderer 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.

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.

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.

14.31.1 Materials: The materials shall conform to the following requirements:

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 Engineers to be obtained by the contractor.

Successful Tenderer 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.

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.

All electrodes to be used under the contract shall comply with any of the following Indian Standard Specifications as may be applicable.

IS:814: Covered electrodes for metal arc welding of Structural Steel.

IS:815: Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

IS:144: Covered electrodes for the metal arc welding of high tensile structural steel.

All bolts and nuts shall be of grade 5.6HRH 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 16mm 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 44Kg/Sq.mm. and a minimum elongation of 23 percent on a gauge length of 5.6A, where 'A' is the cross-sectional area of the test specimen-

IS:1367: Technical supply conditions for threaded fasteners.

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 electrogalvanized.

14.31.2 Fasteners & Connections:

BOLTS: All connections shall be bolted with 16mm bolts.

SPLICES: Splicing shall be avoided unless the length of a member exceeds 6.0 m or so. The member of splices shall be limited to a practical minimum. No credit shall be allowed for bearing on a butting area. Lap joints in leg members shall be preferred to butt joints.

STEP BOLTS: Step bolts shall be of 16mm 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 125mm 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 40cm centers. They shall be furnished for one leg of each steel structure column from its base elevation.

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.

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.

14.32 Material/ Workmanship

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.

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 Tenderer 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 Tenderer.

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.

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.

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, leveling, 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.

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.

14.33 Packaging & Protection

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 Tenderer 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 Tenderer shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railway etc. shall be to the account of the Tenderer. Employer takes no responsibility of the availability of the wagons.

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.

14.34 Finishing of Metal Surfaces

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.

14.34.1 Hot Dip Galvanising

The minimum weight of the zinc coating shall be 610gm/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface, which shall be embedded in concrete the zinc coating shall be 610gm/sqm 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 2.5mm 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

- i. Coating thickness
- ii. Uniformity of zinc
- iii. Adhesion test
- iv. 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.

14.34.2 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 be 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 and swarf 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 phosphating, 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 color 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 Tenderer proposes to 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 tenders for Employer's review and approval.

14.35 Handling, Storing and Installation

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Tenderer shall unload, store, erect, install, wire, test and place in to commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workman like 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 energization at rated voltage.

Tenderer 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. Tenderer 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.

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. Tenderer shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings / instructions correctly. Where material/ equipment is unloaded by Employer before the Tenderer arrives at site or even when he is at site. Employer by right can hand over the same to Tenderer and there upon it will be the responsibility of Tenderer to store the material in an orderly and proper manner.

The Tenderer shall be responsible for making suitable indoor storage facilities to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

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 Tenderer shall immediately proceed to correct the discrepancy at his risks.

132KV Suspension and Tension Insulator Hardware Fittings with Insulators: will be as per standard technical specification of Sub-Station Projects of AEGCL.

14.36 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 :

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.

Bolts, nuts & Washers: Manufacturer's certificate, dimension check, material testing

Electrodes: Manufacturer's certificate, thickness and quality of flux coating.

Welds: Inspection, X-ray, ultrasonic test, magnetic particle tests as required

Paints: Manufacturer's certificate, physical inspection reports.

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.

14.37 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 localized 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, 3mm 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 2mm at each end. The erection clearance at ends of beams without cleats shall not be more than 3mm 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 1.5mm larger than the diameter of the bolt passing through them unless otherwise stated.

All members shall be cut to jig and all hole 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 up to 8mm thick and in no case shall a hole be punched where the thickness of the material exceeds 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 any way.

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 3mm. 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 20 mm.

14.38 Cleaning & Galvanizing:

14.38.1 Cleaning:

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

14.38.2 Galvanizing:

All materials shall be hot-dip galvanized after fabrication and cleaning. Re tapping 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 electrogalvanized as per IS:1573.

Finished materials shall be dipped in to 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.

14.38.2.1 Mass of Zinc Coating:

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

Sl. No.	Product	Electro meter reading (micron)	Minimum value of average mass of coating
i)	Casting - gray iron, malleable iron		610 (gm/m ²)
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

14.38.2.2 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.

14.38.3 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 re-galvanizing is required, any member which become damaged after having been dipped twice shall be rejected.

14.38.4 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.

14.38.5 Shop Test:

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

- General Inspection
- Material test.
- Assembly test.
- Galvanizing test.

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

14.39 Foundation Works:

14.39.1 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 Tenderer. 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 what so ever in soil parameters will be entertained.

14.39.2 Design of Foundations:

1 . 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.

2. 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 over turning 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 | : | 200mm |
| ii. Minimum bar dia for foundation | : | 10 mmTOR |
| iii. Minimum bar dia for columns | : | 12mmTOR with binder spacing limited to 190 mmc/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. | | |

3. Other Details

i. 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.

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

ii. 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.

iii. 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:

- Detail dimensions of foundation.
- Details of setting dimensions of foundation.

- 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.
- Details of type size and length of each reinforcing steel including schedule of bar bending to be submitted to the Engineer at site.

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.

14.40 Technical Specification for Underground Fibre Optic Cable

This section describes the functional requirements, major technical parameters and Type testing, Factory Acceptance Testing & Site Acceptance Testing requirements for underground fibre optic cables and HDPE pipes. Marking, packaging, transportation & installation requirements have also been described. The payment will be made for the executed route length only. However, specified service loops and lengths for wastage, installation/working for FO cable & HDPE ducts shall be considered as required by the Tenderer for which no additional payment will be made.

14.40.1 General

The underground fibre optic cable shall be armoured and shall be suitable for direct burial as well as for underground installation in pipes. The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport. The fibre optic cable shall be a UV resistant, rodent proof. The underground fibre optic cable (UGFO) shall be offered from a manufacturer who has been manufacturing UGFO for the last five (5) years and UGFO manufactured & supplied by such manufacturer shall have been in satisfactory operation.

14.40.2 Applicable Standards

The cable shall conform to the standards named below and the technical specifications described in the following sections.

- ITU-T Recommendations G.652
- Electronic Industries Association, EIA/TIA 455-78A, 455-3A/33/41/25A / 81A / 82B, 455-62A, 455-164A/167A/174, 455-168A/169A/170/175A, 455-176, 455-59, EIA/TIA 598, EIA 455- 104.
- International Electro technical Commission standards, IEC60304, IEC60794-1-2, IEC60811-5-
- Bellcore GR-20
- Indian Railways standard specification no IRS:TC55(Oct 96) (including all amendments)
- ASTM: A167-92, ASTM:751-92b, ASTM: A751-92, ASTM: A370-82, ASTM: D2581-91, ASTM: D2287-81, ASTM:D 638 for FRP, ASTM :D 217,556, 93-IP-34 for Jelly, ASTM:D 570,211 for PBTP, ASTM: D1505for Poly Carbonate, ASTM: D1633,150 for HDPE.

14.40.3 Fibre Type(s) and Counts

The Cable shall consist of 24 fibres Dual-Window Single mode (DWSM), G.652 optical fibres and shall meet the requirements stipulated in Table 1

DWSM Optical Fibre Characteristics (Table-1)

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 μm ($\pm 0.6 \mu\text{m}$)
Cladding Diameter:	125.0 μm +/- 1 μm
Mode Field concentricity error	$\leq 0.6\%$
Cladding non-circulatory	$\leq 1\%$
Cable Cut-off Wavelength λ_{cc}	$\leq 1260 \text{ nm}$
1550 nm loss performance	As per G .652
Proof Test Level	$\geq 0.69 \text{ Gpa}$

Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339 nm 5.3 ps/(nm x km) 1271-1360 nm
Zero Dispersion Wavelength:	1300 to 1324 nm
Zero Dispersion Slope:	0.092 ps/(nm ² xkm) maximum
Polarization mode dispersion Coefficient	≤0.2 ps/km ^{1/2}
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C - + 85°C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤0.05 dB @ 1550 nm (30±1 mm radius Mandrel) 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

14.40.4 General Cable Construction

Consist of a central fibre optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn. The central fibre optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc. The fibre optic unit shall be of loose tube construction. The inner polyethylene jacket and outer sheath jackets shall be free from pinholes, joints, splits or any other defects. All fibre optic cable shall have a minimum service life span of 25 years. The cable construction and mechanical parameters for the Armoured OFC shall be as specified in the Table 2 below.

Table 2 Armoured Cable Construction and Mechanical Parameters		
Parameter	Units	Description
No of fibres in the cable		24
Type of fibres in the cable		G.652
No. of loose tubes		Minimum 2
Cable design life		More than 25 years

i. Colour Coding & Fibre Identification

Individual optical fibres within a fibre unit, and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme. The colour coding system shall be discernible throughout the design life of the cable. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing. Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres are included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibre shall be suitably bundled, tagged, and identified at the factory. The colouring scheme shall be submitted along with the cable DRS/drawing for Employer's approval.

ii. Strength Members

The armoured optical fibre cable shall have solid non-metallic strength member(s)/ Solid metallic member(s) or the combination of both. The metallic strength member shall be of high grade steel wire, music spring quality as per ASTM-A228/A228M-93 and shall have suitable chemical coating for proper adhesion with sheath material. The central fibre optic unit should include a central strength member of non-metallic Fibre Reinforced Plastic (FRP) only. Peripheral strength members and aramid yarns are also acceptable. The central FRP strength member may be of slotted type with SZ lay (reverse

oscillation lay) of fibre units or it may be cylindrical type with helical or SZ lay of fibre units. The construction of the central strength member shall be such as to meet the mechanical strength requirements specified in this specification.

iii. Filling Compound

The interstices of the central fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any longitudinal water migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC60794-1-2-F5. The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, anti-hygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The filling compound shall remain stable for ambient temperature up to +70°C and shall not drip, flow or leak with age or at change of temperature. Reference method to measure drip point shall be as per IEC 60811-5-1 and drip point shall not be less than 70°C.

iv. The Sheath / Inner jacket

The Sheath shall be made of High-Density Polyethylene-HDPE (Red /Black) and shall be smooth, concentric, and free from holes, splits, blisters and other surface flaws. The sheath shall be extruded directly over the central fibre optic unit and shall also be non-hygroscopic. The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The sheath shall be made from good quality of weather resistant polyethylene compound HDPE and thickness shall be > 1.5mm including the strength member if used in the sheath.

v. Armouring of cable

Over the inner PE sheath armouring and outer sheath shall be provided to make the cable termite and rodent proof. The thickness of the stainless-steel alloy armour shall be > 0.125mm. The steel armour shall be both side coated with a copolymer of thickness > 0.05mm so as to bond the armouring to the outer jacket and make a unitary construction. Stainless steel shall be armouring corrugated transversely for lateral strength and bending flexibility to be applied longitudinally with an overlap of 10% (minimum) over the inner PE sheath. The corrugation over the entire length of the tape used in the cable shall be uniform, electrically continuous (applicable to all metallic elements used in the cable) and bonded to the outer sheath. The force of adhesion of the armour to the outer sheath shall be minimum 14 Newton and shall be tested as per ASTM:4565 test method. Suitable glue adhesive should be provided in between overlap portion of cable armouring for bonding to avoid ingress of moisture (below the armour). The height of the corrugation shall be 0.6mm (min.) and the pitch shall be 2.5mm(max.). Height and pitch of corrugation shall be measured between crest and trough base line. The corrugated armouring of stainless steel shall offer excellent corrosive resistance and shall be AISI Alloy no. 304 and the chemical composition and mechanical properties of steel shall be as specified in table 1 & 2 of ASTM: A167-92b for AISI 304 respectively.

vi. The Outer Jacket

A non-metallic moisture barrier sheath (Red or Black in colour) shall be applied over the armour, which shall consist of tough weather resistance made of HDPE. The thickness shall be uniform and shall not be less than 2.0mm (Red in colour) for the cable having inner and outer HDPE sheath. The outer jacket shall have smooth finish and shall be termite resistant. The raw material and additive used to make the outer sheath termite proof shall be clearly mentioned by the manufacturer of the cable.

- vii. In case of HDPE material black in colour is used, the material from finished product shall be subjected to the following tests mentioned in Table 3 below;

Table 3	
1.Density	0.94 to 0.965 gm/cc
2.Melt flow index	< 0.8 gm/10 minutes at 1900 C
3.Carbon black content	(2.5±0.5)%
4.Carbon black Dispersion	Uniform dispersion

5.ESCR	No crack till 48H in 10% lgepal solution 50°C
6.Moisture Content	<0.3% for 24H, ASTM D570
7.Tensile strength and Elongation at break	>2 Kg.mm ² and > 500% respectively

Rip Cord: Suitable rip cord(s) shall be provided to open the outer sheath of the cable. The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

14.40.5 Mechanical Parameters & Tests: The offered cable shall meet requirement of mechanical characteristic & tests specified in this specification.

