NEPAL ELECTRICITY AUTHORITY

(An Undertaking of Government of Nepal)
Project Management Directorate

CHOBHAR PATAN CHAPAGAUN 132 kV UNDERGROUND TRANSMISSION LINE PROJECT

A component of
Electricity Grid Modernization Project

BIDDING DOCUMENT
FOR

Design, Supply, Installation, Testing and Commissioning of New Patan 132/11kV GIS Substation (Package A1.2)

(Procurement of Plant)

Single-Stage, Two-Envelope
Bidding Procedure

Issued on:	**5 July, 2023**
Invitation for Bids No.:	**PMD/EGMPAF/CPCUGTLP-079/80-01**
OCB No.:	**PMD/EGMPAF/CPCUGTLP-079/80-01**
Employer:	**Nepal Electricity Authority**
Country:	**Nepal**

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Chapter 19 – GAS INSULATED SWITCHGEAR

1. GENERAL CHARACTERISTICS

1.1. The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of it's constituent parts. It should be designed for indoor application with meteorological conditions at site as per Section Project.

1.2. All parts of the switchgear and the bus ducts (for both indoor and outdoor applications) shall be single phase/three phase enclosed for 220kV and three phase enclosed for 132 KV.

1.3. The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included.

1.4. The required overall parameters of GIS are as follows:-

S. No	Technical particulars	220 kV System	132KV system	66KV system
1.	Rated Voltage (RMS)	245 kV	145 kV	72 kV
2.	Rated frequency	50 HZ	50 HZ	50 HZ
	Grounding	Effectively earthed	Effectively earthed	Effectively earthed
3.	Rated power frequency withstand Voltage (1 min) line to earth (rms)	460 kV	275 kV	140 kV
4.	Impulse withstand BIL (1.2/50/mic. Sec) Line to earth	±1050 kVp	±650 kVp	±320 kVp
5.	Rated short time withstand current (1 sec) (As applicable)	40 kA (rms)	31.5kA (rms)	31.5kA (rms)
6.	Rated peak withstand current (as applicable)	125/100 kA (peak)	78.75kA (peak)	78.75kA (peak)
7.	Rated current (at 50 degree C design ambient temperature)	As per BPS		As per BPS

2. REFERENCE STANDARDS

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised as on date of bid opening.

IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52 KV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52 kV
IEC 60376	New sulphur hexafluoride
IEC 62271- 100	High voltage alternating current Circuit breakers
IEC 62271-1	Common clauses for high voltage Switchgear and control-gear standards
IEC 62271-102	Alternating current disconnectors(isolators) and earthing switches
IEC 60044-1	Current transformers
IEC 60044-2	Voltage transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 62271-209	Cable connections for gas-insulated switchgear
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4	Non-linear resistor type arresters for AC systems
IEC 60439	Factory-built assemblies of low-voltage switchgear and control Gear.
IEEE 80 (2000)	IEEE Guide for Safety in AC Substation grounding.
CIGRE-44	Earthing of GIS- an application guide. (Electra no.151,Dec'93).
IEC 61639	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Owner/consultant and the manufacturer shall list all such applicable standards, codes etc.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

3. DEFINITIONS

3.1. **Assembly:** Assembly refers to the entire completed GIS equipment furnished under contract.

3.2. **Bay:** Bay refers to the area occupied by one Circuit Breaker and associated equipment.

3.3. **Compartment:** When used in conjunction with GIS equipment, compartment refers to a gas tight volume bounded by enclosure walls and gas tight isolating barriers.

3.4. **Enclosure:** When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal Power system equipment (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer, surge arresters, interconnecting bus etc.)

3.5. **Manual Operation:** Manual operation means operation by hand without using any other source of power.

3.6. **Module:** When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.

3.7. **Reservoir**: When used in conjunction with GIS equipment reservoir refers to a larger gas-tight volume.

GENERAL DESIGN AND SAFETY REQUIREMENT

3.8. The GIS shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric stress and insulation coordination etc. shall be maintained during design, selection of raw material, manufacturing process etc. so that the GIS provides long life with least maintenance.

The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear

3.9. The GIS assembly shall consist of separate modular compartments e,g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

3.10. The switchgear, which shall be of modular design, shall have complete phase isolation. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5% greater than the rated voltage. These shall be designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

3.11. Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced during maintenance, this compartment shall be designed so that it shall remain in service to perform its intended duty. The gas tight barriers shall be clearly marked on the outside of the enclosures.

The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnector (when bus and bus disconnector are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus.. The design of 220/132 kV GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate Mechanical support and number of intermediate gas tight compartments as required, shall be provided to ensure equipment and operating personnel's safety.

Typical drawings indicating gas tight compartments are enclosed at **Annexure-A**.

3.12. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition.

3.13. Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment. Inspection windows shall be provided for Disconnectors and earth switches.

3.14. The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminum/ copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

3.15. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

3.16. The maximum SF6 gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the first year of operation after commissioning

3.17. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

3.18. The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

3.19. The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuit current.

3.20. The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas-insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas-proof compartments preferably for:

1) Bus bars
2) Intermediate compartment
3) Circuit breakers

4) Line Disconnectors
5) Voltage Transformers
6) Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
7) Gas Insulated bus section between GIS & Oil filled Transformer (if applicable)

3.21. The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.

3.22. The layout of the substation equipment, bus bars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and employer/consultant. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.

3.23. All the elements shall be accessible without removing support structures for routine inspections. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.

3.24. It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force. All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.

3.25. In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. The surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

3.26. The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation.

3.27. The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year- 2000.

The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

3.28. The fabricated metal enclosures shall be of Aluminum alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

3.29. The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in

order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

3.30. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions. The average intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.

3.31. The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

3.32. The ladders and walkways shall be provided wherever necessary for access to the equipment.

3.33. Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 230V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase. 4-wire load. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

3.34. The enclosure & support structure shall be designed that person of 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.

3.35. The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

3.36. Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

Gas Insulating System:

i) Loss of Gas Density.
ii) Loss of Heater power(if required)
iii) Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System:

i) Low operating pressure.
ii) Loss of Heater power.
iii) Loss of operating power.
iv) Loss of control supply.
v) Pole Discordance.

3.37. The equipment will be operated under the following ambient conditions(or as defined in the section project):

a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
b) The humidity will be about 95% (indoors)
c) The elevation as per section project.

3.38. Temperature rise of current carrying parts shall be limited to the values stipulated in IEC-62271-1, under rated current and the climatic conditions at site. The temperature rise for all enclosures shall not exceed 20 degree C above the ambient temperature of 50 degree C. These conditions shall be taken into account by the supplier in the design of the equipment

3.39. **Bellows or Compensating Units:-** Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and of differential thermal expansion between the conductors and the enclosures. The bellows metallic(preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction may be provided and shall be of following types:.

1. Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.

2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.

3. Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.

4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.

5. Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil- SF6 bushings.

The electrical connections across the bellows or compensating units shall be made by means of suitable connectors. For sliding type compensators, markers/pointers shall be provided to observe expansion or contraction during climatic conditions.

3.40. **Indication and verification of switch positions**: Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

Inspection windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

3.41. **Pressure relief device** : Pressure relief devices shall be provided in the gas sections to protect the gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms.

3.42. **Pressure vessel requirements**: The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.)

The bursting strength of Aluminum castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute.

3.43. **Grounding:**

3.43.1. The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

3.43.2. The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure, GIS surge arrestor etc. to the ground bus of GIS.

3.43.3. The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected externally with Copper /Aluminum bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

3.43.4. Each marshaling box, local control panel, power and control cable sheaths and other non- current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

3.43.5. The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be under taken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

3.43.6. All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

3.43.7. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures.

3.44. **UHF sensors for PD detection**: Contractor shall provide adequate number of UHF sensors in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of the employer/consultant. Further UHF sensors shall necessarily be provided in close proximity to VT compartments

However adequacy of number of sensors and their location shall be verified at site by the contractor as per recommendations of CIGRE task force TF 15/33.03.05 (**Task force on *Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method***). In case during site testing additional UHF sensors are required, the same shall also be supplied& installed to complete the technical requirement.

3.45. **Gas Insulated Bus (GIB) layout :**

GIB shall be designed based on the following criteria

(1) Maximum weight of gas in a gas tight section of GIB shall not exceed 250 Kg for 220 kV & 132 kV.

(2) GIS bus ducts of each circuit shall be arranged in preferably horizontal formation and the clearance (outer to outer) between nearest bus ducts of two adjacent circuits shall be minimum one (1) meter.

(3) GIB shall be generally in only one horizontal layer. However in exceptional circumstance two horizontal GIB layers can be provided with the approval of Owner/consultant and the vertical clearance between layers shall be minimum one (1) meter in such case.

(4) The minimum outer to outer horizontal clearance between each GIS bus duct shall 0.5 meter for 220 kV & 132 kV voltage level.

(5) The minimum vertical ground clearance of GIB at road crossing shall be 5.5 meters

(6) The horizontal clearance between GIB and GIS building /any other building wall shall be minimum three (3) meters.

(7) The GIB route inside the GIS Hall shall not obstruct easy access to GIS and control room buildings and shall not obstruct movement of crane, equipment including HV test equipment for maintenance works.

(8) The GIB height outside the GIS hall in switchyard area shall not obstruct easy access to GIB, movement of crane for maintenance work.

(9) Optimisation of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.

(10) For the maintenance of GIB of one circuit, only that circuit shall be isolated

3.46. A portable ladder with adjustable height shall be supplied to access the GIS equipment for O&M purpose.

3.47. **Extension of GIS**

3.47.1. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

3.47.2. As the GIS is likely to be extended in future, the contractor shall make available during detailed engineering stage, the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor connection arrangement, bolt spacing & dimension, rated gas pressure etc. Further GIS manufacturer supplying GIS under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an interface module during later stage while extending GIS by any other GIS manufacturer, without any help of GIS manufacturer who has supplied the GIS equipment in present scope.

3.47.3. The Interface module shall be designed to provide Isolating link with access hole on enclosure. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remain isolated.

3.47.4. Further the contractor who is extending the existing GIS installation shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract and the space (along the length of the hall) inside the GIS hall for interface module shall preferably be limited to 1 meter for 220/132kV

3.48. **SF6 GAS**

The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the **recommendations** of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.

The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations :

IS : 4379 Identification of the contents of industrial gas cylinders.

IS : 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet Indian Boilers Regulations. (Mandatory)

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the owner indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for moisture, air content, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

The contractor shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

The contractor shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

3.48.1. **SF6 gas monitoring devices and alarm circuits:** Dial type temperature compensated gas density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of gas density & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows:-

Compartment/ Sl no	Compartments except CB	Circuit Breaker compartments
1	**"Gas Refill level:** This will be used to annunciate the need for the gas refilling. The contractor shall provide a	**'Gas Refill' level :**This will be used to annunciate the need for gas refilling. The contractor shall provide a contact

	contact for remote indication.	for remote indication.
2	**"SF6 low level" :** This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication	**"SF6 low level" :** This will be used to annunciate the need for urgent gas filling . A contact shall be provided for remote indication
3	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.	**Breaker Block' level :** This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker .At this level the breaker block contact shall operate and the closing & tripping circuit shall be blocked
4	**Not Applicable**	**'Zone Trip' level:** This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly.

The density monitor/pressure switch contacts shall be in accordance with the above requirement.

3.48.2. The contractor should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

3.48.3. **Gas Supply:** The contractor shall include the supply of all SF6 gas necessary for filling & putting into operation the complete switchgear installation being supplied. The empty gas cylinders shall be returnable to the contractor.

4. CIRCUIT BREAKERS

4.1. **General :** SF6 gas insulated metal enclosed circuit breakers shall comply with the latest revisions of IEC- 62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified

Circuit breakers shall be equipped with the operating mechanism. Circuit breakers shall be of single pressure type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing with an operating sequence and timing as specified.

4.2. **Duty Requirements:** Circuit breaker shall be C2 - M2 class as per IEC 62271-100.

Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

4.3. The circuit breaker shall be capable of:

1. Interrupting the steady and transient magnetizing current shall be as follows:

Voltage Level	Type of Transformer	Rating in MVA
220kV	220/132 kV	50 to 200
132kV	132/11kV	10 to 50
132kV	132/66kV	10 to 70

2. Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of U/√3 and 1.4

3. Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

4. Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

5. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.

6. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).

4.4. **Total Break Time :**The total break time shall not be exceeded under any of the following duties :

a) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100)

b) Short line fault L90, L75 (with TRV as per IEC-62271-100)

The Contractor may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), pneumatic/hydraulic pressure and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the contractor may specifically bring out the effect of non-simultaneity between poles and show how it is covered in the total break time.

The values guaranteed shall be supported with the type test reports.

4.5. **Constructional features :**The features and constructional details of breakers shall be in accordance with requirements stated hereunder:

4.5.1. **Contacts:** All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

4.5.2. Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

4.5.3. Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

4.5.4. The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout presssure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)

4.5.5. In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

4.5.6. Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducer for each substation covered under the scope.

4.5.7. Circuit Breaker shall be supplied with auxiliary switch having additional 8 NO(normally open) and 8 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC contacts shall be wired upto the local control cubicle.

4.6. **Operating mechanism**

4.6.1. General Requirements :

a) Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP: 42 degree of protection.

b) The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.

c) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided.

f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts

shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

g) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

4.6.2. Control

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

f) Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

4.6.3. Spring operated Mechanism

a) Spring operated mechanism shall be complete with motor in accordance with Section GTR. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS .

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

4.6.4. Hydraulically Operated Mechanism :

a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc.

b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.

c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.

d) The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.

e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.

f) Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall also be provided.

g) All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage.

4.7. The technical parameters of Circuit breakers are as per Annexure -1

4.8. **Additional data to be furnished during detailed engineering :**

a) Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

c) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.

4.9. **Tests :**

4.9.1. **Type Tests**:

i. In accordance with the requirements stipulated under Section GTR the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

ii. The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval

4.9.2. Routine Tests:

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

i. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be provided.

ii. Functional tests are to be carried out on circuit breaker along with Control Switching device (CSD).

iii. DCRM (Dynamic Contact Resistance Measurement) to be carried out for all CBs during routine test.

5. DISCONNECTORS (ISOLATORS)

5.1. Disconnectors shall be three-pole group operated or Single-pole individual operated (as per single line diagram of the substation/section project) and shall be installed in the switchgear to provide electrical isolation. The disconnectors shall conform to IEC- 62271-102 and shall have the ratings as specified in BPS.