14.40.6 Cable drums, Marking, Packaging and Transport

All optical fibre cable shall be supplied on strong wooden drums provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. The cable drum shall be suitable to carry underground fibre optic cable of required length. However, the exact lengths for drums to be supplied for each link shall be determined by the Contractor during detailed engineering/survey. Drum schedule shall be approved by the Employer before manufacturing the FO cable. Each cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with arrows to indicate the direction of rotation. Both the ends of the cable shall be provided with pulling eye. The pulling eye and its coupling system should withstand the same tensile load as applicable to the cable.

The following marking shall be done on each side of the cable drums.

- i) Drum number
- ii) Consignee's name and address
- iii) Contractor's name and address
- iv) Type of cable
- v) Number of fibres
- vi) Type of fibres
- vii) Year of manufacturing, month & batch no
- viii) Name of manufacturer
- ix) Total cable length
- x) Inner end marking and Outer end marking

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum and following additional information: OTDR length measurement of each fibre and Ratio of fibre and cable length.

14.40.7 Optical fibre cable marking

A suitable marking shall be applied in order to identify this cable from other cables. Marking on the cable shall be indelible, of durable quality, shall last long and shall be applied at regular interval of one-meter length. Marking shall be imprinted and must clearly contrast with the surface and colours used must withstand the environmental influences experienced in the field. The accuracy of the sequential marking must be within + 0.5% of the actual measured length. The sequential length marking must not rub off during normal installation. In case laser printing is used the marking shall not exceed 0.15 mm depth. The optical fibre cable shall have the following markings in every meter.

- i) Type of Cable
- ii) Running meter length
- iii) Number of fibres
- iv) Type of fibre
- v) Laser symbol & caution notice
- vi) Year of manufacture and batch no.
- vii) Manufacturer's name
- viii) Owner's Name

14.40.8 Operating Instructions

Complete technical literature in English with detailed cable construction diagram of various sub-component with dimensions and test data of the cable shall be provided. All aspects of installation shall also be covered in the handbook.

14.40.9 Test and Inspection:

Type Testing

The Tenderer shall offer only the type tested cable and submit along with their TENDER the earlier carried out type test reports for the offered fibre optic cable meeting the requirement. The Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in Table below. The fibre should have been type tested as per relevant international standards for the tests listed in Table below and the Tenderer shall submit the test reports and certificates along with the TENDER. The Contractor shall submit the type test reports of fibres meeting the minimum requirement specified in Tables below.

Type Tests Fibre Optic Cable

TABLE-4

S. No	Test Name	Test Procedure
1	Water Ingres Test	(IEC 60794-1-F5/EIA 455-82B) Test duration:24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning: 72 hours, Test duration: 24 hours
3	Crush test	IEC 60794-1-E3/EIA 455-41)
4	Impact test	(IEC-60794-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A)-2 cycles

Type Tests Fibre Optic Cable

TABLE-5

S. No	Test Name	Acceptance Criteria	Test Procedure
1	Attenuation	As per TS	IEC 60793-1-40 or EIA/TIA 455-78A
2	Attenuation Variation with wavelength		IEC 60793-1-40 or EIA/TIA 455-78A
3	Attenuation at Water Peak		IEC 60793-1-40 or EIA/TIA 455-78A
4	Temp Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 or EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend Performance)	As per TS	IEC 60793-1-47 or EIA/TIA 455-62A
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic dispersion		IEC 60793-1-42 or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 or EIA/TIA 455-176
10	Core-Clad concentricity error		IEC 60793-1-20 or EIA/TIA 455-176
11	Fibre Tensile proof testing		IEC 60793-1-30 or EIA/TIA 455-31B

Factory Acceptance Testing

The tests listed in Table below shall be carried out as Factory Acceptance Test for Underground fibre optic cable meeting the requirements specified in this section.

Factory Acceptance Tests on Underground Fibre Optic Cable

Sl No	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455-78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455-78A or OTDR
3	Visual Material verification dimensional checks as per approved drawings

14.40.10 PLB HDPE PIPE and ACCESSORIES

The following paragraphs describe the functional requirements, major technical parameters and Type and Factory Acceptance Testing requirements for Permanently Lubricant High Density Polyethylene (PLB HDPE) Pipe. PLB HDPE pipe shall be suitable for underground fibre optic cable installation by blowing as well as conventional pulling. The PLB HDPE pipe shall be suitable for laying in trenches by directly burying, laying through G.I./RCC hume pipe and laying through trench less digging. The expected service life of HDPE pipe and accessories shall not be less than 50 years. The unit rates quoted in the price schedule shall be the composite price of PLB HDPE pipe along with all accessories.

A. Construction of PLB HDPE pipe

The PLB HDPE pipe shall have two concentric layers viz. outer layer and inner layer. The outer layer shall be made of HDPE material and the inner layer of solid permanent lubricant. These concentric layers shall be co-extruded and distinctively visible in cross section under normal lighting conditions and generally conform to IS-9938. The colour of the PLB HDPE pipe shall be finalized during detail engineering. In the finished PLB HDPE pipe, the co-extruded inner layer of solid permanent lubricant shall be continuous and integral part with HDPE outer layer and preferably be white in colour. The inner layer of solid permanent lubricant shall not come out during storage, usage and throughout the life of the pipe. The pipe shall be supplied in a continuous length of 1000 (one thousand) meter in coil form, suitable for transportation, installation and handling purposes. The finished pipe shall be of good workmanship such that the pipe is free from blisters, shrink holes, flaking, chips, scratches, roughness, break and other defects. The pipe shall be smooth, clean and in round shape, without eccentricity. The ends shall be cleanly cut and shall be square with axis of the pipe.

General

The HDPE pipe shall conform to the following standard and the technical specifications described in the following sections.

- IS: 4984 / IS: 2530/IS:14151/(part1)/ IS:9938/IS:7328/IS12235(Part-9)/IS:5175
- ASTM D 1693/ ASTM D 638/ ASTM D 648/ ASTM D 790 / ASTM D 1712/ ASTM D 2240/ ASTM D 4565 / ASTM F 2160/ ASTM G 154
- TEC-spec no. GR/CDS-08/02/NOV-04(including all amendments)-HDPE pipe for use as duct for optical fibre cable.

B. Material

The raw material used for the PLB HDPE pipe shall meet the following requirements:

- The anti-oxidant establishers, colour master batch and other additive used shall be physiologically harmless and shall be used only to minimum extent necessary to meet the specification.
- Usage of any additives used separately or together, should not impair the long-term physical and chemical properties of the PLB HDPE pipe. Under Ground Fibre Optics-Technical Specification Page 13 of 32.
- Suitable Ultra Violet stabilizers may be used for manufacture of the PLB HDPE pipe to protect against UV degradation when stored in open for a minimum period of 8 months.
- The ash content of the colour master batch shall not be more than 12% when tested as per method detailed below:

Test Method for ash content: About one gram of the sample under test shall be taken and dried at 105°C for two hours in a platinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600±50°C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.

v. The base HDPE resin used for manufacturing outer layer of pipe shall conform to any grade of IS-7328 or to any equivalent standard meeting the following requirement when tested as per standards referred in this Section below.

- a) Density (outer and inner layer): 940 to 958kg/m³ at 27°C. The density of completed PLB HDPE shall not be differ by more than 0.003gms/cc by this value when tested as per IS:2530 or IS:7328.
- b) Melt Flow Rate (MFR): 0.2 to 1.1 g/10 minutes at 190°C & 5 kg load: when tested as per IS:2530. The MFR of the outer layer of the completed PLB HDPE pipe shall not differ by more than 30% of this value.
- c) Tensile Strength at Yield: 20 N/mm² minimum, when tested as per ASTM D 638, Type-IV specimens
- d) Elongation at break: >600%, when tested as per ASTM D638, Type-IV specimens
- e) Flexural Modulus at 1% strain: 690 N/mm² minimum, when tested as per ASTM D 790.
- f) Hardness, Shore-D: Between 60 and 65 units, when tested as per ASTM D 2240
- g) Heat Deflection Temperature at 45 g/mm²: 65°C minimum, when tested as per ASTM D 648.
- h) Environmental Stress Crack resistance, when tested with 10% Igepal, CO 0630 Solution 50°C: 96 hrs., when tested as per ASTM D 1693, No cracks.
- i) Weathering in artificial (UV) light (Specimens shall be as per ASTM D 638 Type-IV) and cut from compression moulded sheet. After exposure for 720 hrs., Tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength obtained at above.
- j) OIT (in Aluminium Pan): 30 minutes minimum, when tested as per standard
- k) UV Stabiliser Content: Hindered Amine Light Stabiliser minimum 0.15%, when analysed as per FT-IR method.

(VI) In the inner layer of PLB HDPE pipe, the friction reducing, polymeric material to be used as the inner layer lubrication material shall be integral with HDPE layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling.

C. Dimension of pipe

The nominal size of the pipe shall be minimum 40mm for OFC Cable and minimum 160mm for 132KV Cable and Thickness, Pressure of the HDPE pipe will be depending as per the requirement of site Condition.

D. Accessories of PLB HDPE pipe

The following accessories are required for jointing the pipe and shall be supplied along with the pipe. The manufacturers shall provide complete design details, procedure for method of installation and type of the material used for the accessories. No part of the accessories shall contain metal part and minimum pulling force of the coupler shall be 330kgf. The accessories shall pass the ageing test at 70+2°C and there shall be no leakage when tested for 168 hours.

- i) Plastic coupler: The coupler shall be used to join two PLB HDPE pipes. The coupling shall be able to provide a durable airtight and watertight joint between two pipes without deteriorating the strength of the pipes. The strength of coupler shall match the primary strength of the PLB HDPE pipe and threaded coupler is not acceptable. The jointing shall meet the air pressure test of 15 kg/cm² for a minimum period of 2 hours without any leakage.
- ii) End plug: This shall be used for sealing the ends of empty pipe, prior to installation of FO cable and shall be fitted immediately after laying of the PLB HDPE pipe, to prevent entry of any unwanted elements such as dirt, water, moisture, insects/rodents etc.
- iii) Cable sealing plug: This is used to hold the cable and prevent entry of any unwanted elements, as specified above.
- iv) End cap: This cap is made of hard rubber, shall be fitted with both ends of PLB HDPE pipe to prevent the entry of any unwanted elements such as dirt, water, moisture, insects/rodents during transportation and storage.
- v) Set of installation/maintenance accessories comprising of C-Spanners for tightening plastic coupler (4 nos.), Rotary duct cutter (2 nos.), spare cutting wheel (4 nos. Per Rotary Duct cutter), Chamferring tool for giving slight chamfer to the ends of PLB HDPE pipe shall be used during maintenance of the PLB HDPE pipes and these items (1set) shall be supplied along with the pipe.

E. Workmanship

The pipe shall be free of blisters, shrink holes, break and other defects. The PLB HDPE pipe ends shall be cut as square as possible to longitudinal aspects. The internal and external PLB HDPE pipe surfaces shall be smooth. The colour should be uniform throughout.

F. Marking

All the pipe, shall be clearly marked at intervals of 1 meters with the following data which is not less than 5 mm high. The details of marking on pipe shall be approved by Employer before commencement of manufacturing.

Owner's Name with logo

ii) Manufacture's name or trade mark

iii) Year of manufacturing

iv) Type of PLB HDPE pipe and size

v) Running length marking

G. Tests & Inspection:

The general condition of testing & inspection is given in section-03 of technical specification.

a) Type Test

The PLB HDPE pipes & accessories offered to be supplied should have been type tested as per requirement specified in relevant TEC specification or equivalent standard. The Tenderer shall enclose the previous type test report and/or type approval certificate from Telecom Engineering Centre (TEC), Department of Telecommunication, according to relevant TEC for the proposed PLB HDPE duct meeting the specified requirement.

b) Factory Acceptance Testing:

The following tests shall be carried out during Factory Acceptance Testing (FAT) in Table 2- 4.

Installation of Underground Fibre Optic Cable System

The Underground Fibre Optic Cable shall be installed along the power cable to be supplied & installed under this Project. This part of the section describes the installation procedures, installation of PLB HDPE pipes, installation of RCC hume pipes and GI Pipes, marking, backfilling, installation of underground FO cable, construction of manholes, splicing, termination and site acceptance testing requirements of the underground fibre optic cabling system.