5.2. **Construction & Design**.

5.2.1. The disconnectors shall be operated by electric motor suitable for use on DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

5.2.2. Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall confirm to all three test duties viz TD1,TD2 and TD3 as per Annexure –F of IEC: 62271- 102.They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure –B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

5.2.3. The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

5.2.4. It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

5.2.5. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

5.2.6. The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the Local Control Cabinet (LCC) .

5.2.7. Remote control of the disconnectors from the control room/SAS shall be made by means of remote/ local transfer switch.

5.2.8. The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

5.2.9. Each disconnector shall be supplied with auxiliary switch having additional 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for future use over and above those required for switchgear interlocking and automation purposes. These spare NO and NC contacts shall be wired up to the local control cabinet.

5.2.10. The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

5.2.11. The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

5.2.12. The disconnectors and safety grounding switches shall have a mechanical and electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

5.2.13. The local control of the Isolator and high-speed grounding switches from the Local Control Cabinet (LCC) should be achieved from the individual control switches with the remote/local transfer switch set to local.

5.2.14. All electrical sequence interlocks will apply in both remote and local control modes.

5.2.15. Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the local control cubicle (LCC) and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

5.2.16. All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

5.2.17. The disconnecting switches shall be provided with rating plates and shall be easily accessible.

5.2.18. The mechanical endurance class shall be M2 as per IEC for 765kV, 400kV and 220kV and it shall be M1 class for 132kV disconnectors

5.2.19. Mechanical position indication shall be provided locally at each disconnector and Electrical indication at each Local Control Cabinet (LCC) / SAS.

5.3. The technical parameters of disconnectors are as per **Annexure-2**

6. SAFETY GROUNDING SWITCHES

6.1. Safety grounding switches shall be three-pole group operated or single-pole individual operated (as per single line diagram of the substation/section project). It shall be operated by DC electric motor and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

6.2. Each safety grounding switch shall be electrically interlocked with its associated disconnectors and circuit breaker such that it can only be closed if both the circuit breaker and disconnectors are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnectors.

6.3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control room.

6.4. The details of the inscription and colouring for the indicator are given as under :

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

6.5. Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

6.6. Each ground switch shall be fitted with auxiliary switches having 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for use by others over and above those required for local interlocking and position indication purposes.

6.7. Provision shall be made for padlocking / suitable locking arrangement for the ground switches in either the open or closed position.

6.8. All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 100 sq. mm.

6.9. The main grounding connections on each grounding switch shall be rated to carry the full short circuit current for 1 sec. and shall be equipped with a silver- plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

6.10. The safety grounding switches shall conform to the requirements of IEC-62271- 102 and shall have electrical endurance class: E0 & shall have mechanical endurance class M1 for 220/132 kV voltage level.

6.11. Combined Disconnectors & Safety grounding switch arrangement shall also be acceptable.

6.12. Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

6.13. Continuous current rating of the grounding switches (not less than 100A) shall be specified by the manufacturer, which can be safely injected for Bay/ Bus equipment testing.

7. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

7.1. Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, trapped charge in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive and capacitive currents and to withstand the associated TRV. These shall confirm to class B and electrical endurance class E1 as per annexure – C of IEC : 62271-102

7.2. High Speed Grounding switches shall be provided with individual/three pole operating mechanism suitable for operation from DC.

7.3. The switches shall be fitted with a stored energy closing system to provide fault making capacity.

7.4. The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating as stated in clause 1.4 above. The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102.

7.5. Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the Local Control Cabinet (LCC) and provision for taking the signal to Control Room/SAS.

7.6. The details of the inscription and colouring for the indicator shall be as under:-

	INSCRIPTION	COLOUR
Open position	OPEN	GREEN
Closed position	CLOSED	RED

7.7. High speed ground switch operation should be possible locally from Local Control Cabinet (LCC)

7.8. These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if disconnectors are closed. Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

7.9. Each high speed ground switch shall be fitted with auxiliary switches having 4 NO (Normally Open) and 4 NC (Normally Closed) contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the Local Control Cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

7.10. All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 100 sq. mm.

7.11. The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

7.12. The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

7.13. Continuous current rating of the High speed grounding switches (not less than 100A) shall be specified by the manufacturer, which can be safely injected for Bay/ Bus equipment testing.

8. INSTRUMENT TRANSFORMERS

8.1. Current Transformers

The current transformers and accessories shall conform to IEC: 60044-1 and other relevant standards except to the extent explicitly modified in the specification.

8.1.1. **Ratios and Characteristics: The** CT core distribution for various voltage levels shall be as per Table 3. Further the numbers of cores, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with above table.

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

8.1.2. **Rating and Diagram Plates: Rating** and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

8.1.3. **Constructional Details**:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering purposes and shall be of metal-enclosed type.

b) Each current transformer shall be equipped with a secondary terminal box with terminals for the secondary circuits, which are connected to the Local Control Cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

d) For 245/145 kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified in the Section – Project.

e) For 245/145 kV current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 5% to 120%(or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.

f) The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably built in construction of the CTs.

g) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the Secondary terminal box.

h) The current transformers shall be suitable for high speed auto-reclosing.

i) Provisions shall be made for primary injection testing either within CT or outside.

j) All the current transformers shall have effective electromagnetic shields to protect against high frequency transients. Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

8.2. VOLTAGE TRANSFORMERS

The voltage transformers shall conform to IEC- 60044-2 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

8.2.1. **Ratios and Characteristics**: The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with annexure -4 & Table 4

8.2.2. **Rating and diagram plates** :Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

8.2.3. **Secondary Terminals, Earthing**

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

8.2.4. The transformer shall be able to sustain full line to line voltage without saturation of transformer.

8.2.5. Constructional Details of Voltage Transformers :

a) The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall ensure that there is no risk of Ferro resonance due to the capacitance of the GIS.

c) The voltage transformers shall have three secondary windings.

d) Voltage transformers secondary shall be protected by Miniature Circuit breakers (MCBs) with monitoring contacts for all the windings. The secondary terminals of the VT's shall be terminated to preferably stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

e) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

f) The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 50 VA on all the three windings without any adjustments during operation.

g) The diagram for the interconnection of the VTs shall be provided inside secondary terminal box.

8.3. **Tests:**

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.

9. SURGE ARRESTORS

9.1. The surge arrestors shall confirm in general to latest IEC –60099-4.

9.2. **Insulation co-ordination and selection of surge arrestor**: The contractor shall be fully responsible for complete insulation co-ordination of switchyard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters locations, energy capability etc. of surge arrestors such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. The locations of surge arrestors shown in single line diagram is indicative only. If the contractor feels that at some more locations the surge arrestors are required to be provided the same should also be deemed included in the offer.

The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected arrestor's protective and withstand levels, discharge and coordinating currents and arrestor ratings and comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for Owner's approval.

9.3. **Duty requirements of GIS Surge Arrestor**

9.3.1. The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

9.3.2. The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

9.3.3. 245 & 145kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV & 145 kV system respectively on two successive operations.\

9.3.4. The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

9.3.5. The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

Equipment to be	220KV system	132KV system	66KV system

protected	Lightning impulse (kVp)	Lightning impulse (kVp)	Lightning impulse (kVp)
Power Transformer	± 950	± 550	± 325
Instrument Transformer	± 1050	± 650	± 325
Reactor	-	-	-
CB/Isolator Phase to ground	± 1050	± 650	± 325
CB/Isolator Across open contacts	± 1200	± 750	± 350

9.3.6. Constructional Features

The nonlinear blocks shall be of sintered/infered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

9.4. **Tests**

9.4.1. In accordance with the requirements stipulated, the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

9.4.2. Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

9.4.3. Test on Surge Monitors: The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstand tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

9.5. **Technical Parameters** : Technical parameters are as per annexure 5;

10. OUTDOOR BUSHINGS :

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR.

The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC - 60137.

10.1. Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 25 mm/kV and in highly polluted area it shall not be less than 31mm/kV (as per section- Project).

10.2. **Bushing types and fitting**: The details of bushing shall be as follows

SF6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137. All details of the bushing shall be submitted for approval and design review.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462 (Type & Routine test)

10.3. **Mechanical forces on bushing terminals:** Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/Al tube on the other side and short circuit forces. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.

10.4. Type test reports as per applicable IEC including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in section GTR for approval.

10.5. The technical parameters of Bushing are as per Annexure -6.

11. SF6 GIS TO XLPE CABLE TERMINATION

11.1. The underground cables shall be connected to GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure. The line bays and transformer bays shall have suitable GIS cable termination enclosure as per SLD.

11.2. The SF6 GIS to XLPE cable termination shall conform to IEC-62271-209.

11.3. The rating of XLPE cables for different voltages are specified in the Section project.

11.4. Cable termination kit shall be in the scope of the contract. The ducts and the casing shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

11.5. The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The contractor may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

11.6. All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be the scope of the contract. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.

11.7. The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The general arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

11.8. Type test reports of radio interference voltage (RIV) level shall be submitted for approval

12. TRANSFORMER TERMINATION MODULE (If applicable)

12.1.1. The transformer termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fitting.

12.1.2. The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the transformers and reactors shall be supplied by the respective supplier's and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope.

12.1.3. Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer's/consultant approval and for co-ordination with transformer and reactor supplier. Any modification suggested by autotransformer and reactor supplier shall have to be carried out by the supplier to facilitate proper connection with the bushings of the autotransformer and reactors.

12.1.4. In case of single phase transformers are being installed in the substation, HV &LV auxiliary bus for the transformer bank for connecting spare unit shall be formed inside the GIS.

13. LOCAL CONTROL CUBICLE (LCC)

13.1. **Functions**

13.1.1. Each circuit-breaker bay shall be provided with a local control cubicle containing local control switches and a mimic diagram for the operation and semaphore for status indication of the circuit-breaker and all associated isolators and earth switches together with selector switches to prevent local and remote and supervisory controls being in operation simultaneously

13.1.2. Status indications in the LCC shall be semaphore type or LED type.

13.1.3. Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.

13.1.4. If Disconnector or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.

13.1.5. 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc .

13.1.6. Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged.

13.1.7. Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.

13.1.8. LCC shall be suitable for remote operation from substation automation system (SAS) . Each gas tight compartment shall be monitored individually per phase basis through SAS

13.2. **Constructional features**

13.2.1. Local Control cubicle shall be either mounted on the GIS with front access or free standing, floor mounting type. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

13.2.2. Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM gaskets conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors.

13.2.3. Each LCC panel should have its own separate AC supply source feed from the ACDB. The DC supply shall be from respective relay & protection panel power, control, interlocking, signaling. Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses. All fuses shall be HRC cartridge type mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

13.2.4. Each LCC Panel shall be provided with the following

1. **Plug Point**: 230V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
2. **Interior Lighting**: Each panel shall be provided with a fluorescent lighting fixture rated for 230 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.
3. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 230V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit

13.2.5. Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles.

13.2.6. Local control cubicles shall be provided to be free standing and shall be equipped with anti-condensation heaters. A suitable humidity stat and thermostat shall be included in the heater circuit.

13.2.7. The interior of each cubicle shall be finished with a semi gloss white surface. An interior lamp suitable for the local LVAC supply, controlled by a door-operating switch, shall be fitted at the top of each panel.

13.2.8. The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door.

13.2.9. An interlocking scheme shall be provided that takes into account the following basic requirements.

- To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
- prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.

13.2.10. Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

13.2.11. Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.

13.2.12. Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

13.2.13. Bus coupler circuit breaker shall be interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over on that side of the breaker is in progress.

13.2.14. All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.

14. GIS BUILDING

14.1. The buildings shall house each voltage class Gas Insulated Switchgear (GIS) separately and other associated equipment inside in each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per section project

14.2. Wherever GIS hall of proposed voltage is already existing, then the existing GIS hall of respective class shall be suitably extended (wherever applicable) to accommodate the number of bays/diameters as specified in the Section Project.

14.3. The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.

14.4. The area for GIS hall(s) is indicated in the enclosed General Arrangement drawing. The area given is for reference only and may vary according to requirement of the equipment to be installed inside. The contractor shall

finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

14.5. The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, PLCC panels etc. in a separate room in the GIS building.. The size of the room shall be such that all the panels for the future bays/ diameters as per clause 15.1 shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers. The Switchyard panel room as detailed in section Sub-station Automation System is not required for GIS station.

15. ELECTRIC OVERHEAD CRANE :

15.1. One EOT Crane each for GIS hall of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipment.

15.2. The capacity of the crane shall be sized to lift the heaviest GIS switchgear component crane.

15.3. The Crane shall be used for the erection and maintenance of the GIS switchgear component and all plant installed in the GIS switchgear room .On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued.

15.4. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the plant area.

15.5. The crane(s) shall be capable of lifting and accurately positioning all loads ranging from full crane rated capacity to at least 10% rated capacity.

15.6. The crane shall have minimum speeds under full load of:

Speed

(a) Hoisting 2 meters/minute

(b) Cross Travel 10 meters/minute

(c) Long Travel 20 meters/minute

(d) Creep speed shall be of 25% of operating speed

15.7. The electric overhead cranes shall be provided with walkways, platforms. Guard hand rails shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles.

15.8. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul.

15.9. An access platform shall be provided together with a guarded ladder on the crane to allow access to the bridge rails.

15.10. The crane shall be possible to be operated through the cable, through the pendant control and which shall be easily accessible from the floor of GIS building and through remote control device.

15.11. Contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of 5.

a) The crane for 220kV GIS/132kV GIS shall have capacity of minimum 5T safe working load & minimum height of crane have shall be 8.0 meters or as per actual requirement whichever is higher.

15.12. In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders to facilitate movement of EOT crane in the extended portion of GIS hall.

15.13. The following tests may be EOT Crane

1. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test .

2. Further the following tests may be done at site after installation of the crane at site
   a. Check althea accessories for proper function
   b. No load test
   c. Load test as per site conditions

16. VENTILATION SYSTEM FOR GIS HALL

16.1. Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

16.2. To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

1. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.
2. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

The ventilation of the GIS hall shall be of a positive pressure type with minimum 4 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.

17. SEISMIC DESIGN CRITERIA:

17.1. The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act on concurrently. Seismic Qualification requirements shall be as per IEC 62271-207 for the design of equipment. The equipment along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation, but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished. If the equipment has not been type tested earlier, Test Report/Analysis Report should be furnished.

17.2. To prevent the movement of GIS sub-assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-

assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to with-stand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the employer's/consultant approval.