H. Installation of PLB HDPE Pipe

One PLB HDPE pipe shall be laid at bottom of the trench after making the surface smooth and providing minimum 80 mm sieved, stone free sand bedding. After laying the pipe additional sieved sand shall be added to increase the height of the sand layer to a total of 200 mm hence positioning the PLB HDPE pipe in the middle of the layer. Other important steps are described as under:

PLB HDPE Pipe shall be laid in a flat bottom trench free from stones, sharp edged debris.

- a) The Pipe shall be placed in trenches as straight as possible. Minimum bending radius of pipe and fibre optic cable shall always to be taken into account.
- b) The ends of pipes shall always be closed with end plugs to avoid ingress of mud, water or dust i.e. all pipe opening shall be sealed to avoid entry of foreign material.
- c) The pipes shall be joined tightly & properly through plastic couplers and the joint shall be smooth and free from steps. The joints shall be made properly so that it passes the duct integrity test specified in this section. All joints shall be assembled with proper tools only.
- d) Coupler shall not be placed along the bend portion of the pipe
- e) Cable sealing plugs shall be provided at all manhole locations and at locations cable is coming out of the pipe and empty pipe ends i.e. all pipe openings shall be sealed to avoid entry of foreign objects.
- f) PLB HDPE pipes shall be installed in a manner that fibre optic cable can be pulled, blown, de-blown without damaging the fibre optic cable due to stresses. The Contractor shall all joints inspected before carrying out the backfilling, by a representative of Owner/Employer. Joints shall be visually inspected and checked for tightness.

I. Reinstatement

The contractor shall be required to carry out reinstatement of the excavated area. Reinstatement shall include all works necessary (such as reconstruction of metalled/asphalt road, footpath etc) to restore the

excavated area to original quality and shape. Temporary reinstatement of footpath stipulated in this section shall be carried out as a part of backfilling. The Contractor shall be responsible for carrying out complete reinstatement work irrespective of area or type of reinstatement without any additional cost implication to Employer.

J. Installation of GI Pipe

The GI pipe of nominal bore of minimum 100 mm shall be laid wherever road crossings, bridge crossings, railway crossings are encountered on the route as well as on wall/floor crossings in a building. PLB HDPE pipe shall be inserted into GI pipe. Whenever it is not possible to install the FO cable underground due to non availability of the right of way or any other unavoidable reasons, the HDPE ducts along with FO cable shall be installed in GI pipe on the wall inside the sewerage pipe and or on the existing rock/concrete/brick wall/surface with suitable fixing arrangement and concreting, if necessary, with specific approval of the Employer in case to case basis. The GI pipe shall conform to at least medium class and conform to IS: 1239 (Part - I). In regard to bridge and culvert crossing, GI pipe may be installed by concreting the GI pipe along the bridge or by using supporting brackets or by laying underneath the existing footpath etc. The PLB HDPE pipes shall be installed through this GI pipe. Wherever underground fibre optic cable is required to be spliced to overhead fibre optic cable using the outdoor Joint Boxes installed on towers, GI pipes shall be used to protect the portion of the cable/duct upto a height of about 6 to 10 meters and shall be extended in the ground up to suitable depth of the trench so that minimum bending radius of the cable is maintained. The GI pipe shall be properly clamped/ fixed on the tower leg. The Contractor shall supply and install all necessary accessories as part of the installation work. The Contractor shall propose the exact methods and procedures for implementation of crossings taking into consideration the following guidelines, for approval by the Employer:

- a) The GI pipe shall be extended at least 5 meters on each side of crossing subject to availability of space and approval of the Employer.
- b) Two GI pipes shall be joined using proper tools, sockets and accessories etc.
- c) Proper arrangements shall be made to seal the ends of GI pipe after installation of PLB HDPE pipes.
- d) Minimum bending radius of optical fibre cable shall always be taken into consideration.
- e) 1:2:4 concrete shall be used for encasing of the GI pipe, wherever required.
- f) The floor of the trench shall be levelled by laying at least 50 mm of soft soil or sieved sand before installing the GI pipe.
- g) The GI pipes shall be supplied in standard lengths of 6m or as approved by Employer.
- h) The GI pipe shall be sealed at both ends.
- i) The GI pipe of suitable length shall be provided at road crossings, bridge crossings, railway crossings encountered on the route as well as on wall/floor crossings in a building and also for protection of fibre optic cable at tower/pole mounted joint boxes.

K. Underground Fibre Optic Cable Installation:

The cable shall be installed inside the 40mm diameter PLB HDPE pipe installed under this package along the route(s). Generally the cable shall be installed by compressed air blowing technique. However, for spans upto 150 meter, the Contractor can use pulling method for installation of OFC in HDPE pipe. If any temporary manhole or hand hole is required for installation of OFC, the same will be done by the Contractor without any additional cost implication. Adopting pulling method for installation of OFC for spans more than 150 meter, shall be subjected to approval of the Employer and shall be substantiated by proper justification. Contractor shall take into consideration the following guidelines, for installation of OFC approval by the Employer.

- a) The Optical Fibre Cable Drums shall be handled with utmost care. The drum shall not be subjected to shocks by dropping etc. They shall not be normally rolled along the ground for long distance and when rolled, shall in the direction indicated by the arrow. The battens shall be removed only at the time of actual laying.
- b) A blowing machine in association with an appropriate compressor shall be used for blowing.
- c) Temporary blowing chambers (if required) shall be constructed and then backfilled after blowing operation is completed.
- d) Locations along the route, which provide easy access points for blowing machine and compressor, shall be determined.

- e) Before starting the cable blowing, PLB HDPE pipe shall be checked for obstacles or damage. Checking shall be done by using a proper sized mandrel.
- f) Always blow downhill wherever possible.
- g) Multiple blowing machines may be used in tandem if so required.
- h) Care must be taken not to violate the minimum bending radius applicable for the fibre optic cable. Tension in the cable during laying shall not exceed tension limit of the OFC. Installation by pulling may be permitted by the Employer only in specific cases where installation by blowing is not feasible on specific approval from the Employer. In case pulling is used, the pulling speed shall be determined considering the site condition. While installing the cable, excess length of about 10 meters shall be stored at each joint location for each side. Excess length of 10 m shall be kept at one ends of a road crossing culvert crossing and 20 meters at one end of bridges. However, exact excess lengths and manhole locations shall be finalised during detailed engineering depending upon the site requirement.

L. Trenchless Digging:

It is envisaged that trenchless digging shall be used in short section for crossing National highways, important road or rail crossings etc. Trenchless digging shall be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of HDPE pipe.

a. Contractor's Scope of Work for Trenchless Digging:

The Contractor's scope of work under this contract shall include, but shall not be limited to, the following:

- a) Identify, provide and transport all equipment to the locations along the route as per the requirement to install PLB HDPE pipe by trenchless digging method.
- b) Excavation and backfilling of entry and exit pits.
- c) Detection and protection of existing underground facilities of other utilities along the route.
- d) Installation of 40 mm PLB HDPE pipe along the specified route by trenchless digging method and joining of PLB HDPE pipe by plastic coupler and sealing of PLB HDPE pipe at both ends by end plugs.
- e) Installation of manholes, termination of PLB HDPE pipes into the manholes and sealing of PLB HDPE pipes at the manhole entry as per approved drawings.
- f) Providing all plants, tools and tackles, consumables, marking and fencing required for the execution of the work as per the best engineering and safety practices.
- g) Maintain all lights, guards, plates, safety measures, sign boards etc. When and where necessary and/or required by the Owner/Employer or by any other statutory authority for the protection of works and/or for the safety and convenience of the public or the workers at the installation sites.
- h) Arrange electricity by arrangement of generators or other means at the site wherever required.
- i) Arrange construction water at the sites.
- j) Intimation to road maintenance agency, traffic police, other concerned utilities as necessary.
- k) Testing and inspection of installed PLB HDPE pipes and manholes.
- l) Rectifications, re-digging and re-installation of PLB HDPE pipes in case of problem during testing and fibre optic cable blowing/pulling.

b. As Built Drawings/details

The Contractor shall submit the as built drawings for the whole route indicating the route, depth of digging and manhole locations for easy maintenance of the installed system.

List of Drawings/documents required to be submitted for Employer's Approval

The Contractor shall ensure that the required drawings and documents are submitted well in time to avoid any delay in approval and project execution. The following minimum drawings and documents are required to be submitted by the Contractor for approval of the Employer:

- a. The methods/procedures and the equipment/machines to be used for different types of trenchless digging techniques
- b. Bill of quantities for various items as per contract
- c. SAT Reports
- d. As built drawings

M. Site Acceptance Testing (SAT)

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment/material for SAT shall be called Pre-SAT activities. During installation the Contractor shall maintain proper record of measurements in approved format and shall be given to the Owner/Employer (along with As Built drawing of the routes) for cross checking during SAT.

SAT for Excavation, Backfilling, Installation of Pipes, Manholes.

The tests shall include but shall not be limited to the following:

Depth Check: One sample every 200 mtrs, Contractor shall prepare a sample pit at a location identified by the Employer. Depth of each item, warning tape, no. Of warning bricks (if applicable), pipes, cable etc. Shall be measured. Depth shall be as per technical specifications and shall correspond to recorded measurements.

Crossings: 10% of each type, visual inspection for checking conformance with drawings, thickness of Concrete, RCC Hume Pipe and GI pipe.

Manholes: As per technical specifications.

After inspection the Contractor shall backfill and carry out other restoration work at no additional cost to the Owner/Employer.

SAT for Underground Fibre Optic Cable

SAT for optical fibre cable shall be carried out link by link. Prior to installation, every fibre optic cable segment shall be tested for continuity and attenuation and measurements shall be recorded. Test requirements are as per table 2-7. Any discontinuity or attenuation beyond permissible limits in any of the fibres has to be recorded and brought to the notice of Employer. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Test requirements are indicated in table 2-9 and in no case losses attributed due to other factors viz. Extra splice, kinks, will be acceptable to the limit determine by the following formula:

- i. Max attenuation @ 1550 nm: $0.21\text{dB/km} + 0.05\text{dB} \times \text{total no of splices} + 0.5\text{dB} \times \text{connector}$
- ii. Max attenuation @ 1310nm: $0.35\text{dB/km} + 0.05\text{dB} \times \text{total no of Splices} + 0.5\text{dB} \times \text{connector}$

Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable failure during installation. The Contractor shall have to either replace the concerned cable span at its own cost or provide additional splicing, joint box and manholes required to rectify the fault at its own cost. The fibre attenuation shall be tested again after replacement or rectification of fault. In case it is found that the splices are bad (loss is unacceptable as per approved test procedures), the Contractor shall have to do re-splicing and provide new Joint Box wherever required at no additional cost to the Owner/Employer. After re-splicing the end to end testing shall be repeated. The splice testing requirements are indicated in table below.

Table 6: Fibre Optic Cable Pre-Installation Testing

Item	Description
1	Physical Inspection of the cable assembly for damage
2	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm

Table 7: Fibre Optic Cable Splice Testing

Item	Description
1	Per splice attenuation with OTDR (bi-directional average) at 1550 nm
2	Physical inspection of Joint Box for proper fibre routing techniques
3	Physical inspection of sealing techniques, weatherproofing, etc

Table 8: Fibre Optic Cable Commissioning Testing

Item	Description
1	Fibre continuity and link attenuation (bi-directional) for each fibre at 1310 & 1550 nm by OTDR
2	Fibre continuity and link attenuation (bi-directional) for each fibre at 1310 & 1550 nm by Power Meter & Laser Source

SAT for PLB HDPE pipe:

For PLB HDPE pipes, duct integrity tests shall be carried out as described below. The Duct cleaning (Sponge test) test shall be carried out on all the ducts before blowing/pulling of the cable between two consecutive manholes on the PLB HDPE pipes.

- i. Duct cleaning (Sponge test)
Compressed air should be blown through the PLB HDPE pipe in order to remove dirt and water, if any, with the help of suitable Air Compressor. A short blast of air about 2-3 Bar shall be blown through the PLB HDPE pipe for about 2 minutes. Sponge shall be blown through the duct to thoroughly clean the duct from inside.
- ii. Crush and deformity test
Place a shuttle of length <15cm and O.D. 80% of the inner diameter of the offered PLB HDPE pipe. Connect the compressor pipe with a suitable flexible wire grip at the other end to catch the shuttle and start blowing operation to the pipe and check if shuttle reaches at the other end. If shuttle gets stuck the Contractor shall adopt suitable arrangement at site to locate the deformity/damage in the HDPE pipe, repair the pipe and ensure end-to-end continuity of the duct in sound condition.