18. DESIGN REVIEW

18.1. Design reviews shall be conducted by Employer/consultant or an appointed consultant during the detailed Engineering of the GIS; however the entire responsibility of design shall be with the supplier.

18.2. Employer/consultant may also visit to the supplier's works to inspect design, manufacturing and test facilities.

18.3. The design review will commence after placement of award with the successful contractor and shall be finalised before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the GIS under the scope of this specification. Employer/consultant reserve the right to waive off the design review during detailed engineering.

18.4. The design review shall be conducted generally following the, "User Guide for the application of Gas Insulator Switchgear (GIS) rated voltage of 72.5kV and above" – CIGRE report No. 125 prepared by CIGRE Working Group 23.10.

18.5. The manufacturer will be required to demonstrate the use of adequate safety margins for thermal, mechanical, dielectric, insulation coordination and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

18.6. The scope of such a design review shall at least include the following:

1.	Dielectric Stress of Solid Insulation like Gas Barrier, support insulator etc.
2.	Dielectric stress of SF6 Gas Volume.
3.	Mechanical strength of enclosure, expansion joints etc.
4.	Criteria for providing expansion joint.
5.	Sealing system
6.	Insulation coordination
7.	Thermal stress and resulting increase in gas pressure during short circuit condition.
8.	Earthing of enclosure w.r.t circulating current.
9.	Seismic design, as per IEC 62271-207
10.	Circuit Breaker .
11.	Isolator and Earth switch.
12.	Voltage transformer.
13.	Current Transformer.
14.	Surge Arrester.
15.	Bushing.
16.	Ducting.
17.	Corrosion protection.
18.	Electrical and physical Interfaces with substation.
19.	Testing capabilities.
20.	Inspection and test plan.
21.	Transport and storage.

22.	Maintainability.
23.	Site Test.

18.7. Further, the manufacturer shall furnish the following information

a) Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.

b) Study report of VFTO generated for GIS installation.

c) The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification elsewhere.

d) The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure above during detailed engineering.

e) The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms

f) Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers

g) Design calculation for simulated parameters for Seismic level as applicable

h) Insulation Coordination studies including studies to recommend for additional surge arrestor

i) Calculation in support of touch & step voltages in all enclosures and earthing of complete GIS installation.

j) Measures to mitigate transient enclosure voltage by high frequency currents.

k) Calculation for providing bus duct supports.

19. TYPE TESTS

The offered GIS equipment shall conform to the type tests as per IEC-62271-203. Contractor shall submit type test reports for the following type tests & additional type tests.

Sl.	Description of the Type Test for GIS
1	Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2	Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit
3	Tests to prove the ability of the main and earthing circuits to carry the rated peak and rated short time withstand current
4	Tests to verify the making and breaking capacity of the included switching devices
5	Tests to prove the satisfactory operation of the included switching devices
6	Tests to prove the strength of the enclosures
7	Gas tightness tests
8	Tests on partitions
9	Tests to prove the satisfactory operation at limit temperatures
10	Tests to assess the effects of arcing due to internal fault
11	Verification of the degree of protection of the enclosure
12	Tests to prove performance under thermal cycling and gas tightness tests on insulators
13	Additional tests on auxiliary and control circuits

14	Reactor current switching test
15	Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure.
16	Electromagnetic compatibility tests (if applicable)
17	Radio inference voltage tests (RIV) , if applicable

The test reports of the above type tests for GIS (including type test report on Circuit breaker, Disconnectors, Grounding switches, Current and Voltage transformers as per relevant IEC and type tests of SF6/Air & Oil bushing as per IEC 60137 shall be submitted for approval as per Section- GTR, Technical Specification.

20. GENERAL

20.1. **Painting of enclosure**: All enclosures shall be painted externally as per manufacturer's painting procedure. The painting procedures as followed shall be submitted during detailed engineering.

20.2. **Heaters:** Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed inside the main circuit**.**

20.3. **Identification & rating plate**

Each bay shall have a nameplate showing

a) A listing of the basic equipment (such as a breaker, Disconnectors grounding switches, current transformers, voltage transformers, and bushings etc).

b) A schematic diagram indicating their relative locations.

c) NEA Contract Number.

d) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like Circuit breaker, Disconnectors Grounding switches, Current transformer, Voltage transformers, Surge arrester etc shall be as per their relevant IEC.

21. TRANSPORT OF EQUIPMENT TO SITE

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers and Voltage transformers shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, contractor shall communicate the interpretation of the data within three weeks.

22. PACKING, STORAGE AND UNPACKING

23.1. All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer's works to the site.

23.2. The SF6 metal clad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

23.3. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

23.4. Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

23.5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metal clad equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch.

23.6. All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided as part of the contract and shall remain the property of NEA. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, 'O' rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification serial numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer's works for repair.

23.7. Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

23.8. For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.

23.9. The contractor will be able to use the available storage areas at site. The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungoral growth. The scope of providing the necessary protection, storing off the ground, as required etc. is included in the works to be performed by the contractor.

23.10. The equipment shall only be unpacked or removed from the containers immediately prior to being installed. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen/air or SF6 gas until required.

24. INSTALLATION OF GIS

24.1. Civil works of GIS Hall shall be completed in all respects for taking up the installation and it shall be ensured that all dust and dirt in the hall are removed. All openings (including Bus Duct) except entry door should be closed and proper sealed

24.2. The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall supervise critical & important erection works. The help of local technicians can be taken only for material handling and non-critical erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate.

24.3. Assembly drawing for GIS erection for the section under progress shall be available and displayed in GIS hall at the time of work.

24.4. Proper power supply shall be ensured by installing DG Set of proper rating and frequency if required prior to commencement of erection work so that assembly work is not interrupted in the middle which is critical for GIS installation.

24.5. Working personnel shall clean their shoes or apply covers on shoes before entering the immediate working area. The working clothes of authorized personnel shall be made of non fluffy material.

24.6. GIS hall door shall have automatic close facility after entry of personnel to avoid dust and moisture entry. Walls and ceiling shall be in a condition so that neither dirt nor plaster might fall or rub off and formation of condensation water in ceiling shall be prevented under any circumstances.

24.7. Floor in the installation area shall have a firm surface and shall be kept dust free with a vacuum cleaner. Vacuum cleaning to be done at regular interval through out the day with separate team of persons assigned for cleaning work only.

24.8. Only T&P and consumables required for GIS erection shall be kept in GIS during erection.

24.9. In case of outdoor installation of GIS or of GIS components open gas compartments shall be protected from dust and moisture ingress (by tarpaulin covers etc)

24.10. Bus duct exit in the GIS hall wall shall be kept covered by suitable means until permanent cover is provided after installation of bus ducts.

24.11. A separate room shall be identified in consultation with NEA/consultant for carrying out repair works/ small part assembly and the room shall be weather protected and lockable. All excess material (not required for immediate installation works) test equipment and tools and tackles to be stored separately from GIS hall in the separate room for rework

24.12. All assembly work shall be done by qualified personnel only who are to be identified before starting of erection work.

24.13. Erection agency shall submit method statement and make available formats for checking during each stage of hall preparation, assembly process and final checks to be approved before start of erection. Method statement shall include record of shock/ impact recorder at the time of unpacking. Shock recorder down loaded data and analysis shall be submitted before commencement of erection work. In case of violation of shock limits, expert form manufacturer shall visit and do the internal inspection before giving clearance for erection.

24.14. Cleaning is of utmost importance and hence before assembly, all the loose metal parts, subassemblies and all contact& sealing surfaces shall be cleaned before installation. Cleaning shall be e carried out with specified cleaning agents of the manufacturer in no condition water is to be used except for external surfaces. Further, Prior to opening, gas compartment shall be thoroughly cleaned and vacuum cleaning of the installation area shall also be done specially the immediate vicinity of the flanges to be connected. Dust disturbance in the area to be avoided

Also, before closing a flange connection clean the immediate vicinity and all accessible parts of the components shall be connected with a vacuum cleaner

24.15. Once the transport covers are removed installation of flanges shall be done without any interruptions, if interruptions cannot be avoided open flanges are to be covered with clean plastic foil. Transport covers, O-rings and other packing material shall be taken out of GIS after immediately after removal.

24.16. O Rings shall be properly stored and taken out only before installation. O Rings are also to be cleaned before use with manufacturer authorized cleaning agent.

24.17. At all points of time during installation authorized personnel shall use disposable gloves to avoid contamination.

24.18. Cable termination work shall commence only after completion of GIS equipment as during GIS installation period laying and termination of cables interferes with the GIS erection work and affects cleanliness.

24.19. Approved Field Quality Plan shall be followed strictly during site work.

25. ON SITE TESTING

After the switchgear has been completely installed on site and filled with SF6 gas, the complete assembly shall be subjected to the site tests as per IEC – 62271-203 and with the test voltages specified below :-

25.1. The adequacy of number of UHF sensors and their location shall be verified as per recommendations of CIGRE task force **TF 15/33.03.05** (Task force on **Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the acoustic method**). In case during site testing

additional UHF sensors are required, the same shall also be supplied and installed to complete the technical requirement.

25.2. Application of AC voltage equal to 1.2 times the service voltage in order to condition the GIS whilst at the same time permitting measurement of Partial discharge and detection of conductive particles by UHF method.

25.3. In case of a disruptive discharge in the gas as outlined in clause no: C.6.2.2 Procedure b) , annexure – C of IEC : 62271-203 , and a repeat test is performed due to failure during the AC voltage test , then the test shall be carried out at 1.2 times the service voltage .

The analysis of PD measured during High voltage test shall done very carefully and presence of PD measured by any sensor shall be attended and HV test shall be repeated after the rectification work. Calibration of PD sensors shall be completed before start of HV test to establish reference for detection of PD above 5 pc

25.4. Method statement/ procedure of on site high voltage testing and PD measurement shall be submitted by contractor in advance.

26. TESTING & MAINTENACE EQUIPMENT

All testing & maintenance equipment shall be offered, if specified as per relevant schedule of BPS.

26.1. SF6 Gas leakage detector.

The detector shall be portable, battery operated with built in battery charger, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication, and a head phone jack. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard. The test kit shall be compatible for EMI/EMC environment as per IEC 1000.

26.2. Gas filling and evacuating plant :

26.2.1. The plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied to enable any maintenance work to be carried out. **This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas.** The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed from at least one phase of one complete bay(switchgear and associated equipment).

26.2.2. Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.

26.2.3. The minimum capacity of evacuation plant will be as under :

Vacuum Pump: 60 M^3/Hour (Nominal suction pressure)
Compressor : 15 M3/Hour(Delivery)

26.2.4. The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.

26.2.5. The gases compartments shall preferably be fitted with permanent non-return valves through which the gas is pumped into or evacuated form the compartments.

Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be furnished

26.3. **SF6 gas analyzer:**

The SF6 gas analyser should be of portable type and instruments shall have following features:

a. In-built calibration facility.
b. Sensitivity of the equipment shall not be affected by any atmospheric conditions like dust, humidity, heat, wind etc.
c. Equipment shall work on zero gas loss principle i.e. gas should be pumped back to the compartment after measurement without any exposure to the atmosphere.
d. Equipment shall be supplied with suitable regulator which can be used to connect SF6 cylinder if required.
e. Following acidic/impurities products should be detected as per IEC 60480 and IEC 60376
  i) SF6 purity – Range: 0-100 % & Accuracy: +/- 0.5 %
  ii) Dew point - Range : -60 to +20 deg C & Accuracy: +/- 0.5 deg C
  iii) SO2 - Range : 0-150 ppm & Accuracy : +/- 2 %
  iv) CF4 – Range : 0-60% vol & Accuracy : +/- 1 %
  v) HF - Range : 0-200ppm & Accuracy : +/- 5 %
f. Instrument should work on AC source as well as on rechargeable battery
g. Input pressure: upto 10 bar
h. It should be housed in a robust IP67 case with wheels

26.3.1. Portable Partial Discharge(PD) monitoring system

26.3.2. The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

26.3.3. It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharges in cable joints and terminations.

26.3.4. Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed by the contractor.

26.3.5. The equipment shall meet the following requirements

1. Measurement shall be possible in noisy environment.
2. Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.


3. Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.

4. The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.

5. Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.

6. Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.

7. The function of software shall be covering the following:

a) Data recording, storage and retrieval in computer
b) Data base analysis
c) Template analysis for easy location of fault inside the GIS
d) Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.
e) Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
f) Expert software system for accurate interpretation of cause of PD.
g) Report generation.

8. To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.

9. Supplier shall have “Adequate after sales service” facility.

10. Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS

11. Instrument shall be robust and conform to relevant standard.

26.3.6. **Calibration:** The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

26.3.7. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

ANNEXURE-1

TECHNICAL PARAMETERS FOR CIRCUIT BREAKER

Sl no	Parameter	220kV system	132 kV system	66 kV system
1.	Rated voltage kV (rms)	245	145	72
2.	Rated frequency (Hz)	50	50	50
3.	No. of poles	3	3	3
4.	Type of circuit breaker	SF6 insulated.	SF6 insulated.	SF6 insulated.

5.	Rated continuous current (A) at an ambient temperature of 50^0C	1600/3000 (as applicable)	1250/2000 (as applicable)	1250/2000 (as applicable)
6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions as specified.	40 kA (As applicable)	31.5 kA (As applicable)	31.5 kA (As applicable)
7.	Symmetrical interrupting capability kA (rms) (As applicable)	40	31.5	31.5
8.	Rated short circuit making current kAp (As applicable)	100	80	80
9.	Short time current carrying capability for one second kA (rms) (As applicable)	50/40	80	80
10.	Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms) (The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC-62271-100	As per IEC	As per IEC	As per IEC
11.	First pole to clear factor	1.3	As pr IEC	As pr IEC
12.	Rated break time as IEC (ms)	60	60	60
13.	Total break time (ms)	65	65	65
14.	Total closing time (ms)	Not more than 200	Not more than 200	Not more than 200
15.	Rated operating duty cycle	O-0.3s-CO-3 min-CO		
16.	Reclosing	Single phase &Three phase auto reclosing.	Single phase &Three phase auto reclosing.	Single phase &Three phase auto reclosing.
17.	**Rated insulation levels**			
	Full wave impulse withstand (1.2 /50 µs) between line terminals and ground:	±1050 kVp	± 650 kVp	± 325 kVp
	Full wave impulse withstand (1.2 /50 µs) Between terminals with circuit breaker open:	±1050 kVp	± 750kVp	± 350kVp
	Rated switching impulse withstand voltage (250/2500 µs) Dry & wet.	NA	NA	NA
	Rated switching impulse withstand voltage (250/2500 µs) Dry &wet Between terminals with circuit breaker open:	NA	NA	NA

	One minute power frequency withstand voltage between line terminals and ground	460 kV rms.	275 kV rms	140 kV rms
	One minute power frequency withstand voltage between terminals with circuit breaker open	530 kV rms.	315 kV rms	150 kV rms
18.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 266 kV (Micro volts)	1000 µV	500µV	… µV
19.	Max. difference in the instants of closing/opening of contacts (ms) between poles	As per IEC	As per IEC	As per IEC
20.	Trip coil and closing coil voltage with variation as specified in Sec. GTR	220 V DC /110 V DC	220 V DC /110 V DC	220 V DC/110 V DC
21.	Rating of Auxiliary contacts	10A at 220 V DC/110 V DC	10A at 220 V DC/110 V DC	10A at 110 V DC/220 V DC
22.	Breaking capacity of Aux. Contacts less than 20 ms.	10A at 220 V DC/110 V DC	10A at 220 V DC/110 V DC	10A at 110 V DC/220 V DC
23.	System neutral earthing	Solidly Gound		Solidly Gound

ANNEXURE-2

TECHNICAL PARAMETERS FOR DISCONNECTORS/ ISOLATORS

Sl. No	**Particulars**	**220 kV**	**132kV**	**66kV**
1.	Rated voltage (rms) Un	245 kV	145 kV	72 kV
2.	Rated frequency	50 HZ	50 Hz	50 Hz
3.	System earthing	Effectively earthed	Effectively earthed	Effectively earthed
4.	Type	SF6 insulated	SF6 insulated	SF6 insulated
5.	Rated continuous current (A) at 50^0C ambient temp.(as applicable)	1600/3000 (as applicable)	1250 (for line /transformer / bus coupler) (as applicable)	1200/600 (for line /transformer /bus coupler) (as applicable)
6.	Rated short time withstand current of isolator and earth switch(as applicable)	40 kA for 1 Sec.	31.5 kA for 1 second	31.5 kA for 1 second
7.	Rated dynamic short circuit withstand current withstand current of isolator and earth switch(As applicable)	1125/00 kAp.(As applicable)	80 kAp	80 kAp
8.	Rated insulation level:			
	One minute power freq. Withstand voltage: To earth :	460 kV rms.	275 kV rms.	140 kV rms.

	One minute power freq. Withstand voltage: Across isolating distance	530 kV rms.	315 kV rms.	150 kV rms.
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity) To earth:	±1050 kVp	±650 kVp	±325 kVp
	1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity) : Across Isolating distance	±1200 kVp	±750 kVp	±350 kVp
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet :between line terminals and ground:	N.A	N.A	N.A
	Rated switching impulse withstand voltage (250/2500 micro-sec.) Dry & wet :Between terminals with Isolator open:	N.A	N.A	N.A
9.	Mechanical Endurance clause as per IEC	M2	M1	M1
10.	No. of spare auxiliary contacts on each isolator	4 NO and 4 NC	4 NO and 4 NC	4 NO and 4 NC
11.	No. of spare auxiliary contacts on each earthing switch	4 NO and 4 NC	4 NO and 4 NC	4 NO and 4 NC

ANNEXURE-3

TECHNICAL PARAMETERS FOR CURRENT TRANSFORMERS

Sl no	Particular	220 kV	132kV	66kV
1.	Rated voltage Un	245 kV (rms)	145 KV (rms)	72 KV (rms)
2.	Rated frequency	50 Hz	50 Hz	50 Hz
3.	System neutral earthing	Effectively Earthed	Effectively Earthed	Effectively Earthed
4.	Rated short time thermal current for 1 second (as applicable)	40 kA	31.5 kA	31.5 kA
5.	Rated dynamic current	100 kAp.	78.75kA	78.75kA
6.	Rated insulation levels			
i.	1.2/50 micro second impulse voltage	±1050 kVp	±650 kVp	±325 kVp
ii.	one minute power frequency withstand voltage	460 kV (rms)	275 kV (rms)	140 kV (rms)
7.	Maximum temperature rise over an ambient temperature of 40^0C	As per IEC 60044-1	As per IEC 60044-1	As per IEC 60044-1
8.	Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz	1000 µV	500µV	5…µV

Sl no	Particular	220 kV	132kV	66kV
9.	One minute power frequency withstand voltage between sec. Terminal & earth	3 kV (rms)	3 kV (rms	3 kV (rms
10.	Partial discharge level	5 pico coulombs	5 pico coulombs	5 pico coulombs

TABLE-3A

REQUIREMENTS FOR 220 kV CURRENT TRANSFORMER (LINE)

No. of cores	Core no.	Applic-ation	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt. Voltage Vk	Max. CT Sec. Wdg. Resist-ance (ohm)	Max. Excitation current at Vk (in mA)
5	1	BUS DIFF CHE-CK	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.
	2	BUS DIFF MAIN	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.
	3	METE-RING	1600-800/1	20	0.2S	-	-	-
	4	TRAN BACK UP/ LINE PRTN.	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.
	5	TRAN. DIFF/ LINE PRTN.	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.

REQUIREMENTS FOR 220 kV CURRENT TRANSFORMER (TRANSF)

No. of cores	Core no.	Applic-ation	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt. Voltage Vk	Max. CT Sec. Wdg. Resist-ance (ohm)	Max. Excitation current at Vk (in mA)
/. 5	1	BUS DIFF CHE-CK	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.
	2	BUS DIFF MAIN	1600-800/1	-	-	1600/ 800	8/4	25 on 1600/1tap. 50 on 800/1tap.
	3	METE-RING	300-150/1	20	0.2S	-	-	-
	4	TRAN BACK UP/ LINE PRTN.	300-150/1	-	-	As Required		

	5	TRAN. DIFF/ LINE PRTN.	300-150/1	-	-	As Required

All relaying CTs shall be of accuracy class PS as per IS: 2705.

Note: The rating and ratio of the current transformer will be finalized during DDE.

TABLE-3B

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER (LINE)

No. of cores	Core no.	Applic-ation	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt. Voltage Vk	Max. CT Sec.Wdg Resistance (ohm)	Max. Excitation current at Vk (in mA)
5	1	BUS DIFF CHE-CK	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
	2	BUS DIFF MAIN	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
	3	METE RING	800-600/1	20	0.2S	-	-	-
	4	TRAN BACK UP/ LINE PRTN.	800-600/1	-	-	800-600	8/4	25 on 800/1 50 on 400/1
	5	DIFF/ LINE PRTN.	800-600/1	-	-	800-600	8/4	25 on 800/1 50 on 400/1

REQUIREMENTS FOR 132 kV CURRENT TRANSFORMER (TRANSF)

No. of cores	Core no.	Applic-ation	Current ratio	Output Burden (VA)	Accuracy Class as Per IEC: 44-1	Min. Knee pt. Voltage Vk	Max. CT Sec.Wdg. Resistance (ohm)	Max. Excitation current at Vk (in mA)
5	I. 1	BUS DIFF CHE-CK	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
	2	BUS DIFF MAIN	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
	3	METE RING	400-200/1	20	0.2S	-	-	-

	4	TRAN BACK UP/ LINE PRTN.	400-200/1	-	-	400-200	8/ 4	25 on 600/1 50 on 300/1
	5	DIFF/ LINE PRTN.	400-200/1	-	-	400-200	8/ 4	25 on 800/1 50 on 400/1

All relaying CTs shall be of accuracy class PS as per IS: 2705.

Note: The rating and ratio of the current transformer will be finalized during DDE.

Table- 3C

REQUIREMENTS FOR 245 kV CURRENT TRANSFORMER

(For Bus Coupler bay)

Core no.	Application	Current Ratio	Output Burden (VA)	Accuracy class as per IEC: 60044-1	Min knee point voltage V_K	Max. CT sec. Wdg resistance (ohms)	Max. Excitation current at V_K (in mA)
1	protection	3000-1600-800/1	-	PS	3000-1600-800	15/ 8/ 4	13.3 on 3000/1 25 on 1600/1 50on 800/1
2	protection	3000-1600-800/1	-	PS	3000-1600-800	15/ 8/ 4	13.3 on 3000/1 25 on 1600/1 50on 800/1
3	Metering	3000-1600-800/1	20	0.2S	-	-	-
4	protection	3000-1600-800/1	-	PS	3000-1600-800	15/ 8/ 4	13.3 on 3000/1 25 on 1600/1 50on 800/1
5	protection	3000-1600-800/1	-	PS	3000-1600-800	15/ 8/ 4	13.3 on 3000/1 25 on 1600/1 50on 800/1

TABLE – 3D

REQUIREMENTS FOR 145 kV CURRENT TRANSFORMER

(For Bus coupler bay)

Core no.	Application	Current Ratio	Output Burden (VA)	Accuracy class as per IEC: 60044-1	Min knee point voltage V_K	Max. CT sec. Wdg resistance (ohms)	Max. Excitation current at V_K (in mA)
1	protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
2	protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
3	Metering	2000-1000/1	20	0.2S	-	-	-
4	protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1
5	protection	2000-1000/1	-	PS	2000-1000/1	10/5	30 on 2000/1 60 on 1000/1

ANNEXURE-4

TECHNICAL PARAMETERS FOR VOLTAGE TRANSFORMERS

Sl. No.	Particular	220 kV	132kV	66kV
1	Rated system voltage (Un)	245 kV (rms)	145 KV (rms)	72 KV (rms)
2	Rated frequency	50 Hz	50 Hz	50 Hz
3	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed
4	System fault level	50/40 kAp. (As applicable) for 1 Second.	31.5 kA	31.5 kA
5	Rated insulation levels			
i.	1.2/50 micro second impulse voltage	±1050 kVp	±650 kVp	±325 kVp
ii.	one minute power frequency withstand voltage	460 kV (rms)	275 kV (rms)	140 kV (rms)
iii.	250/2500 micro second switching impulse voltage (dry & wet)	NA	NA	NA
6	One minute power frequency withstand voltage for secondary winding	3 kV (rms)	3 kV(rms)	3 kV(rms)
7	Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz	1000 µV	500µV	….µV
8	Rated total thermal burden	400 VA		

Sl. No.	Particular	220 kV	132kV	66kV
9	Partial discharge level	10 Pico coulombs.	10 pico coloumbs	10 pico coloumbs

TABLE -4A

REQUIREMENT OF VOLTAGE TRANSFORMERS

Sl. No	PARTICULARS	220 kV			132kV /66		
1	Rated primary voltage	220/√3 kV			132//√3 kV 66//√3 kV		
2	Type	Electromagnetic			Electromagnetic		
3	No. of secondaries	3			3		
4	Rated voltage factor	1.2 continuous			1.2 continuous		
		1.5 for 30 seconds			1.5 for 30 seconds		
5	Phase angle error	±10 minutes (for metering core)			±10 minutes (for metering core)		
		Sec I	Sec II	Sec III	Sec I	Sec II	Sec III
6.	Rated secondary voltage (V)	110/ √3	110/ √3	110/ √3	110/ √3	110/ √3	110/√3
7.	Application	Prote ction	Prote ction	Meterin g	Prot ecti on	Prot ecti on	Metering
8.	Accuracy	3P	3P	0.2	3P	3P	0.2
9.	Output burden (VA) (minimum)	50	50	50	50	50	50

ANNEXURE-5

TECHNICAL PARAMETERS OF GIS SURGE ARRESTOR

Sl. No.	Particulars	220 kV	132 kV	66 kV
1	Rated system voltage	245 kV	132kV	66kV
2	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed
3	Rated arrestor voltage	216 kV	120 kV	60 kV
4	Nominal discharge current	10 kA of 8/20 µs wave	10 kA of 8/20 µs wave	10 kA of 8/20 µs wave
5	Rated frequency	50 Hz	50 Hz	50 Hz

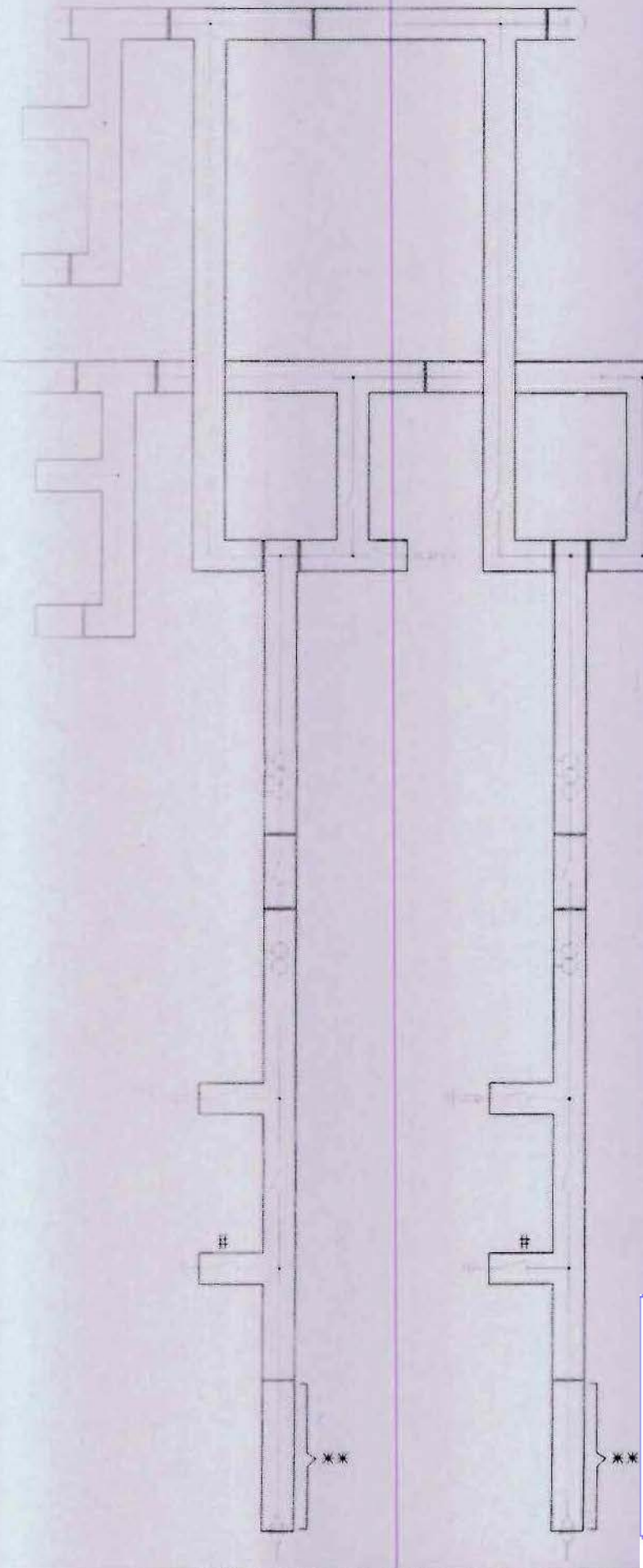
Sl. No.	Particulars	220 kV	132 kV	66 kV
6	Minimum discharge capability voltage corresponding to minimum discharge characteristics	5 KJ/kV (referred to rated arrestor)	5 KJ/kV (referred to rated arrestor)	5 KJ/kV (referred to rated arrestor)
7	Continuous operating voltage at 50^0C	168 kV	102 kV	
8	Min. switching surge residual voltage	-		
	Max. switching surge residual voltage	500 kVp	280kVp	
9	Max. residual voltage at 5 kA	560 kVp	310kVp	
11	Max. residual voltage at 10 kA nominal discharge current	600 kVp	330 kVp	
12	Max. residual voltage at 20 kA nominal discharge current	-		
13	Steep fronted wave residual voltage	650kVp 10kA		
14	Long duration discharge class	3	3	3
15	High current short duration test value (4/10 micro second wave)	100 kAp	100 kAp	100 kAp
16	Current for pressure relief test	50kA/50kA (as applicable)	31.5 kA	31.5 kA
17	Prospective symmetrical fault current	40 kA rms for 0.2 Sec	As per IEC	As per IEC
18	Pressure relief class:	A	A	A
19	RIV at 1.1 $U_n/\sqrt{3}$ kV rms(micro volts)	Less than 500	Less than 500	Less than 500
20	Partial discharge at 1.05 COV (pC)	Not more than 5	Not more than 5	Not more than 5
21	Reference ambient temp.	50 ^{0}C	50 ^{0}C	50 ^{0}C