14.40.11 Documentation

Apart from survey reports as mentioned above, the Contractor will submit the following documents after completion of the job and acceptance by the Employer:

- (a) As built drawing of the route indicating the distance from road centre, OFC drum length, location of other utilities, link Q, OFC loop length, name of the road, sections and positions of PLB HDPE pipes, couplers, warning bricks/stone, manholes, G.I. pipes, RCC pipes, joint box, conduits, bends, trays, optical fibre cable loop lengths in manholes etc.
- (b) Depth of PLB HDPE pipe in various sections of the route executed through open trenching.
- (c) Sections of trenching digging executed through various methods.
- (d) Specific deviation w.r.t. the installation and supply items, if any, from the technical specification. If there is no deviation, either explicit or implicit, the Contractor will provide a certification to this effect.
- (e) Without submission of the above documentations, the Site Acceptance Testing of various items as described above will be deemed to be incomplete.

14.40.12 Miscellaneous Jobs

In order to provide end-to-end connectivity, it may be required to execute some miscellaneous jobs as detailed below.

- i. Routing of Cables inside building.
- ii. In order to route the OFC (Optical Fibre Cable) from the underground trench to the control room building it is necessary to install the cable on walls inside PLB HDPE pipe over the existing cable tray/raceways inside the building.
- iii. Installation of PLB HDPE pipe on wall
- iv. The PLB HDPE pipe may be required to be installed on the wall using steel or G.I clamps. The contractor will provide the required clamps and other consumables sufficient for such installation. The contractor will take care of aesthetics while installation. The OFC will be pulled through the PLB HDPE pipe with due care as described in relevant Para of this specification.

14.40.13 Inspection & Testing:**Type Testing**

Tenderer shall offer the type tested product meeting the requirement of technical specifications.

Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Visual inspection shall be carried out on 100% basis for all the equipment/items offered. Factory acceptance testing shall be carried out on Underground fibre optic cable, Joint box, PLB HDPE pipe etc.

14.40.14 System Maintenance

The one-year period commencing immediately after the operational acceptance is called the Defect liability Period/warranty period. Operational Acceptance shall be given on successful completion of SAT. During this period, the Contractor shall replace or repair all defective parts. The one year period commencing immediately after the operational acceptance is called the Warrantee Period/Defect Liability Period. During the Warranty Period/Defect Liability Period, the Contractor shall guarantee that there shall be minimum outage of the supplied system. During this period, the Contractor shall replace or repair all defective parts and shall have prime responsibility for maintaining an operational system.

14.40.15 Documentation

The documentation provided shall include the following:

- (a) Detailed list of the deliverables
- (b) Description of the products
- (c) Technical particulars
- (d) Installation manuals
- (e) Maintenance manuals
- (f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality

14.40.16 TECHNICAL PARTICULARS FOR 33KV

Sl.No.	ITEMS	PARTIULARS
1	Description of Cable	ARMOURING: ARMOURED CORE MATERIAL: COPPER INSULATION: XLPE NOMINAL AREA: 1000 SQ.MM. NO.OF CORE: Single Core SHEATHING MATERIAL: EXTRUDED PVC, INNER & OUTER VOLTAGE GRADE: 33KV
2	Highest system voltage	36 KV
3	Voltage Grade	19/ 33KV
4	Earthing System	Effectively earthed
5	Frequency	50 Hz
6	Size of Cable	1000 sqmm
	No. of Core	1C
7	Rated Power Frequency Withstand Voltage (1 min)	70 KV (rms)
8	Impulse withstand BIL (1.2/ 50/ micro Sec) Line to earth	±170 kVp
9	Rated short time withstand current	31.5 KA (rms) for 3 sec
10	Rated peak withstand current (1 sec)	50 KA
11	No of phase per Ckt	3
12	Maxm.Conductor temp	90 degree C at maxm. continuous current
13	Maxm. Permissible short circuit Temperature	250 degree C for one second

TECHNICAL SPECIFICATION FOR XLPE CABLE WITH TERMINATION

Sl.No.	ITEMS	PARTIULARS
14	End Sealing	H.S. Caps
15	CABLE DETAILS : CONDUCTORS	
i	Conductor material	Plain un-tinned annealed copper
ii	Conductor Shape	Compacted circular.
iii	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.
iv	Resistivity of the semiconducting screen	Maximum 1000 ohm-meter
16	INSULATION	
i	Insulation material	XLPE
ii	Insulation thickness	8.8 mm (Nominal thickness)
iii	specified insulation resistance at 90°C	1x10 ¹² ohm cm
iv	Insulation Screen: Type & Material	Freely strippable (with heat) type extruded non-metallic semi conducting compound followed by copper metallic tape with minimum 25 % overlapping.
16	Resistivity of the semiconducting compound	Max 500 Ohm-meter
17	Longitudinal water barrier Material	Layer of semiconducting tape with suitable water swellable absorbent with 50% overlap.
18	Overall sheath	Extruded black HDPE (TypeST7) with anti termite and anti rodent treatment.
19	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.
	Armouring	Armoured
20	TESTS	
i	Type Test	All tests as per specifications IEC Standards.
ii	Routine Test	All tests as per specifications IEC Standards.
iii	Acceptance Test	All tests as per specifications IEC Standards.
iv	Whether test will be witnessed by purchaser or his representative	Yes. Acceptance test will be witnessed.
21	Bending Radius	The minimum bending radius of XLPE insulated cables is 25D

14.40.17 Technical Particulars For 132 KV XLPE Cable

Sl.No.	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 swellable semiconducting non woven tape over insulation screen, followed by radial sealing (metal sheath of Corrugated Aluminum),and overall extruded black HDPE Sheathed (TypeST7).
2	Highest system voltage	145KV
3	Voltage Grade	76/132KV
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
8	Lightning impulse withstand voltage	±650KV/peak 1050peak
10	No of phase per Ckt	3
11	Earthing system	Effectively earthed
12	Size of Cable	400/ 630/ 800/ 1000sq.mm
13	Max. in Conductor Temp.	90°C at maximum continuous current.
14	Fault level	40KA for 3second (considering parallel path of lead sheath and screen copper for metallic screen)
15	Maximum permissible short ckt temperature.	250°C for one second.
16	CABLE DETAILS : CONDUCTORS	
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 900C	1x10 ¹² 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 semiconducting tape with suitable water swellable absorbent with 50% overlap.
16.9	Radial moisture barrier Material	Seamless or seam welded Corrugated Aluminum sheath with anti-corrosive material.
16.10	Overall sheath	Extruded black HDPE (TypeST7) 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	500 metres with a tolerance range of $\pm 5\%$ 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	TESTS Applicable standards	IEC60840
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	Installation, Termination And Joints	
21	Ambient temperature Ground temperature Thermal resistivity of soil	450C 300C 1500C cm/Km
22	Laying Configuration	Trefoil formation.
23	Depth	1.5 m below ground level.
24	Termination	
25	Type	AS per requirement
26	Joints Required	No

27	Earth Link Boxes Required	Yes. In both end and at joints as per cable bonding system
28	Surge Suppressor Required	Yes
29	Type Bonding '	Single end bonding/ cross bonding

132 KV TSS GOLOKANJ

145 KV, 4400 pF,
40 KA for 1 sec
 $\frac{132kV}{\sqrt{3}} / \frac{110kV}{\sqrt{3}} / \frac{110kV}{\sqrt{3}}$ (1-1-1)
Core I: 0-2
Core II: 3-P

LA
120 KV, 10 KA

CURRENT TRANSFORMER, 40 KA for 1 sec
400-200/1-1-1-1A,
CORE - IV, CLASS PS
CORE - III, CLASS PS
CORE - II, CLASS 5P20, 15VA
CORE - I, CLASS 0.25, 30VA

TANDEM
ISOLATOR
1250 A, 40 KA for 1 sec

ISOLATOR WITH ES
1250 A, 40 KA for 1 sec

CIRCUIT BREAKER
132 KV, 3 PHASE, 3150A, 40 KA for 1 sec

ISOLATOR WITHOUT ES
1250 A, 40 KA for 1 sec

ISOLATOR WITHOUT ES
1250 A, 40 KA for 1 sec

CURRENT TRANSFORMER, 40 KA for 1 sec
400-200/1-1-1-1A,
CORE - IV, CLASS PS
CORE - III, CLASS PS
CORE - II, CLASS 5P20, 15VA
CORE - I, CLASS 0.25, 30VA

CIRCUIT BREAKER
132 KV, 3 PHASE, 3150A, 40 KA for 1 sec

ISOLATOR WITHOUT ES
1250 A, 40 KA for 1 sec

POTENTIAL TRANSFORMER

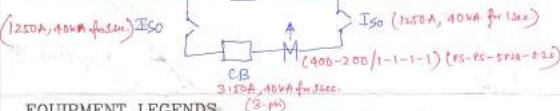
ISOLATOR WITHOUT ES
1250 A, 40 KA for 1 sec
 $\frac{132kV}{\sqrt{3}} / \frac{110kV}{\sqrt{3}} / \frac{110kV}{\sqrt{3}}$ Core I: 0-2
Core II: 3-P
Single Ratio

PROPOSED EXTENDED
132 kV Transfer Bus

PROPOSED EXTENDED
132 kV Main Bus

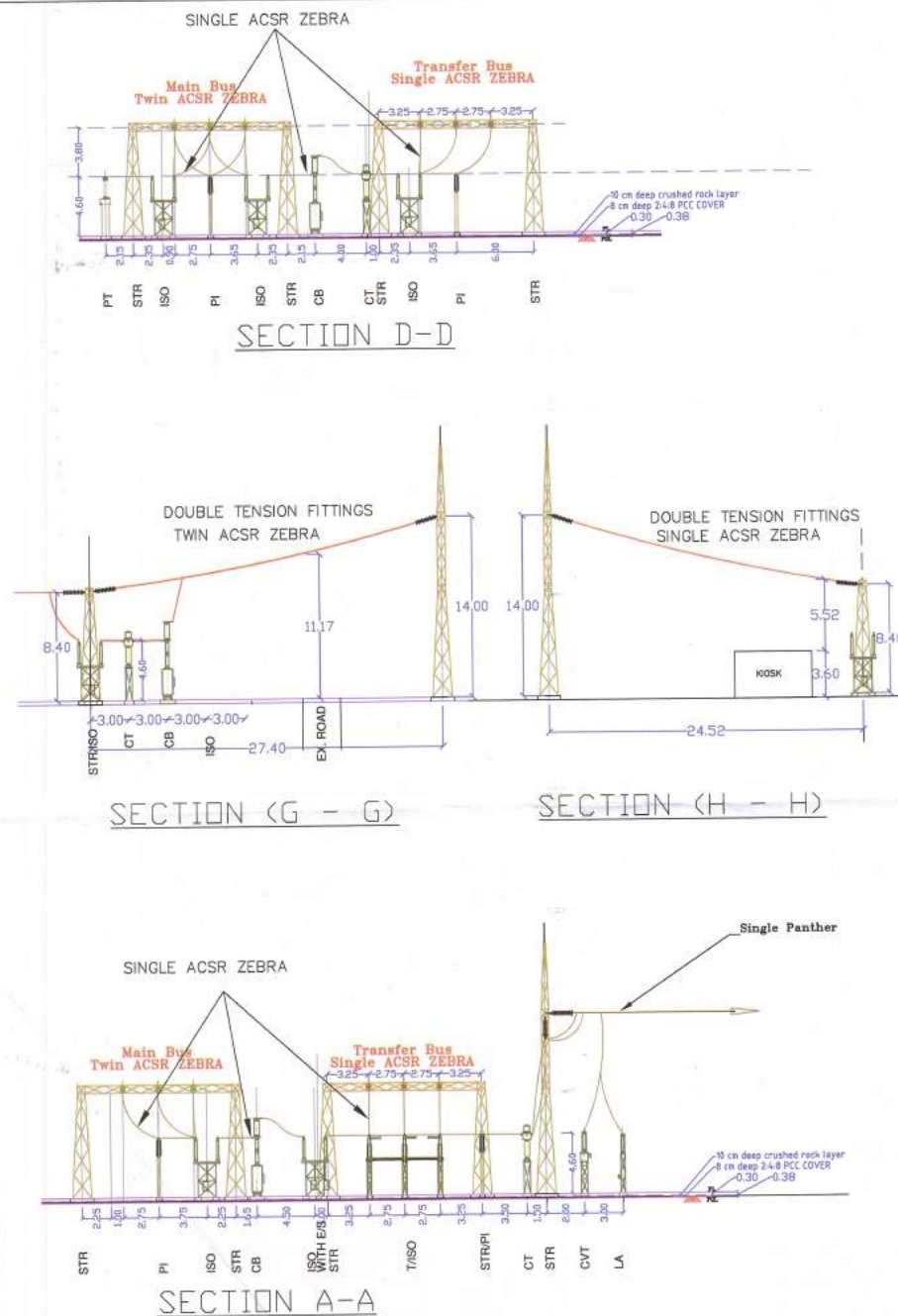
EXISTING
132 kV Main Bus

GAURIPUR GSS BAY EXTENSION



EQUIPMENT LEGENDS

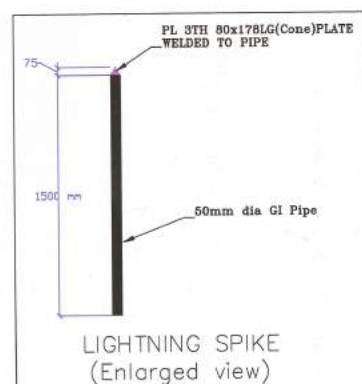
POWER TRANSFORMER	CIRCUIT BREAKER	ISOLATOR WITHOUT ES	ISOLATOR WITH ES	CURRENT TRANSFORMER	POTENTIAL TRANSFORMER	LIGHTNING ARRESTER	WAVE TRAP	CVT