ANNEXURE-6

TECHNICAL PARAMETERS FOR SF6/AIR BUSHING

Sl. No.	Particular	220 kV	132kV
1	Rated Voltage (kV)	245 kV (rms)	145 kV (rms)
2	Rated Current (Amp)	1600	600
3	1.2/50 micro second impulse voltage (Lightning impulse withstand voltage)	1050 kVp	630 kVp

Sl. No.	Particular	220 kV	132kV
4	250/2500 micro second switching impulse voltage	-	
5	One minute power frequency withstand voltage		275 kV (rms)
6	Minimum total Creepage distance in mm	6125	3625
7	Minimum Cantilever strength (kN)	8	5



NOTES :

1). PROVISION OF RUPTURE DISC,ABSORBER,GAS FILLING & GAS MONITORING ARRANGEMENT TO BE KEPT IN EACH GAS COMPARTMENT.

** NUMBER OF GAS COMPARTMENTS IN THIS SECTION SHALL BE AS PER THE ACTUAL LAYOUT & SHALL BE FINALISED DURING DETAILED ENGG.

LEGENDS

SIGN	NAME	DESCRIPTION
	CB	CIRCUIT BREAKER
	DS	DISCONNECTING SWITCH
	ES/FES#	EARTHING SWITCH
		BARRIER INSULATOR
		SF6 GAS DENSITY MONITOR
	CT	CURRENT TRANSFORMER
	BSG	SF6/AIR BUSHING

Reference drawing only for tender proposes

Nepal electricity authority
(GoN Undertaking)
Project Management Directorate
Electricity Grid Modernization Project

Substation Construction Project

Title: **Typical Gas Schematic Diagram (Double Main Scheme)**

CHAPTER 20- Section 1

GENERAL TECHNICAL REQUIREMENT (GTR)-TRANSFORMER & REACTOR

Table of Content

1.0 FOREWORD

1.1 The provisions under this Chapter are intended to supplement general requirements for the materials, equipments and services covered under other Chapters of tender documents and is not exclusive. However in case of conflict between the requirements specified in this Chapter and requirements specified under other Chapters, the requirements specified under respective Chapters shall prevail.

2.0 GENERAL REQUIREMENT

2.1 The bidders shall submit the technical requirements, data and information as per the technical data sheets provided in the bid documents.

2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification. An indicative list of such drawings and documents for transformer and reactor are enclosed in Annexure-A.

2.3 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Employer. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the specific requisite schedule, will not be considered as valid deviation.

2.4 Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

2.5 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 equipment 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.

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of Nepal.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standard specified under Annexure-B of this Chapter, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IEC/CIGRE/IEEE/NEMA.

3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure B / individual Chapters for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out in additional information schedule along with English language version of such standard. The equipment conforming to standards other than specified under Annexure B / individual Chapters for various equipments shall be subject to Employer's approval.

3.7 The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1 All equipment shall perform satisfactorily under various electrical, electromechanical and meteorological conditions of the site of installation.

4.2 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.3 The equipment shall also comply to the following:

a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

b) All piping, if any between equipment control cabinet/ operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.4 EHV equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

4.4.1 System Parameter

Sl. No.	Description of parameters	220 KV System	132 KV System	33 KV System	22 KV System	11 KV System
1.	System operating voltage	220KV	132KV	33KV	22KV	11KV
2.	Maximum system operating voltage (rms),Um	245KV	145KV	36KV	25KV	12KV
3.	Rated frequency	50Hz	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3	3
5.	Rated Insulation levels					
i)	Full wave impulse withstand voltage(1.2/50 micro sec.)	1050KVp	650KVp	170KVp	150KVp	75KVp
ii)		-	-	-	-	-

iii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet One minute power frequency dry and wet withstand voltage (rms)	460KV	275KV	70KV	50KV	28KV
6.	Corona extinction voltage	156KV	105KV	-		
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 508kV rms for 765kV, 320KV rms for 400KV system and 156KV rms for 220KV system & 92 KV rms for 132KV system	1000 micro-volt	500 micro-volt	-	-	-
8.	Minimum creepage distance	25 mm/KV (6125 mm)	25 mm/KV (3625 mm)	25 mm/KV (900 mm)	25 mm/KV (625 mm)	25 mm/KV (300 mm)
9.a	Min. clearances in air for Transformer & Reactor					
i.	Phase to phase	2300 mm (for BIL-950 kVp)	1220 mm (for BIL-550 kVp)	350 mm (for BIL-170 kVp)	280 mm (for BIL-150 kVp)	110 mm (for BIL-75 kVp)
ii.	Phase to earth	1800 mm (for BIL-950 kVp)	1050 mm (for BIL-550 kVp)	320mm (for BIL-170 kVp)	280mm (for BIL-150 kVp)	110mm (for BIL-75 kVp)
9.b	Min. clearances in air for other switchyard equipments					
i)	Phase to phase	2100 mm	1300 mm	320 mm	280 mm	110 mm
ii)	Phase to earth	2100 mm	1300 mm	320 mm	280 mm	110 mm
iii)	Sectional clearances	5000 mm	4000 mm	3000 mm	2800 mm	2500 mm
10.	Rated short circuit current for 1 sec. duration	40 kA	31.5 kA	25 kA	25 kA	25 kA
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Note : The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.

5.2 The list of drawings/documents which are to be submitted to the Employer shall be discussed and finalised by the Employer at the time of award.

The Contractor shall necessarily submit all the drawings/ documents unless anything is waived.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material

description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

5.3.3 Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.

5.4 The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor 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.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Employer would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ by Employer on initial submission	As per agreed schedule
ii)	Resubmission (whenever required) time).	Within 4 (four) weeks from date of comments including both ways postal
iii)	Approval or comments of resubmission.	Within 4 weeks of receipt
iv)	Furnishing of distribution copies in bound volume (5 copies per substation and one copy for Corporate office of Employer)	3 weeks from the date of final approval

v)	Furnishing of distribution copies of test reports	
(a)	Type test reports (one copy per substation plus one copy for corporate office of Employer)	3 weeks from the date of final approval
(b)	Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ operation manuals (4 copies per substation and two copies for corporate office of Employer)	As per agreed schedule
(vii)	Visual Compact Disk (VCD) highlighting installation and maintenance techniques/ requirements of transformer & reactor (one per substation plus one for corporate office of Employer)	-do-
(viii)	As built drawings on CD/optical Disc (Two sets per substation plus one set for corporate office of Employer)	On completion of entire works

NOTE :

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) The drawings which are required to be referred frequently during execution should be submitted on cloth lined paper or Laminated Sheets. The list of such drawings shall be finalised with the Contractor at the time of Award.

(3) All major drawings should be submitted in Auto Cad Version 2000 or better.

(4) 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.

(5) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.

(6) The Contractor shall furnish to the Employer catalogues of spare parts.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase 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 Contractor 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 Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, 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. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in Nepal unless the Contractor has any special requirement for the

specific application of a type of oil or grease not available in Nepal. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help Employer in establishing equivalent Nepal make and Nepal Contractor. The same shall be applicable to other consumables too.

6.1.8 A cast iron or welded steel base plate shall be provided for all rotating equipment which are to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of design with pads for anchoring the units, shall have a raised up all around and shall have threaded in air connections, if so required.

6.2 **Provisions 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. The indoor equipments located in non-air conditioned areas shall also be of same type.

6.2.1 **Space Heaters**

6.2.1.1 The heaters shall be suitable for continuous operation at 230 V AC supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55

b) Installed indoor in air conditioned area: IP-31

c) Installed in covered area: IP-52

d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.

The degree of protection shall be in accordance with IEC-947 (Part-I)/ IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Employer. The rating plate of each equipment shall be according to IEC requirement.

6.3.2 All such nameplates, instruction plates, rating plates of transformers & reactors shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Employer & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Employer. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at Corporate Office of Employer, Nepal or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Employer's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the contractor and finalised after discussions before the award of contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by EMPLOYER after discussion. However, in case detailed valid programme approved by EMPLOYER for the equipment already exist, same would be followed till its validity. A quality assurance programme of the contractor shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for bidder's key personnel;

(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;

(f) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Employer.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The contractor would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employer's inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective Chapters. Employer reserves the right to witness any or all the tests. The Contractor shall intimate the

Employer the detailed program about the tests atleast three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

9.2 The reports for all type tests and additional type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accredition body of the country where laboratory is located) or witnessed by the representative(s) of EMPLOYER or Utility/third party.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

9.3 The Employer intends to repeat the type tests and additional type tests on transformers & reactor for which test charges shall be payable as per provision of contract. The price of conducting type tests and additional type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

9.4 The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times free access to the Contractor's/sub-vendors premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Employer and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.5 The Contractor shall give the Employer /Inspector thirty (30) days written notice of any material being ready for joint testing including contractor and Employer. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Employer /inspector, unless witnessing of the tests is virtually waived, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Employer or Inspector shall, within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Employer /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Employer /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Employer.

9.8 In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer /Inspector or to his authorised representative to accomplish testing.

9.9 The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

9.10 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

9.11 The Employer reserves the right for getting any field tests not specified in respective Chapters of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Employer.

10. TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Employer will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment. However necessary fee shall be reimbursed by Employer on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments 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 Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Employer to repack 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 should be taken into account. The Contractor 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, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration 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 pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 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 & bolts and spring washers shall be electro galvanized to service condition 4. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to equivalent international standards.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor 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. Contractor 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.

13.3 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.4 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.5 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.7 Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

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

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

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

13.11 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 4.4.1 the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.12 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 SPECIAL TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment which are proprietary in nature. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase /Wire	Neutral connection
400V	+/- 10%	50 +/- 5%	3/	Solidly 4 WireEarthed.
230V	+/- 10%	50 +/- 5%	1/	Solidly 2 WireEarthed.

Combined variation of voltage and frequency shall be limited to +/- 10%.

16.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

16.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IEC-439 and the clauses given below:

16.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

16.3 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements. A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

16.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/ cracked during the operation of the equipment.

16.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/ cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

16.6 All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on

this gland plate. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

16.7 A 230V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

16.8 For illumination of a 20 Watts fluorescent tube or 15 watts CFL shall be provided. The switching of the fittings shall be controlled by the door switch.

16.9 All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted.

16.10 Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

16.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

16.12 a) The following routine tests alongwith the routine tests shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

17.0 SUPPORT STRUCTURE

17.1 The support structures to be supplied by the contractor for the tertiary arrangement should be hot dip galvanised with minimum 610 gram/sq.m net of zinc.

17.2 Support structure shall meet the following mandatory requirements:

17.3 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

18.0 TERMINAL BLOCKS AND WIRING

18.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

18.2 Terminal blocks shall be 650 V grade and have continuous rating to carry the maximum expected current on the terminals. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. The terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix (cage clamp type), Wago or equivalent.

18.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

18.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

18.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

18.6 The terminal blocks shall be of extensible design.

18.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

18.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

18.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

a) All circuits except CT circuits	Minimum of two of 2.5 sq mm copper flexible.
b) All CT circuits	Minimum of 4 nos. of 2.5 sq mm copper flexible.

18.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

18.11 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltges either transferred through the equipment or due to transients induced from the EHV circuits.

18.12 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment

19.0 LAMPS AND SOCKETS

19.1 Lamps

All incandescent lamps shall use a socket base as per IEC, except in the case of signal lamps.

19.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard plugs. They shall be switched sockets with shutters.

19.3 Hand Lamp:

A 230 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

19.4 Switches and Fuses:

19.4.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

19.4.2 All fuses shall be of HRC cartridge type mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

20.0 Bushings, Hollow Column Insulators, Support Insulators:

20.1 Bushings shall be manufactured and tested in accordance with IEC: 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233. The support insulators shall be manufactured and tested as per IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon rubber insulator, conforming to IEC-1109.

20.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

20.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

20.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

20.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

20.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

20.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

20.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with International Standards. The type test reports shall be submitted for approval.

Annexure –A

INDICATIVE LIST OF DRAWINGS FOR TRANSFORMER & REACTOR

1. Outline General Arrangement (OGA)drawing of transformer & reactor
   a) Plan
   b) Elevation
   c) End View
   d) Neutral formation of three phase bank

   List of all accessories with detailed weights, dimensions, clearances, spacing of wheels in direction, center of gravity, location of cooler etc.

2. Foundation Plan showing reaction at points of support, clamping arrangement & location of jacking pads.
3. Technical Data requirement sheet of transformer & reactor
4. Over fluxing withstand duration curve
5. Schematic wiring and diagram of cooling arrangement along with write up on scheme
6. Schematic wiring and diagram of OLTC along with write up on scheme
7. Mounting Arrangement and wiring diagram of remote WTI along with write up
8. Bushing Drawing showing electrical and mechanical characteristics
   a) HV Bushing
   b) LV Bushing
   c) Neutral bushing
9. Outline and General Arrangement of Cooler Control Cabinet
10. Cooler Control cabinet schematic and wiring diagram
11. Magnetisation Characteristics of bushing CTs
12. Hysteresis Characteristics of iron core
13. Rating and Diagram Plate
14. Overall Transport dimension Drawing of transformer & reactor
15. Drawing showing typical sectional view of the windings with details of insulation, cooling circuit method of cooling and core construction etc.
16. Oil Flow Diagram
17. Valve Schedule Plate drawing
18. Twin Bi-directional Roller
19. Connection Diag.of all protective devices to marshalling box showing physical location
20. List of spares
21. Technical Literature on all fittings and accessories.
22. Calculation to support short circuit withstand capacity of transformer & reactor
23. Calculation of hot spot temperature
24. Value of air core reactance with a typical write-up of calculation
25. Oil sampling Bottle details
26. Typical heating and cooling curves
27. OGA of RTCC panel
28. **RTCC panel schematic and wiring diagram**
29. **Outline and General Arrangement drawing of Common Marshalling Box**
30. **Schematic wiring and diagram of Common Marshalling Box**
31. **OGA of Ladder for transformer & Reactor**
32. **Transformer oil storage tank drawing**
33. **33 KV / 22kV / 11kVNeutral CT drawing and technical data sheet**
34. Customer inspection schedule
35. Test procedure of transformer & reactor
36. Type test Reports of transformer & reactor
37. O & M manual of transformer & reactor

ANNEXURE - B

LIST OF SPECIFICATIONS

GENERAL STANDARDS AND CODES

IEC-60 (Part 1 to P4)	-	High Voltage Test Techniques
IEC 66	-	Environmental Test
IEC-117	-	Graphical Symbols
IEC-156,	-	Method for the Determination of the Electrical Strength of Insulation Oils.
IEC-270,	-	Partial Discharge Measurements.
IEC-376 Hexafluoride	-	Specification and Acceptance of New Sulphur
IEC-437	-	Radio Interference Test on High Voltage Insulators.
IEC-506,	-	Switching Impulse Tests on High Voltage Insulators.
IEC-507	-	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems.
IEC-6094	-	Common Specification for High Voltage Switchgear & Control gear Standards.
IEC-815	-	Guide for the Selection of Insulators in respect of Polluted Conditions.
IEC-865 (P1 & P2)	-	Short Circuit Current - Calculation of effects.
ANSI-C.1/NFPA.70	-	National Electrical Code
ANSI-C37.90A	-	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21,	-	Specification for Electromagnetic Noise and
C63.3	-	Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	-	Techniques for Dielectric Tests
ANSI-C76.1/EEE21	-	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings.
ANSI-SI-4	-	Specification for Sound Level Meters
ANSI-Y32-2/C337.2	-	Drawing Symbols
ANSI-Z55.11	-	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	-	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	-	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	-	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
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

TRANSFORMERS & REACTORS

IEC 60076	Power transformers
IEC 60076-1	Part 1: General
IEC 60076-2	Part 2: Temperature rise
IEC 60076-3	Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4	Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-3-1	Part 3-1: Insulation Levels and Dielectric Tests – External Clearances in Air
IEC 60076-5	Part 5: Ability to withstand short circuit
IEC 60076-6	Part 6: Reactors
IEC 60076-7	Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8	Part 8: Application guide
IEC 60076-10	Part 10: Determination of sound levels
IEC 60076-10-1	Part 10-1: Determination of sound levels - Application guide
IEC 60076-11	Part 11: Dry-type transformers
IEC 60076-12	Part 12: Loading guide for dry-type power transformers
IEC 60076-13	Part 13: Self-protected liquid-filled transformers
IEC 60076-14	Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
IEC 60076-15	Part 15: Gas-filled power transformers
IEC 60076-16	Part 16: Transformers for wind turbine applications
IEC 60076-18	Part 18: Measurement of frequency response
IEC 60076-19	Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC 60076-21	Part 21: Standard requirements, terminology, and test code for step-voltage regulators
IEC 60044	Current transformers
IEC 60050	International Electrotechnical Vocabulary
IEC 60050(421)	International Electrotechnical vocabulary- Chapter 421 : Power Transformers and Reactors
IEC 60060	High Voltage test techniques
IEC 60060-1	General definitions and test requirements
IEC 60060-2	Measuring systems
IEC 60071	Insulation co-ordination
IEC 60071-1	Part 1: Definitions, principles and rules
IEC 60071-2	Part 2 : Application guide
IEC 60137	Bushing for alternating voltage above 1000V
IEC 60214	On-Load Tap changers
IEC 255-21-3	Relays vibration
IEC 60270	Partial discharge measurements
IEC 60296	Specification for Unused Mineral Oil for Transformers and Switchgear
IEC 60422	Supervision and Maintenance guide for Mineral Insulating Oil in Electrical Equipment
IEC 60475	Method of Sampling Liquid dielectrics
IEC 60529	Classification of Degrees of Protection provided by Enclosures

IEC 60542	Application Guide for On-Load Tap-Changers
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment for the Analysis of Free and Dissolved Gases
IEC 60651	Sound Level Meters
IEC 61083	Digital Recorders and Software for High Voltage Impulse testing
IEC 61083-1	Part 1: Requirements for digital recorders in high voltage impulse tests
IEC 61083-2	Part 2: Evaluation of software used for the determination of the parameters of impulse waveforms
CISPR 16	Specification for radio disturbance and immunity measuring apparatus
CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR-18	Radio Interference Characteristics of Power Lines and High Voltage Equipment
ISO 9001	Quality system-Model for Quality Assurance in Design /development
Cigre Publication 202	Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above. August 2002-Cigre Working Group 12.22
WG 12-15	Guide for Customers Specifications for Transformers 100 MVA and 123 kV and above
WG 12 19	Short Circuit Performance of Transformers.
BS-4360	Specification for weldable structural steel
BS-5135	Specification for arc welding of carbon and carbon manganese steels
BS-5500	Specification for unfired fusion welded pressure vessels
ISO-8501	Preparation of steel surface before application of Paints and related product
IEC-60599	Mineral oil impregnated electrical equipment in service – guide to the interpretation of dissolved and free gases analysis
IEC-60034-5	Degrees of protection provided by integral design of rotating electrical machines(IP Code) classification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas-insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IEC 60529 / IP : 55	Degree of protection for cooler control cabinet , MOLG ,Cooling fan , oil pump, Buchholz Relay
IEC 60529 / IP : 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP : 43	Degree of protection for Remote tap Changer cubicle (RTCC)

Clamps & connectors

NEMA-CC1	-	Electric Power connectors for sub station
NEMA-CC 3	-	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors

Wires and cables

ASTMD-2863	-	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IEC-96 (part 0 to p4)	-	Radio Frequency cables.
IEC-183	-	Guide to the Selection of High Voltage Cables.
IEC-189 (P1 to P7)	-	Low frequency cables and wires with PVC insulation and PVC sheath.
IEC-227 (P1 to P7)	-	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V.
IEC-228	-	Conductors of insulated cables
IEC-230	-	Impulse tests on cables and their accessories.
IEC-287 (P1 to P3)	-	Calculation of the continuous current rating of cables (100% load factor).
IEC-304	-	Standard colours for insulation for low-frequency cables and wires.
IEC-331	-	Fire resisting characteristics of Electric cables.
IEC-332 (P1 to P3)	-	Tests on electric cables under fire conditions.
IEC-502	-	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	-	Tests on gases evolved during combustion of electric cables.
Galvanizing		
ASTM-A-123	-	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.
ASTM-A-121-77	-	Zinc-coated (Galvanized) steel barbed wire
Painting		
ANSI-Z551	-	Gray finishes for industrial apparatus and equipment
SSPEC	-	Steel structure painting council
HORIZONTAL CENTRIFUGAL PUMPS		
API-610	-	Centrifugal pumps for general services
	-	Hydraulic Institutes Standards
BS:599	-	Methods of testing pumps
PTC-8.2	-	Power Test Codes - Centrifugal pumps

CHAPTER 20 – Section 2
TECHNICAL SPECIFICATIONS FOR TRANSFORMERS
Table of Content

1.0 General

1.1 This specification covers design, engineering, manufacture, testing at manufacturer's works, delivery at site including all materials, accessories, spares, unloading, handling, proper storage at site, erection, testing and commissioning of the equipment specified.

1.2 Transportation

The Contractor shall dispatch the transformer filled with oil or in an atmosphere of nitrogen or dry air. In the former case the contractor shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the contractor to take care of pressure drop of nitrogen or dry air during transit and storage till completion of oil filling during erection. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided.

Transformer shall also be fitted with at least one Electronic impact recorder (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is installed on its foundation. The data of electronic impact recorder(s) shall be down loaded at site and a soft copy of it shall be handed over to Engineer-in-charge. Further, within three weeks the contractor shall communicate the interpretation of the data. In the unlikely event of impact recorder output not available at site, the equipment shall be thoroughly internally inspected by the manufacturer's representative before erection at site to ensure healthiness of the equipment. Contractor shall mount Vehicle tracking system (GPRS/ GPS/ GSM based) to track the exact position of the vehicle on which the equipment is being loaded for transportation in order to ensure traceability and safety during transportation.

2.0 Performance

2.1 The transformers shall be used for bi-directional flow of rated power.

2.2 Transformers shall be capable of operating under natural cooled condition up to the full/Specified load. Transformers shall be fitted with coolers, capable of dissipating total losses at continuous maximum rating.

2.3 The transformers shall be capable of being operated, without danger, on any tapping at the rated MVA with voltage variation of ± 10% corresponding to the voltage of the tapping.

2.4 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that under 10 per cent continuous over voltage condition it does not exceed 1.9 Tesla at any tap position.

2.5 DGA of oil shall be monitored by the Employer and the interpretation of DGA results will be as per IEC - 60599. 1. DGA suitable for detecting 8 gases shall also be included in Power Transformer. Similarly, it shall be communicable and connected to existing SAS system.

2.6 Radio Interference and Noise Level

2.6.1 The transformers shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuit.

2.6.2 The noise level of transformer, when energized at normal voltage and frequency with cooler equipments in operation shall not exceed, when measured under standard conditions, the values specified at relevant clause.

2.7 The transformers shall be capable of being loaded in accordance with IEC-60076-7. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

2.8 The transformer and all its accessories including CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs. The short circuit level of the HV & LV System to which the subject transformers will be connected is 40 kA for 1 sec (sym, rms, 3 phase fault) on 220kV, 31.5 kA (sym, rms,3 phase fault on 132 kV) & 25kA (sym rms 3 phase fault on 11kV).

2.9 Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

2.10 Transformers shall withstand, without injurious heating, combined voltage and frequency fluctuations which produce the following over fluxing conditions:

110% for continuous operation
125% for 1 - minute
140% for 5 – seconds

2.11 Dynamic Short Circuit Test requirement

(i) out based on design of short circuit tested 132 kV or above voltage class transformer For 220 kV Class Transformer:

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on any rating of 220 kV or above voltage class transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report / Certificate along with bid.. Further design review of offered 220 kV class transformers shall be carried out based on design of short circuit tested 220 kV or above voltage class transformer.

(ii) For 132 kV Class Transformer:

Bidder / Manufacturer should have successfully carried out Dynamic Short Circuit Test on any rating of 132 kV or above voltage class transformer as on the originally scheduled date of bid opening and shall enclose the relevant Test Report / Certificate along with bid. Further design review of offered 132 kV class transformers shall be carried.

2.12 **Design review**

The transformers shall be designed, manufactured and tested in accordance with the best international engineering practices under strict quality control to meet the requirement stipulated in the technical specification. Adequate safety margin with respect to thermal, mechanical, dielectric and electrical stress etc. shall be

maintained during design, selection of raw material, manufacturing process etc so that the transformer provide long life with least maintenance.

Design reviews shall be conducted by Owner or an appointed Consultant at different stages of the procurement process for transformer, however the entire responsibility of design shall be with the manufacturer.

Owner/consultant may visit to the manufacturers works to inspect design, manufacturing and test facilities.

The design review will commence after placement of award with successful bidder and shall be finalised before commencement of manufacturing activity. These design reviews shall be carried out in detail to the specific design with reference of the transformer under scope of this specification.

The design review shall be conducted generally following the "Guidelines for conducting design reviews for transformers 100 MVA and 123kV and above" prepared by Cigre SC 12 Working Group 12.22.

The manufacturer shall provide all necessary information and calculations during design review to demonstrate that the transformer meets the requirements for short circuit strength and durability. The latest recommendations of IEC and Cigre SC 12 shall be applied for short circuit withstand evaluation.

The manufacturer will be required to demonstrate the use of adequate safety margin for thermal, mechanical, dielectric and vibration etc. design to take into the account the uncertainties of his design and manufacturing processes.

The scope of such a design review shall at least include the following:

1.	Core and magnetic design
2.	Winding and tapping design
3.	Short-circuit withstand capability
4.	Thermal design including review of localised potentially hot area.
5.	Cooling design
6.	Overload capability
7.	Eddy current losses
8.	Seismic design, as applicable
9.	Insulation co-ordination
10.	Tank and accessories
10.1	Bushings and barrier design
10.2	Tap changers
10.3	Protective devices
10.4	Radiators
10.5	Oil and oil preservation system
11.	Corrosion protection
12.	Electrical and physical Interfaces with substation
13.	Earthing
14.	Processing and assembly
15.	Testing capabilities
16.	Inspection and test plan
17.	Transport and storage
18.	Sensitivity of design to specified parameters
19.	Acoustic Noise
20.	Spares, inter-changeability and standardization

21.	Maintainability

3.0 Construction Details

The features and construction details of each power transformer shall be in accordance with the requirement stated hereunder.

3.1 Tank and Tank Accessories

3.1.1 Tank

3.1.1.1 Tank shall preferably be of welded construction and fabricated from tested quality low carbon steel of adequate thickness.

3.1.1.2 All seams and those joints not required to be opened at site shall be factory welded, and wherever possible they shall be double welded. After completion of tank and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing members. The requirement of post weld heat treatment of tank/stress relieving shall be based on recommendation of BS-5500 table 4.4.3.1.