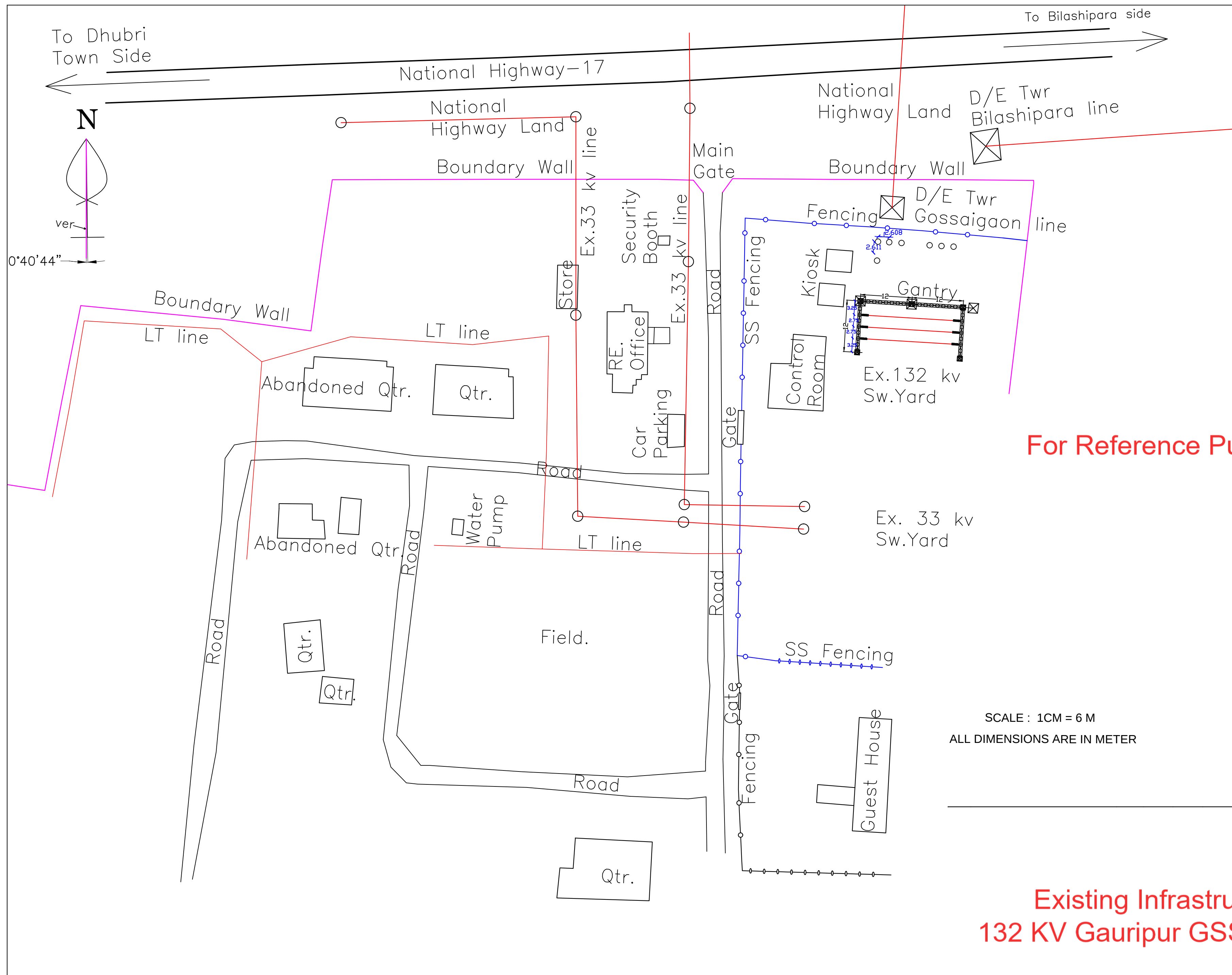
1	SF6 Circuit Breaker (CB)	
2	Power Transformer (TRAFO)	
3	HCB Isolator w/o Earth Switch	
4	HCB Isolator with 1 Earth Switch	
5	HCB Isolator w/o Earth Switch (Tandem Type)	
6	Lightning Arrestor (LA)	
7	Coupling Capacitor with Potential Device (CVT)	
8	Voltage Transformer (VT)	
9	Current Transformer (CT)	
10	Wave Trap (WT)	
11	Post Insulator (PI)	
12	Cable Termination	