3.1.1.3 Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

3.1.1.4 The transformer shall have conventional type tank. In case the joint is welded it shall be provided with flanges suitable for repeated welding. The joint shall be provided with a suitable gasket to prevent weld splatter inside the tank. Proper tank shielding shall be done to prevent excessive temperature rise of the joint.

3.1.1.5 Each tank shall be provided with:

(a) Lifting lugs suitable for lifting the equipment complete with oil.

(b) A minimum of four jacking pads in accessible position to enable the transformer complete with oil to be raised or lowered using hydraulic jacks. Each jacking pad shall be designed to support with an adequate factor of safety for at least half of the total mass of the transformer filled with oil allowing in addition for maximum possible misalignment of the jacking force to the centre of the working surface.

(c) Suitable haulage holes shall be provided.

3.1.1.6 The tank shall be designed in such a way that it can be mounted on the rollers.

3.1.1.7 The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.

3.1.1.8 Paint system and procedures

The painting details for transformer main tank, pipes, conservator tank, radiator, control cabinet/ marshalling box / oil storage tank etc. shall be as given below. The paint should not fade during drying process. The paint should be able to

withstand temperature up to 120 deg. C .The detailed painting procedure shall also be submitted for approval in case of award .

	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total dry film thick-ness (DFT)	Colour shade
Main tank, pipes, conservator tank, oil storage tank etc. (external surfaces)	Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40μm)	Epoxy high build Micaceous iron oxide (HB MIO) (75μm)	Aliphatic polyurethane (PU) (Minimum 50μm)	Minimum 155μm	RAL 7035
Main tank, pipes (above 80 NB), conservator tank, oil storage tank etc. (Internal surfaces)	Shot Blast cleaning Sa 2 ½*	Hot oil resistant, non-corrosive varnish or paint or epoxy	--	--	Minimum 30μm	Glossy white for paint
Radiator (external surfaces)**	Chemical / Shot Blast cleaning Sa 2 ½*	Epoxy base Zinc primer (30-40μm)	Epoxy base Zinc primer (30-40μm)	PU paint (Minimum 50μm)	Minimum 100μm	Matching shade of tank/ different shade aesthetically matching to tank
Radiator and pipes up to 80 NB (Internal surfaces)	Chemical cleaning, if required	Hot oil proof, low viscosity varnish	--	--	--	--
Control cabinet / marshalling box/RTCC	Seven tank process as per IEC	Zinc chromate primer (two coats)	--	EPOXY paint with PU top coat	Minimum 80μm	RAL 7035 shade for exterior and interior

Note: * Indicates Sa 2 ½ as per Swedish Standard SIS 055900 of ISO 8501 Part-1.
** **Radiator hot dip galvanized may also acceptable**.

3.1.2 **Tank Cover**

3.1.2.1 The tank cover shall be designed to prevent retention of rain water and shall not distort when lifted. The internal surface of the top cover shall be shaped to ensure efficient collection and direction of free gas to the buchholz relay.

3.1.2.2 At least one adequately sized inspection openings shall be provided in the transformers for easy access to bushings and earth connections. The inspection

covers shall not weigh more than 25 kg. Handles shall be provided on the inspection cover to facilitate lifting.

3.1.2.3 The tank covers shall be fitted with pockets at the position of maximum oil temperature at maximum continuous rating for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank. The thermometer shall be fitted with a captive screw to prevent the ingress of water.

3.1.2.4 Bushing turrets, covers of inspection openings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

3.1.2.5 All bolted connections shall be fitted with weather proof, hot oil resistant, resilient gasket in between for complete oil tightness. If gasket is compressible, metallic stops/other suitable means shall be provided to prevent over-compression. All gasketed joints shall be designed, manufactured and assembled to ensure long-term leak and maintenance free operation. Groove provided to accommodate round nitrile rubber cord for rectangular openings shall be milled.

3.1.2.6 Tank hotspot

The maximum temperature on any metal part shall not exceed 130 deg. Celsius.

3.1.2.7 Currents flowing in tank cover and bushing turrets

To allow for the effect of possible induced and capacitive surge current, good electrical connection shall be maintained between the tank and turrets.

3.1.2.8 The transformer shall be provided with pipe flange of suitable diameter with bolted blanking plate, gasket and shall be fitted at the highest point of the transformer tank for maintaining vacuum in the tank.

3.1.3 **Axles and Wheels**

3.1.3.1 The transformer shall be mounted on rollers, as per manufacturer's standard practice.

3.1.3.2 The roller mounted transformers are to be provided with flanged bi-directional wheels and axles. This set of wheels and axles shall be suitable for fixing to the under carriage of transformer to facilitate its movement on rail track. Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

3.1.3.3 The rail track gauge shall be 1676 mm.

3.1.4 **Foundation and Anti Earthquake Clamping Device**

To prevent transformer movement during earthquake, suitable clamping devices shall be provided for fixing the transformer to the foundation.

3.1.5 **Conservator & Oil Preservation System**

Main conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture, and shall be fitted with magnetic oil level gauge with low oil level potential free contacts.

3.1.5.2 OLTC shall have conventional type conservator with prismatic oil level gauge.

3.1.5.3 **Conservator tank and pipe work**

3.1.5.3.1 Conservator tank shall have adequate capacity with highest and lowest visible-levels to meet the requirements of expansion of total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100degC. The capacity of the conservator tank shall be such that the transformer shall be able to carry the specified overload without overflowing of oil. The Calculation shall be submitted during design review.

3.1.5.3.2 The conservator shall be fitted with integral lifting lugs in such a position so that it can be removed for cleaning purposes. Suitable provision shall be kept to replace air cell and cleaning of the conservator wherever applicable.

3.1.5.3.3 Conservator shall be positioned so as not to obstruct any electrical connection to transformer. Pipe work shall neither obstruct the removal of tap changers for maintenance or the opening of inspection or manhole covers.

3.1.5.3.4 Pipe work connections shall be of adequate size for their duty and as short and direct as possible. Only radiused elbows shall be used.

3.1.5.3.5 The feed pipe to the transformer tank shall enter the transformer cover plate at its highest point and shall be straight for a distance not less than five times its internal diameter on the transformer side of the Buchholz relay, and straight for not less than three times that diameter on the conservator side of the relay.

3.1.5.3.6 This pipe shall rise towards the oil conservator, through the Buchholz relay, at an angle of not less than 5 degree.

3.1.5.4 **Oil Preservation Equipment**

The requirements of air cell type oil sealing system are given below.

3.1.5.4.1 Contact of the oil with atmosphere is prohibited by using a flexible air cell of nitrile rubber reinforced with nylon cloth.

3.1.5.4.2 The temperature of oil is likely to rise upto 100 deg C during operation. As such air cell used shall be suitable for operating continuously at 100 deg C.

3.1.5.4.3 Air cell of conservator shall be able to withstand the vacuum during installation /maintenance periods. Otherwise provision shall be kept to isolate the conservator from the main tank when the latter is under vacuum by providing a vacuum sealing valve or other suitable means in the pipe connecting main tank with the conservator. The transformer manual shall give full and clear instructions on the operation, maintenance, testing and replacement of the air cell. It shall also indicate shelf life, life expectancy in operation, the recommended replacement intervals and the supplier.

3.1.5.4.4 The connection of air cell to the top of the conservator is by air proof seal preventing entrance of air into the conservator.

3.1.5.5 **Maintenance-free Dehydrating Breather**

Conservator of Main Tank and OLTC each shall be fitted with a maintenance-free dehydrating breather in which only pure silica gel has been filled as dehydrating

agent. Connection shall be made to a point in the oil conservator not less than 50 mm above the maximum working oil level by means of a pipe with a minimum diameter of 25 mm. Breathers and connecting pipes shall be securely clamped and supported to the transformer, or other structure supplied by the contractor, in such a manner so as to eliminate undesirable vibration and noise. The design shall be such that:

a) Incoming air is directed toward the desiccant (silica gel) and dried.
b) The desiccant is regenerated/de-humidified by an installed heating element that shall be sensor-controlled and self-regulating.
c) Silica gel is isolated from atmosphere by an oil seal.
c) Moisture absorption indicated by a change in color of the crystals.
d) Breather is mounted approximately1200mm above rail top level.
e) The maintenance free dehydrating breathers shall have a humidity and temperature sensor and must have 3 LED for status indication and a data logger to log all important events. The maintenance free breather shall be equipped with a self learning algorithm alpha control for the OLTC conservator and beta control for main tank conservator. Moving parts such as solenoid valves or fans are not accepted. Additionally an Anti-Condensation heater shall be installed in the control box and test button is required for auto-diagnosis and testing functions

3.1.5.6 Pressure Relief Device

Adequate number of pressure relief devices shall be provided at suitable locations. These shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to equipment. The device shall operate at a static pressure less than the hydraulic test pressure of the transformer tank. It shall be mounted directly on the tank. One set of electrically insulated contacts shall be provided for alarm/tripping.. Discharge of pressure relief device shall be properly taken through pipes and directed away from the transformer/other equipment and this shall be prevented from spraying on the tank. Following routine tests shall be conducted on PRD

a. Air pressure test
b. Liquid pressure test
c. Leakage test
d. Contact test
e. Dielectric test.

3.1.5.7 Buchholz Relay

A double float/reed type Buchholz relay shall be provided. Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation and taking gas sample. A copper/stainless steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. Buchholz relay shall be type tested as per international standards. Buchholz relay and its terminal box shall conform to IP 55 degree of protection.

3.1.5.8 Temperature Indicators

3.1.5.8.1 Oil Temperature Indicator (OTI)

All transformers shall be provided with a 150 mm (approx.) dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device shall be provided in the OTI. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Temperature indicator dials shall have linear gradations to clearly read atleast every 2 deg C. Accuracy of OTI shall be ± 3.0 deg C or better. The setting of alarm and tripping contacts shall be adjustable at site.

In addition to the above, the following equipment shall be provided for remote indication of oil temperature:

a) Signal transmitter

Signal transmitter shall have additional facility to transmit signal for recording oil temperature at Employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent. The RTD may be placed in the pocket containing temperature sensing element and image coil for OTI system which will be used for both remote OTI and DAS. Necessary equipment for sending the signal to remote OTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote oil temperature indicator
It shall be suitable for flush mounting on Employer's/RTCC panel. This shall not be repeater dial of local OTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection between cooler control cabinet and remote OTI control circuit, shall be in the scope of Contractor. Only one ROTI with a four point selector switch shall be provided.

3.1.5.8.2 Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each winding shall be provided (HV and LV). It shall comprise the following:

i) Temperature sensing element.
ii) Image coil.

iii) Auxiliary CTs, if required to match the image coil, shall be furnished and mounted in the cooler control cabinet.

iv) 150 mm (approx) dia local indicating instrument with maximum reading pointer and two adjustable electrically independent, ungrounded contacts; besides that required for control of cooling equipment if any, one for high winding temperature alarm and one for trip. Temperature indicator dials shall have linear gradations to clearly read at least every 2 deg C.

v) Calibration device.

vi) Accuracy of WTI shall be ± 3.0 deg C or better.
The setting of alarm and tripping contacts shall be adjustable at site and typical values are as given below which will be reviewed during detailed engineering based on manufacturer's recommendation.
Alarm – 110degC
Trip - 120degC

vii) In addition to the above, the following equipment shall be provided for remote indication of winding temperature for each of the winding:

a) Signal transmitter for each winding

Signal transmitter shall have additional facility to transmit signal for recording winding temperature at Employer's data acquisition system, for which duplex platinum RTD with nominal resistance of 100 ohms at zero degree centigrade shall be supplied. The RTD shall be three wire ungrounded system. The calibration shall be as per SAMA (USA) standard or equivalent. The RTD may be placed in the pocket containing temperature sensing element and image coil for WTI system which will be used for both remote WTI and DAS. Necessary equipment for sending the signal to remote WTI and DAS shall be provided. In lieu, separate RTD for each of the functions shall be provided.

b) Remote winding temperature indicator

It shall be suitable for flush mounting on Employer's panel. This shall not be repeater dial of local WTI and will operate by signal transmitter.

Any special cable required for shielding purpose, for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of Contractor. Only one RWTI with a selector switch shall be provided for all the windings (HV and LV).

3.1.9 **Earthing Terminals**

3.1.9.1 Two (2) earthing pads (each complete with two (2) nos. holes, M 10 bolts, plain and spring washers) suitable for connection to 75 x 6 mm galvanised steel grounding flat shall be provided each at position close to earth of the two (2) diagonally opposite bottom corners of the tank.

3.1.9.2 Two earthing terminals suitable for connection to 75 x 6 mm galvanised steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately.

3.2 **Core**

3.2.1 The core shall be constructed from prime quality, non-ageing, cold rolled, super grain oriented, silicon steel laminations.

3.2.2 The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating. The temperature of any part of the core or its support structure in contact with oil shall not exceed 120 deg C under normal operating

condition and 130 deg C under most extreme operating condition. Adequate temperature margin shall be provided to maintain longer life expectancy for this material.

3.2.3 The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 KV (rms) for 1 minute.

3.2.4 Core and winding shall be capable of withstanding the shock during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

3.2.5 All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding.

3.2.6 Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

3.2.7 The supporting frame work of the core shall be so designed as to avoid presence of pockets which would prevent complete emptying of tank through drain valve or cause trapping of air during oil filling.

3.2.8 Adequate lifting lugs will be provided to enable the core and windings to be lifted.

3.2.9 The core shall be earthed to the core clamping structure at one point only, through a removable external link suitably located and protected to facilitate testing after installation of the transformer.

In case core laminations are divided into sections by insulating barriers or cooling ducts parallel to the plane of the lamination, tinned copper bridging strips shall be inserted to maintain electrical continuity between sections.

A drawing furnishing the details of the internal earthing design shall be included in the manual.

3.3 **Windings**

3.3.1 The Contractor shall ensure that windings of all transformers are made in dust proof and conditioned atmosphere.

3.3.2 The conductors shall be of electrolytic grade copper free from scales and burrs.

3.3.3 The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

3.3.4 Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

3.3.5 The coils would be made up, shaped and braced to provide for expansion and contraction due to temperature changes.

3.3.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and to equalise the distribution of currents and temperature along the winding.

3.4 **Unused inhibited Insulating Oil**

3.4.1 The insulating oil shall be virgin high grade inhibited, conforming to IEC-60296 & all parameters specified below, while tested at supplier's premises. The contractor shall furnish test certificates from the supplier against the acceptance norms as mentioned below, prior to dispatch of oil from refinery to site. Under no circumstances, poor quality oil shall be filled into the transformer and only thereafter be brought up to the specified parameter by circulation within the transformer.