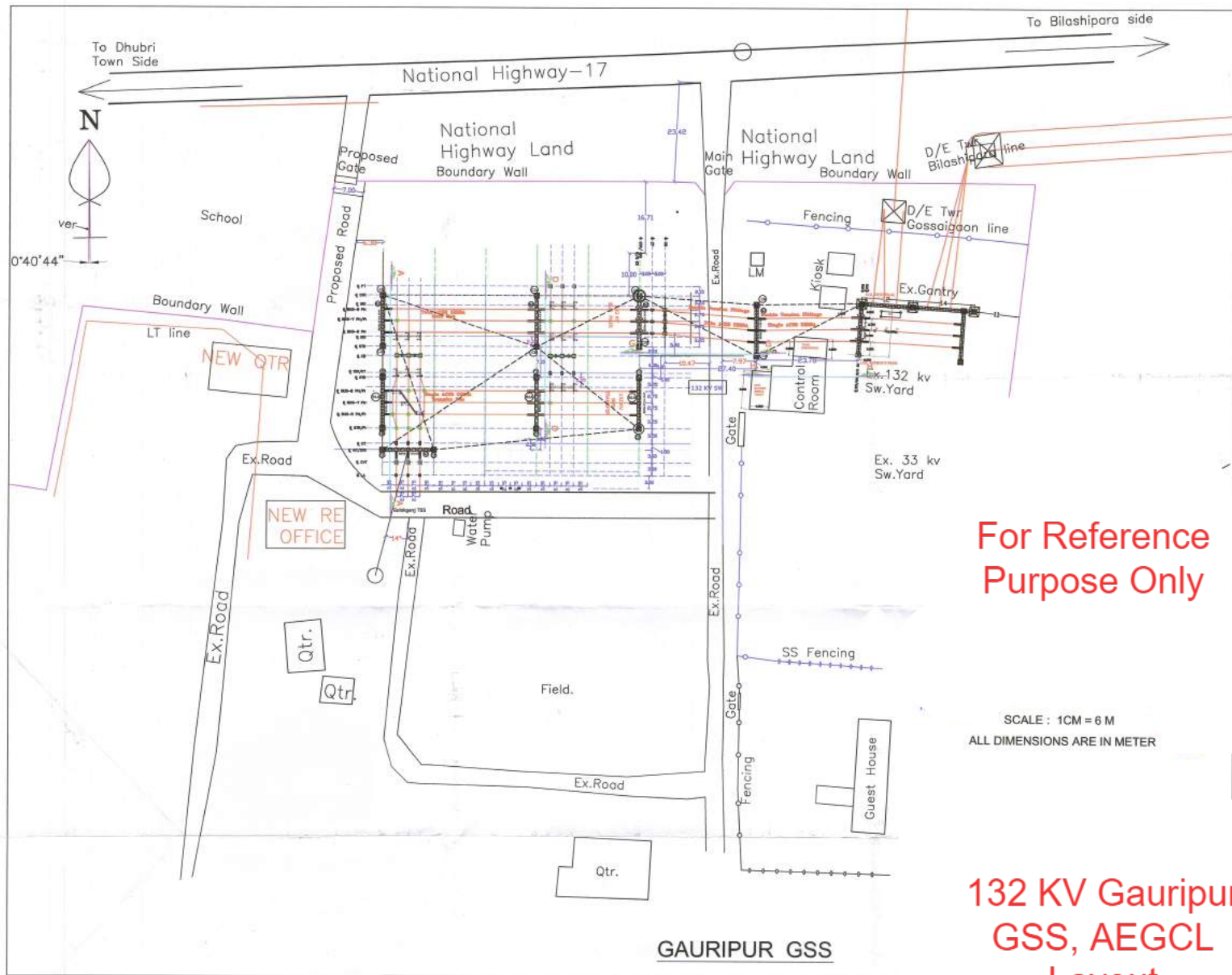
SCALE 1CM= 2.5 M

ALL DIMENSIONS ARE IN METER



132 KV Gauripur, AEGCL Section
Drawing for Reference Purpose Only



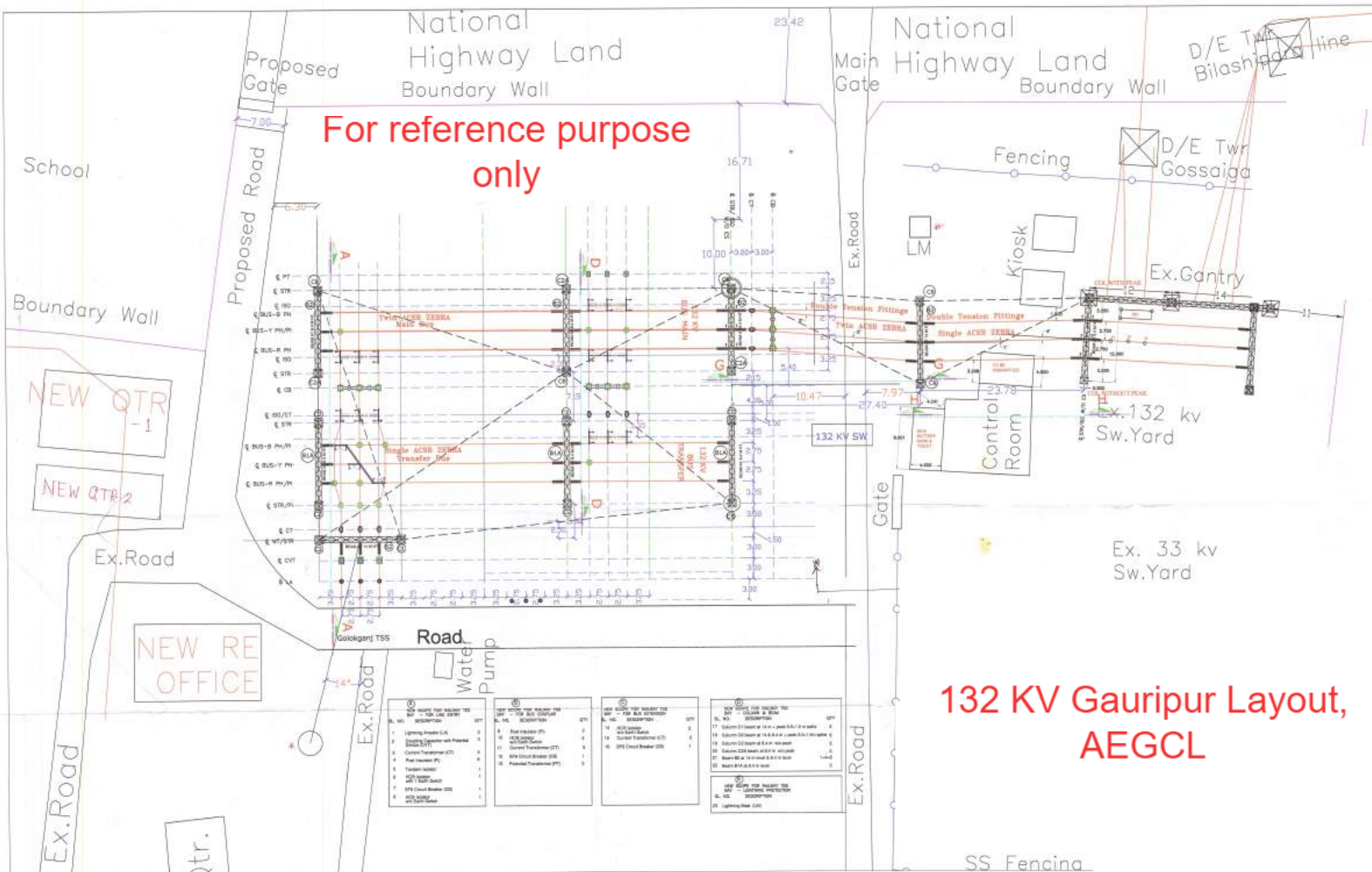


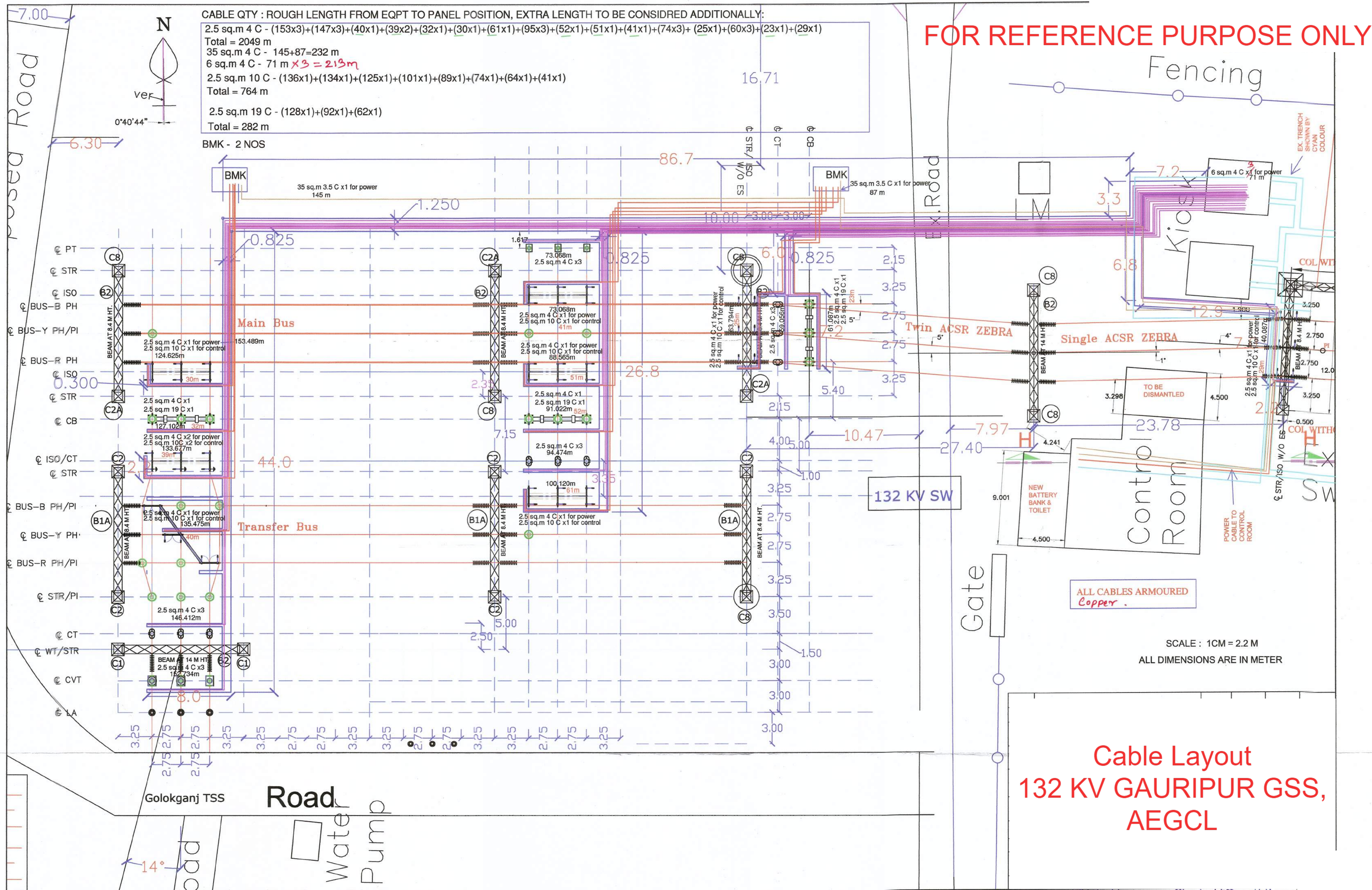
For Reference
Purpose Only

SCALE : 1CM = 6 M
ALL DIMENSIONS ARE IN METER

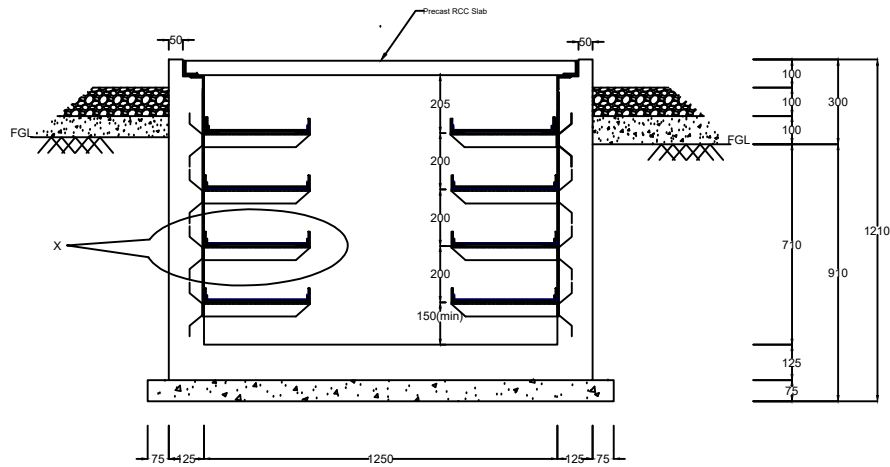
132 KV Gauripur
GSS, AEGCL
Layout

GAURIPUR GSS

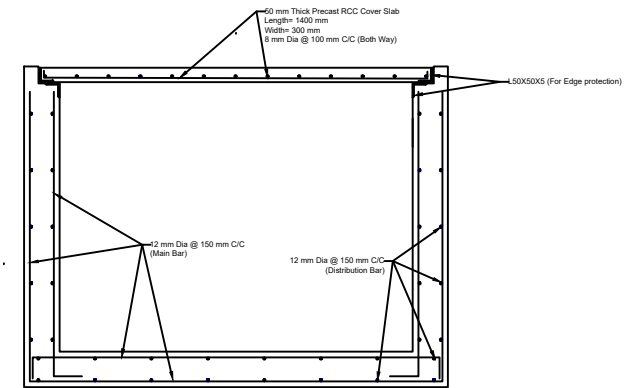




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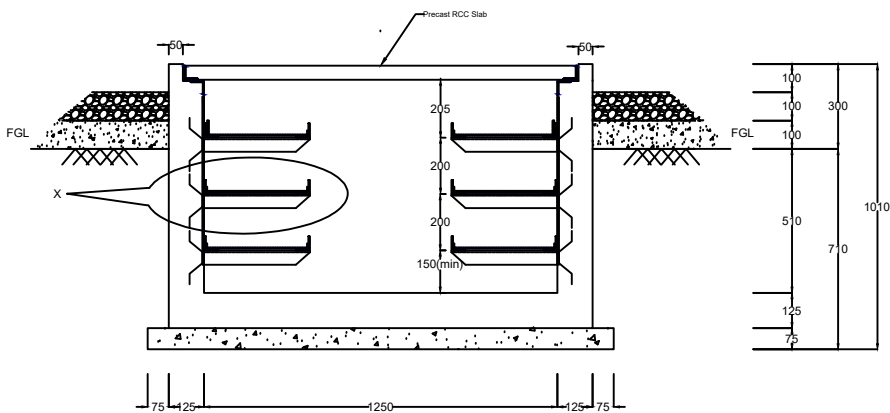


SECTIONAL DETAILS

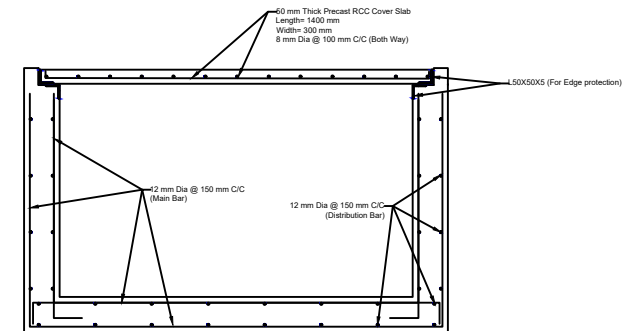


REINFORCEMENT DETAILS

CABLE TRENCH TYPE 'A'



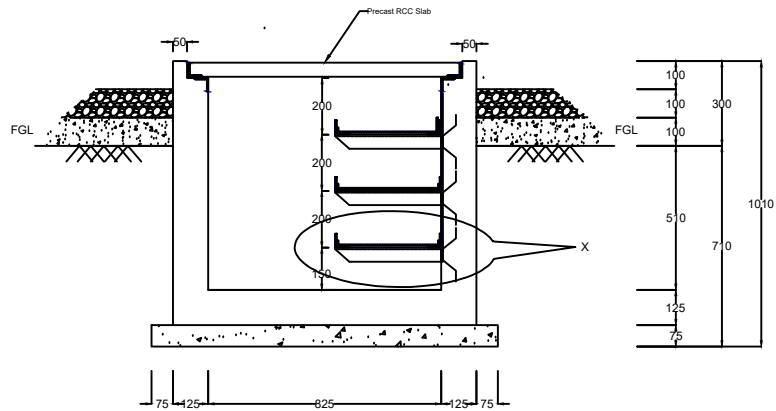
SECTIONAL DETAILS



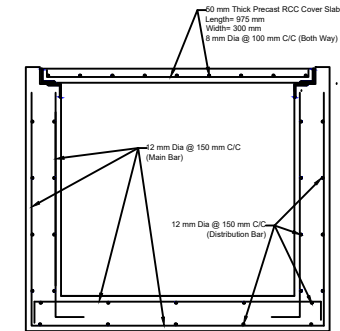
REINFORCEMENT DETAILS

CABLE TRENCH TYPE 'B'

132 KV Gauripur GSS, AEGCL

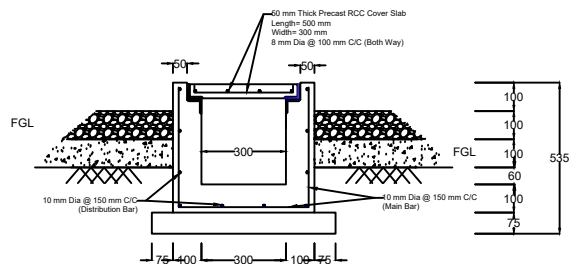


SECTIONAL DETAILS



REINFORCEMENT DETAILS

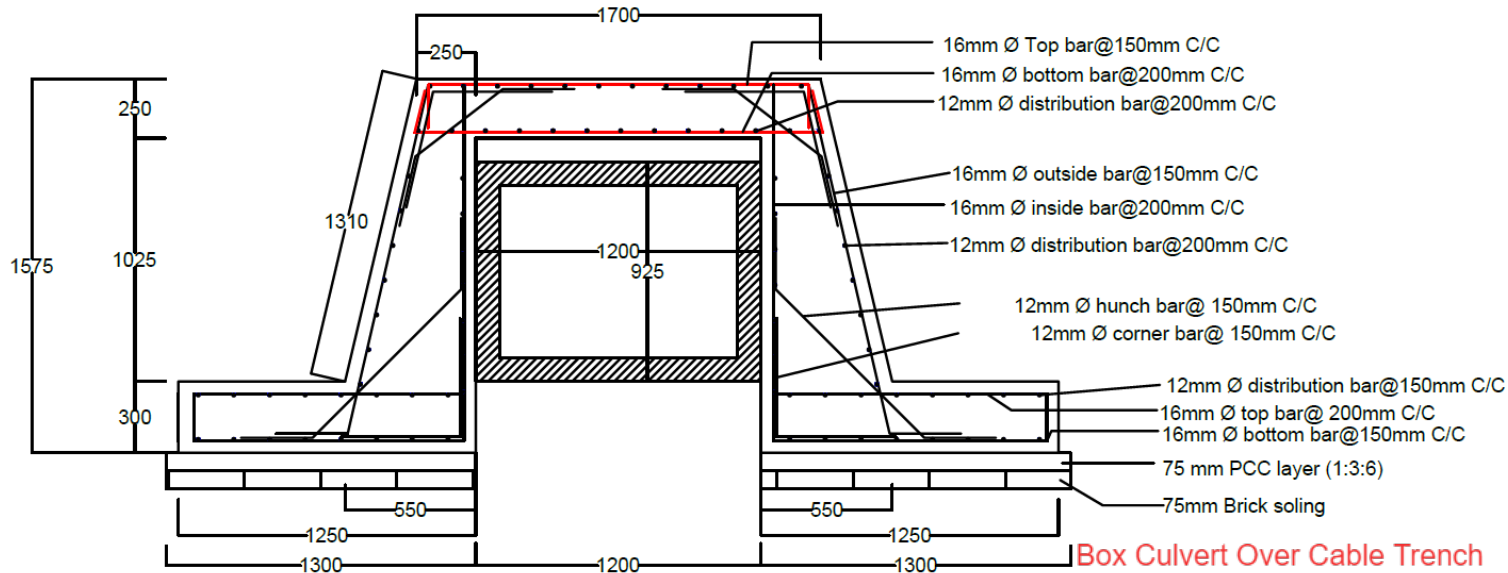
CABLE TRENCH TYPE 'C'



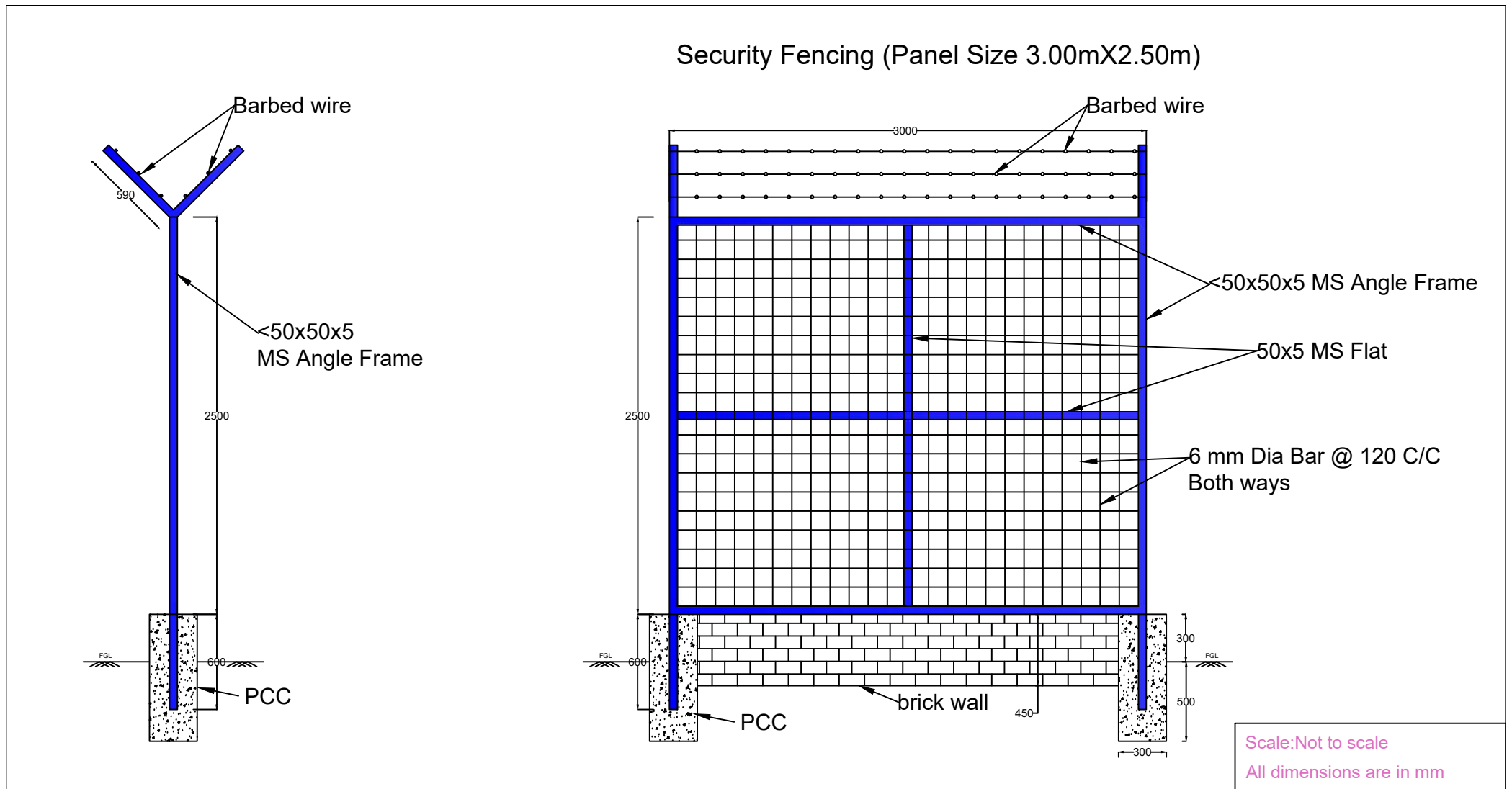
CABLE TRENCH TYPE 'D'

132 KV Gauripur GSS, AEGCL

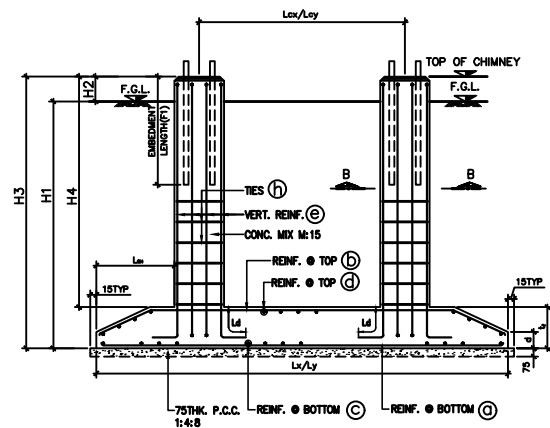
For Reference Purpose Only



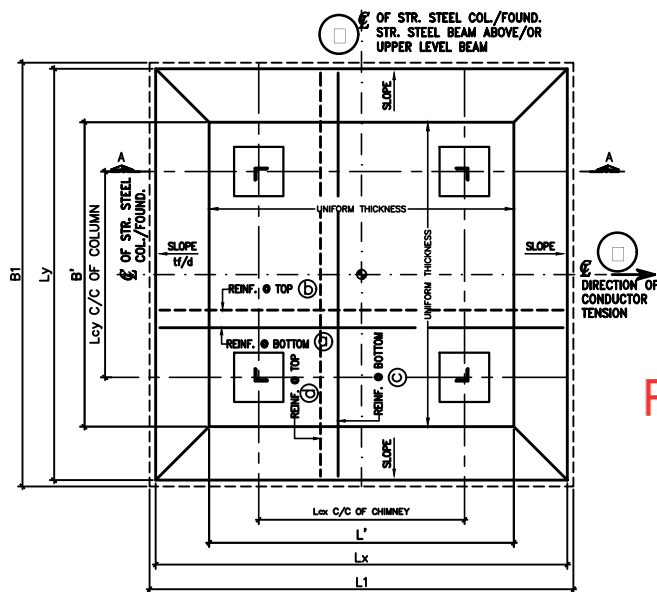
Box Culvert Over Cable Trench
132 KV Gauripur GSS, AEGCL



For reference purpose only at 132 KV Gauripur,
AEGCL

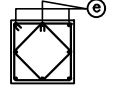
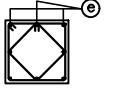
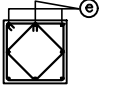


SECTION A-A



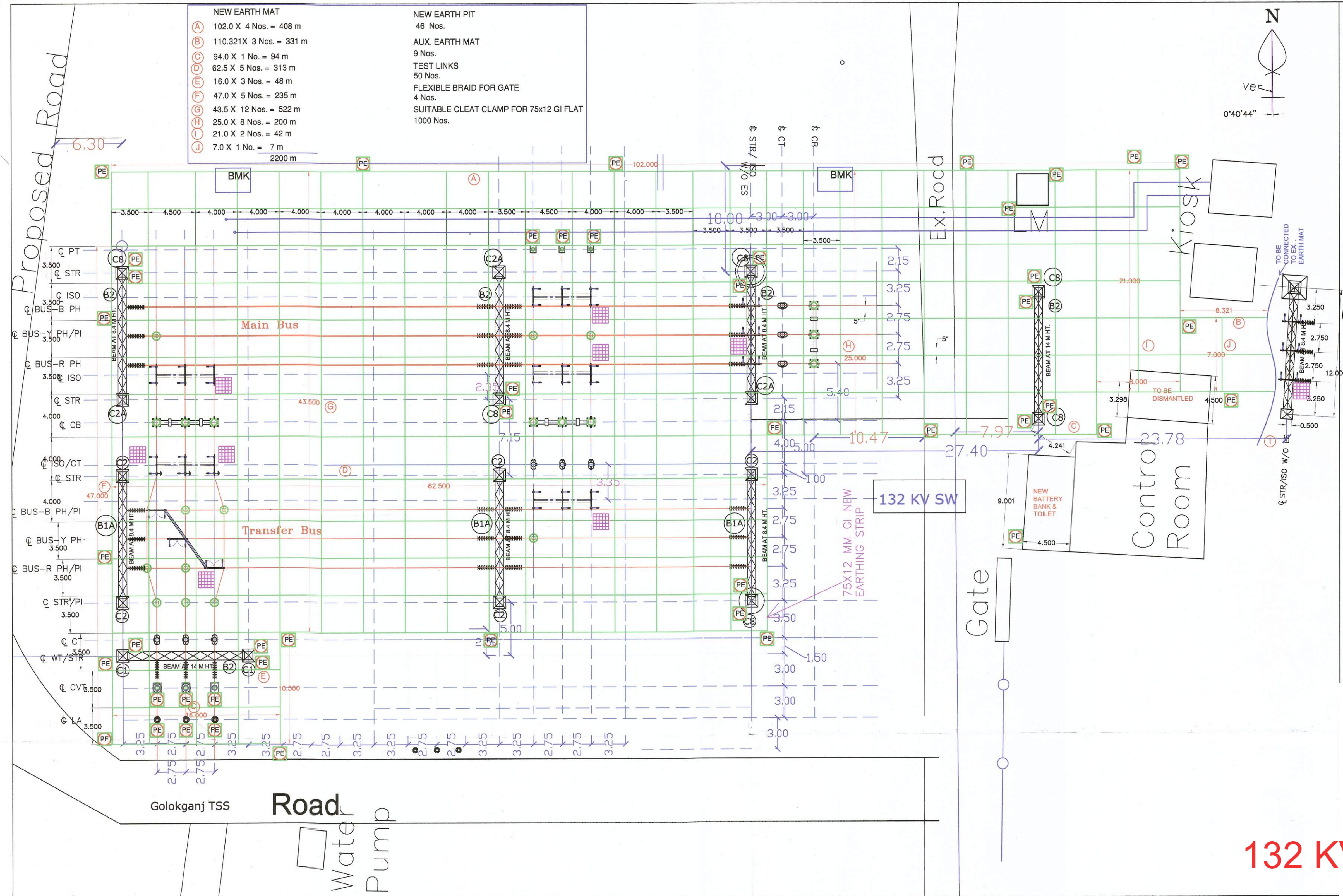
TYP. FOUNDATION PLAN FOR COLUMN
(FOR COLUMN TYPE C1, C2, C2A & C8)

FOUNDATION & COLUMN SCHEDULE FOR TOWER MARKED :-

TOWER MARKED	C1	C2 & C2A	C8
RAFT SLAB SIZE $L_x \times L_y$ IN MM.	5000X5000	4200X4200	5000X5000
PART WITH UNIFORM THICKNESS IN MM.	3000X3000	3000X3000	3000X3000
RAFT SLAB - UNIFORM THICKNESS - $\forall$ IN MM.	450	450	450
RAFT SLAB - END PROJECTION - $\forall/\forall$ IN MM.	450 / 200	450 / 200	450 / 200
H1	3000	3000	3000
H2	300	300	300
H3	3300	3300	3300
SIZE OF CHIMNEY $O_x \times O_y$ IN MM	500 X 500	500 X 500	500 X 500
CHIMNEY C/C DISTANCE, L_{x-Ly}	1440	1456	1440
REINFORCEMENT IN RAFT SLAB IN BOTH DIRECTIONS			
REINFORCEMENT @ BOTTOM - (a)(c)	$\sim 16 \text{ @ } 200\text{mm C/C}$	$\sim 16 \text{ @ } 200\text{mm C/C}$	$\sim 16 \text{ @ } 200\text{mm C/C}$
REINFORCEMENT @ TOP - (b)(d)	$\sim 16 \text{ @ } 200\text{mm C/C}$	$\sim 16 \text{ @ } 200\text{mm C/C}$	$\sim 16 \text{ @ } 200\text{mm C/C}$
CHIMNEY REINFORCEMENT			
VERTICAL REINF. - (e)	8 - ~ 16	8 - ~ 16	8 - ~ 16
TIES - (h)	$\sim 8 \text{ @ } 200 \text{ C/C}$	$\sim 8 \text{ @ } 200 \text{ C/C}$	$\sim 8 \text{ @ } 200 \text{ C/C}$
SECTION: B-B			

For reference purpose only at 132 KV Gauripur
GSS, AEGCL

For Reference Purpose Only

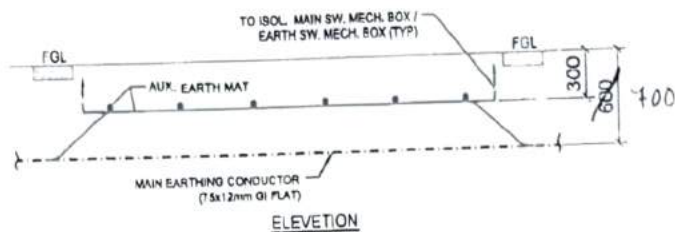
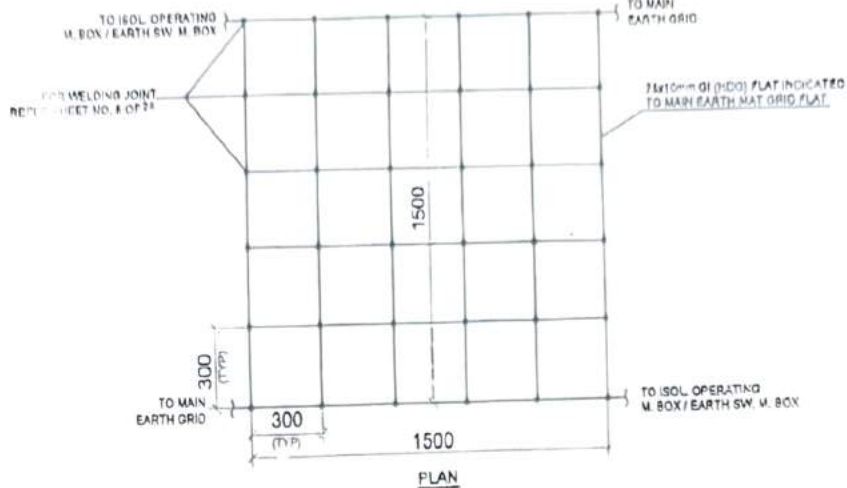


NOTES:

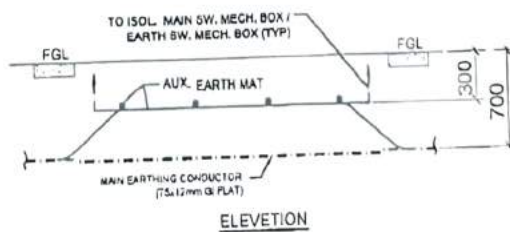
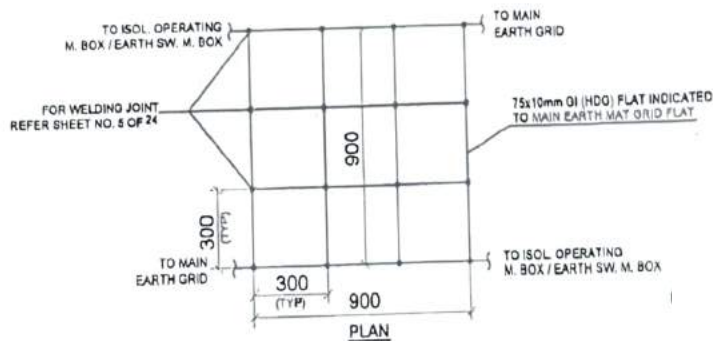
- All dimensions are in meters unless noted otherwise.
- Earth system shall be according to the following IS-3043-code of practice for earthing IEEE std. 80-2000 guide for safety in alternating current sub station grounding.
- All cable supports and cable trays running in trances or elsewhere are to be earthed.
- Spacing between the earth pits/rods shall be maintained at 3000 mm(min).
- The size of main earth mat conductor is 75x12 mm GI Flat and will be laid at 0.6 m. below FGL with each spacing of 4.5m (max) between conductors.
- Auxiliary Earthmat to be provided for ISO with & without E/S. For without ES - one no & for with ES - two nos.
- Dimensions of Auxiliary Earthmat = 1.5m x 1.5m
- Depth of Auxiliary Earthmat = 0.3 m.
- The spacing of each mesh of Auxiliary Earthmat = 0.3 m.
- The voltage equipments such as LA, CVT & Column with peak (C1 & C8) earthed with Pipe Electrodes (PE).
- Each earthing chamber covered with GI Cover.
- Metallic pipes, conduits and cable trays sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall be connected to earthing system.
- Metallic conduits and water pipes shall not be used as earth continuity conductor.
- Lighting poles, junction boxes on the poles, cable boxes/glandes, lockout switches etc. shall be connected to the conductor.
- Two separate and distinct ground connection shall be provided for grounding of electrical equipments in compliance with IE rules.
- Gravel along with PCC cover shall be extended over the earth mat at a distance 1.5 m (min) beyond the perimeter of earth mat.
- Treated earth pit shall be as per IS 3043-1987 with 3 mtr. long 40 mm dia perforated GI pipe.
- Wherever the earthmat conductor crosses the cable trenches, crossing under the trench shall be made & shall have a minimum clear distance of 300 mm below the trench.
- Cable Trench metallic parts shall be connected by 50x6 mm GI flat & the cable tray system shall be further connected to earth mat at every 30mtr.
- All metallic parts of trench shall be earthed through earth mat.
- The lighting spikes & shield wires shall be earthed through an independent earthing pipe electrode (PE).
- All electrodes must be connected to the main grid.
- Whenever main earth conductor fouls with civil foundations the earth conductor shall be re-routed by minimum interference & complete continuity of the earth conductor shall be ensured. If need arises the re-routed conductor may be welded. All such locations shall be approved before execution at site.
- The new earthmat shall be connected to the existing earthmat.
- Any new fence & gate to be made would be earthed.
- A separate 75x12 mm GI flat shall run along the security fence for earthing of mettalic fencing & for the seurity gate, PE type electrode shall be used.
- New battery room to be earthed.
- The earth strip below the existing road shall be laid at (0.6+0.3=0.9 m) below FGL.
- All the angular points of the earth mat shall be properly welded with proper thickness.

SCALE: 1CM = 2.0 M

Earth Mat
132 KV Gauripur GSS, AEGCL



TYPICAL AUX. EARTH MAT DETAIL
FOR 220KV ISOLATOR WITH 1 EARTH SWITCH

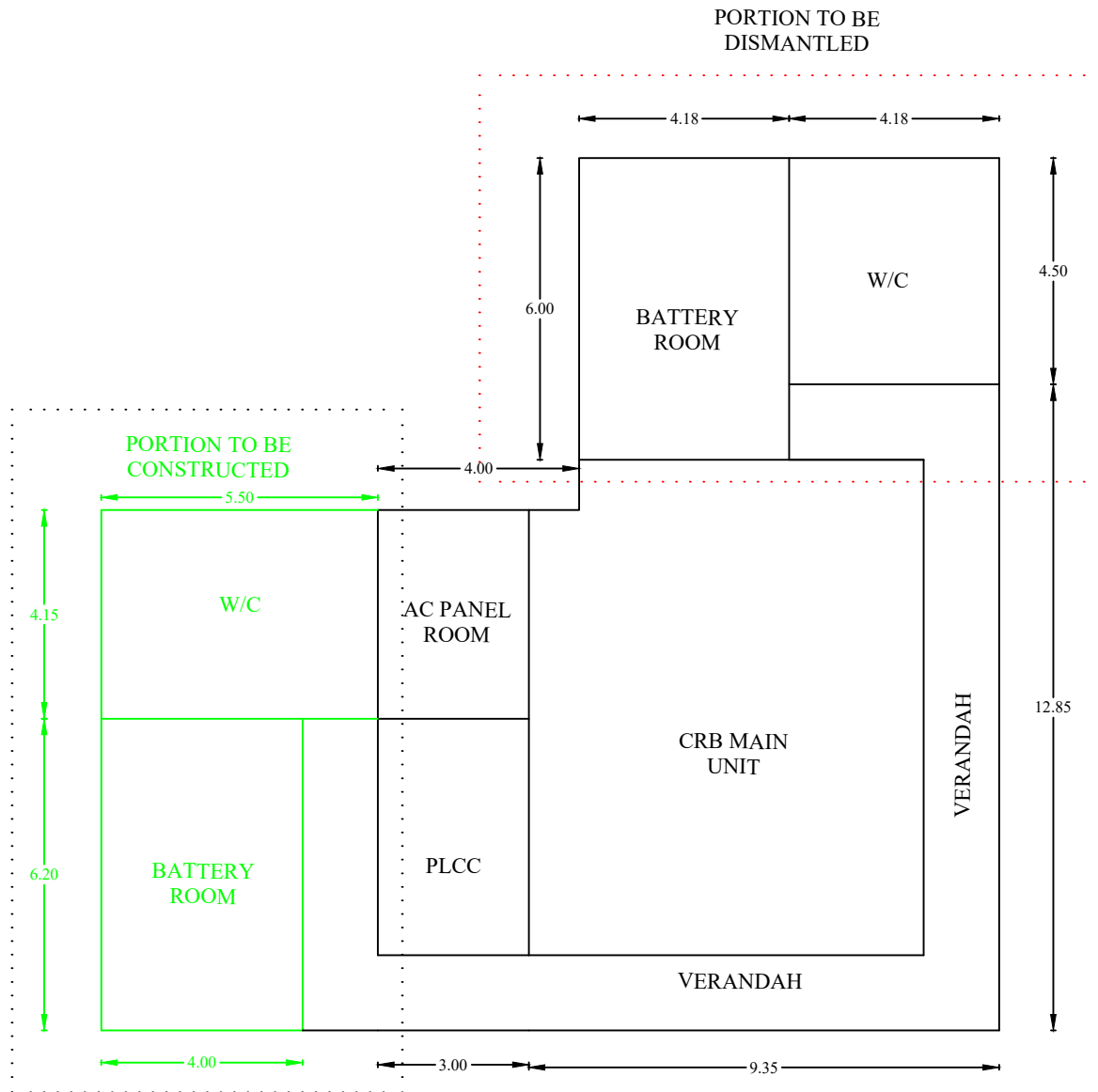


TYPICAL AUX. EARTH MAT DETAIL
FOR 33KV ISOLATOR WITH 1 EARTH SWITCH

Title
TYPICAL EARTHING DRAWING

For reference purpose only at 132 KV Gauripur GSS, AEGCL

For Reference Purpose Only



LAYOUT DIAGRAM OF THE EXISTING CRB WITH PROPOSED EXTENSION
AT 132 KV GSS, AEGCL, GAURIPUR