Sl. No.	Property	Test Method	Limits
A1.	Function		
1a.	Viscosity at 100degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.) 3 mm2/s
1b.	Viscosity at 40degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)12 mm2/s
1c.	Viscosity at -30degC	ISO 3104 or ASTM D445 or ASTM D7042	(Max.)1800 mm2/s
2.	Appearance	A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature	The oil shall be clear and bright, transparent and free from suspended matter or sediment
3.	Pour point	ISO 3016 or ASTM D97	(Max.)- 40degC
4.	Water content a) for bulk supply b) for delivery in drums	IEC 60814 or ASTM D1533	(Max.) 30 mg/kg 40 mg/kg
5.	Electric strength (breakdown voltage)	IEC 60156 or ASTM D1298	(Min.) 50 kV(new unfiltered oil) / 70 kV (after treatment)
6.	Density at 20 deg C	ISO 3675 or ISO 12185 or ASTM D 4052	0.820 - 0.895 g/ml
7.	Dielectric dissipation factor (tan delta) at 90 deg C	IEC 60247 or IEC 61620 Or ASTM D924	(Max) 0.0025
8.	Resistivity at 90 deg C	IEC 60247	150 X 10^12 Ohm –cm, (Min.) for records only.
9.	Negative impulse testing KVp @ 25 deg C	ASTM D-3300	145 (Min.)
10.	Carbon type composition (% of Aromatic, Paraffins and Naphthenic compounds.)	IEC 60590 or ASTM D 2140	Max.Aromatic : 4 to12 % Paraffins : <50% & balance shall be Naphthenic compounds.
B1.	Refining / Stability		
1.	Acidity	IEC 62021-1 or ASTM D974	(Max) 0.01 mg KOH/g
2.	Interfacial tension at 27degC	ISO 6295 or ASTM D971	(Min) 0.04 N/m
3.	Total sulfur content	BS 2000 part 373 or ISO 14596	0.15 % (Max.)
4.	Corrosive sulphur	IEC 62535	Non-Corrosive on copper and paper
		ASTM D1275B	Non-Corrosive
5.	Presence of oxidation inhibitor	IEC 60666 or ASTM D2668 or D4768	0.08% (Min.) to 0.4% (Max.) Oil should contain no other additives .Supplier should declare presence of additives, if any.
6.	2-Furfural content	IEC 61198 or ASTM D5837	25 Microgram/litre (Max.)

C1.	Performance		
1	Oxidation stability -Total acidity -Sludge - Dielectric dissipation factor (tan delta) at 90degC	IEC 61125 (method c) Test duration 500 hour IEC 60247	 Max 0.3 mg KOH/g Max 0.05 % Max 0.05
2.	Gassing	IEC 60628A or ASTM D2300	No general requirement
3.	Oxidation stability (Rotating Bomb test)	IEC : 61125(Method B) / ASTM D2112 (e)	220 Minutes (Min.)
D1.	Health, safety and environment (HSE)		
1.	Flash point	ISO 2719	(Min.)135degC
2.	PCA content	BS 2000 Part 346	Max 3%
3.	PCB content	IEC 61619 or ASTM D4059	Not detectable (Less than 2 mg/kg)

3.4.2 i) Prior to filling in main tank at site and shall be tested for

1. Break Down voltage (BDV) : 70kV (min.)
2. Moisture content : 5 ppm (max.)
3. Tan-delta at 90 °C : 0.0025 (max)
4. Interfacial tension : More than 0.004 N/m

ii) Prior to energisation at site oil shall be tested for following properties &acceptance norms as per below generally in line with IEC 60422:

1. Break Down voltage (BDV) : 70 kV (min.)
2. Moisture content : 10 ppm (max.)
3. Tan-delta at 90 °C : 0.01 (max.)
4. Resistivity at 90 °C : 6 X 10 ^12 ohm-cm (min.)
5. Interfacial tension : 0.035 N/m (min.)
6. *Oxidation Stability (Test method as per IEC 61125 method C,Test duration: 500hour for inhibited oil)
   a) Acidity : 0.3 (mg KOH /g) (max.)
   b) Sludge : 0.05 % (max.)
   c) Tan delta at 90 °C : 0.05 (max.)
7. * Total PCB content : Not detectable (2 mg/kg total)

* For Sr. No. 6 & 7 separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of Consultant.

3.4.3 At manufacturer's works the quality of oil used for first filling, testing and impregnation of active parts shall meet at least parameters as mentioned in serial no. 1 to 5 of clause 3.4.2 ii) above. The oil test results shall form part of equipment test report.

Oil sample shall be drawn before and after heat run test and shall be tested for dissolved gas analysis. Oil sampling to be done 2 hours prior to commencement of temperature rise test. For ONAN/ONAF cooled transformers, sample shall not be taken earlier than 2 hours after shutdown. The acceptance norms with reference to various gas generation rates shall be as per IEC 61181.

3.5 Terminal Arrangements

3.5.1 Bushings

3.5.1.1 Bushings shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout and movement along with the spare Transformer with bushing erected and provided with proper support from one foundation to another foundation within the substation area. The electrical and mechanical characteristics of bushings shall be in accordance with IEC: 60137/DIN 42530. All details of the bushing shall be submitted for approval and design review.

3.5.1.2 Bushing for various voltage rating shall be as follows

52 kV and above	RIP bushing with porcelain or composite insulator.
36 kV and below	Solid porcelain or oil communicating type. Dimensions of 11 kV bushing shall conform to IEC

3.5.1.3 RIP type bushing shall be provided with tap for capacitance and tan delta test. Test taps relying on pressure contacts against the outer earth layer of the bushing is not acceptable.

3.5.1.4 Where current transformers are specified, the bushings shall be removable without disturbing the current transformers.

3.5.1.5 Bushings of identical rating shall be interchangeable.

3.5.1.6 Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Polymer / composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be finalized during finalization of MQP.The weather sheds of the insulators shall be of alternate shed profile as per IEC 60815- 3. The weather sheds shall be vulcanized to the sheath (extrusion process) or moulded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing. End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. The hollow silicone composite insulators shall comply with the requirements of the IEC publications

IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462 (Type &Routine test)
RIP Bushing shall be specially packed to avoid any damage during transit and suitable for long storage, with non-returnable packing wooden boxes with hinged type cover. Without any gap between wooden planks. Packing Box opening cover with nails/screws type packing arrangement shall not be acceptable. Bushing oil end portion shall be fitted with metal housing with positive dry air pressure and a suitable pressure monitoring device shall be fitted on the metal housing during storage to avoid direct contact with moisture with epoxy. Alternatively, oil filled metal housing with suitable arrangement for taking care oil expansion due to temperature variations shall also be acceptable. Detail method for storage of bushing including accessories shall be brought out in the instruction manual.

3.5.1.7 Clamps and fittings shall be of hot dip galvanised steel.

3.5.1.8 Bushing turrets shall be provided with vent pipes, to route any gas collection through the Buchholz relay.

3.5.1.9 No arcing horns shall be provided on the bushings.

3.5.1.11 Installation procedures for the various voltage class bushings shall be clearly brought out in the Instruction manual.

3.5.1.12 Tan delta measurement at variable frequency (in the range of 20 Hz to 350 Hz) shall be carried out on each condenser type bushing (OIP & RIP) at Transformer manufacturing works as routine test before despatch and the result shall be compared at site during commissioning to verify the healthiness of the bushing.

3.5.1.13 If the bushing Tan delta goes beyond 0.005 or increase is more than 0.001 within the warrantee period w.r.t. pre-commissioning values, the contractor shall arrange to replace the defective bushing by new one. No temperature correction factor shall be applicable for tan delta.

3.5.2 Terminal Marking

The terminal marking and their physical position shall be as per IEC: 60076.

3.5.3 Neutral Earthing Arrangement

i) For 3-Phase Unit

The neutral of the transformer shall be brought out through bushing. The neutral terminal of 3-phase transformer shall be brought to the ground level by a brass/tinned copper grounding bar, supported from the tank by using porcelain insulators. The end of the brass/tinned copper bar shall be brought to the bottom of the tank, at a convenient point, for making bolted connection to two (2) 75 x 12 mm galvanised steel flats connected to Employer's grounding mat.

ii) For 1-Phase Unit

The neutral of the transformer shall be brought out through bushing. The contractor shall connect the neutrals of 1-phase transformers by overhead connection using an overhead common brass/tinned copper/Aluminum pipe /ACSR conductor grounding bus, supported from the tank and fire

walls by using porcelain insulators. All material like Bus post insulator, Aluminium tube, conductor, clamps & connectors, earthing materials, support structure, hardware etc required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor. The neutral formation shall be such that neutral winding of single-phase spare transformer can be disconnected or connected to either of the three phase banks.

i) Spare Unit connection arrangement (as applicable for 1-Phase Transformer)

Connection arrangement of spare unit of transformer with other units shall be made by isolator switching (Isolators are not part of this specification). Nutral formation for spare unit of transformer shall be done by manual connection. The contractor shall make connection arrangement as well as control scheme of OLTC and Cooler in such a way that spare unit of transformer can be connected in place of faulty unit without physically shifting it from its location. For this purpose, HV , LV and Neutral Connections of spare unit are to be extended upto the other unit by forming auxiliary buses and shall be supported by structure mounted bus post insulators at suitable intervals to enable spare unit connection through flexible/rigid conductor and suitable connector in place of existing unit to be replaced. The detail configuration and actual sizes of various items shall be finalised during detailed engineering and shall be subject to Employer's approval. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, cables, support structures, required for the above-mentioned arrangement shall be provided by the contractor.

3.6 Cooling Equipment and its Control

3.6.1 Cooling Equipment

3.6.1.1 The cooler shall be designed using sufficient number of tank mounted radiators. Design of cooling system shall satisfy the performance requirements.

3.6.1.2 Tank mounted radiators shall have its cooling fans , shut off valves at the top and bottom of suitable size, lifting lugs, top and bottom oil filling valves, air release plug at the top, a drain and sampling valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

3.6.1.3 Required number of standby fans of approximately 20% capacity shall also be provided with radiators.

3.6.1.4 Cooling fans shall be directly mounted on radiator. Each fan shall be suitably protected by galvanised wire guard. The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

3.6.1.5 Cooling fans motors shall be suitable for operation from 400 volts, three phase 50 Hz power supply and shall conform to IEC. Each cooling fan motors shall be provided with starter thermal overload and short circuit protection. The motor winding insulation shall be conventional class 'B' type. Motors shall have hose proof enclosure equivalent to IP: 55.

3.6.1.6 The cooler and its accessories shall preferably be hot dip galvanized or corrosion resistant paint (as per clause 3.1.1.8) should be applied to it.

3.6.1.7 Air release device and oil plug shall be provided on oil pipe connections. Drain valves shall be provided in order that each section can be drained independently.

3.6.2 Cooling Equipment Control (ONAN/ONAF COOLING)

3.6.2.1 Automatic operation control of fans shall be provided (with temperature change) from contacts of winding temperature indicator. The Contractor shall recommend the setting of WTI for automatic changeover of cooler control from ONAN to ONAF. The setting shall be such that hunting i.e. frequent start-up operations for small temperature differential do not occur.

3.6.2.2 Suitable manual control facility for cooler fans shall be provided.

3.6.2.3 Selector switches and push buttons shall also be provided in the cooler control cabinet to disconnect the automatic control and start/stop the fans manually.

3.6.2.4 Indicating Devices

Following lamp indications shall be provided in cooler control cabinet:

a) Control Supply failure.
b) Cooling fan failure.
c) Common thermal overload trip

One potential free initiating contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet for further wiring to Common Marshalling Box (CMB).

3.6.2.5 Two auxiliary power supplies, 400 volt, three phase four (4) wire shall be provided at common marshalling box. All loads shall be fed by one of the two sources through an electrically interlocked automatic transfer scheme housed in the CMB. Power supply to individual phase unit shall be extended from the CMB. Power supply to spare unit shall be extended from nearest CMB only. Suitably rated power contactors, separate MCBs/MCCBs shall be provided in the Common Marshalling Box for each circuit.

3.6.2.6 Control and power supplies are to be given for Cooler circuits after suitable selection at Common Marshalling Box. Necessary isolating switches and protective devices shall be provided at suitable points as per Purchaser's approved scheme. The Contractor shall derive AC power for Cooler Control Circuitry from the AC feeder as mentioned above. In case auxiliary power supply requirement for Cooler Control Mechanism is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.

3.6.2.7 For each circuit, suitably rated MCBs/MCCBs as required for further distribution of auxiliary power supply to DM boxes, Online Gases and moisture monitoring system, Online drying system and Fibre optic sensor Box etc. (as applicable), shall be provided by contractor, in individual marshalling boxes /cooler control boxes.

3.6.3 Auxiliary power supply distribution scheme shall be submitted for approval. Supply and laying of Power, Control and special cables from common marshalling box to individual MB/Cooler Control Cubicle (including spare unit) & further distribution from IMB/CCC to all accessories is in the scope of the contractor. Further any special cable (if required) from CMB to Owner's Control Panels/RTCC panels are also in the scope of the contractor.

3.6.4 The cooler control cabinet / Individual Marshalling box shall have all necessary devices meant for cooler control and local temperature indicators. All the contacts of various protective devices mounted on the transformer and all the secondary terminals of the bushing CTs shall also be wired upto the terminal board in the cooler control cabinet/Individual Marshalling box. All the CT secondary terminals in the cooler control cabinet shall have provision for shorting to avoid CT open circuit while it is not in use. All the necessary terminations for remote connection to Purchaser's panel shall be wired upto the Common Marshalling box.

3.6.5 Connection arrangement for spare unit shall be in such a way that spare unit of transformer can be connected in place of faulty unit without physically shifting and all the control, protection, indication signals of spare unit shall also be brought in common marshalling box of all the banks. Necessary arrangement in schematic of Common marshalling box is required to facilitate change-over of all the signals of faulty units to spare unit of Transformer, to ensure flow of control, protection and indication signals between Purchaser's Control panels / Digital RTCC Panel / SCADA and individual units under operation (i.e. any designated unit for bank or spare unit, if it replace any designated unit). To facilitate change-over of spare unit signals with faulty unit in CMB, male-female plug-in connector or better arrangement shall be provided to reduce the outage time

3.6.6 **Valves**

3.6.6.1 All valves shall be of gun metal or of cast steel/cast iron. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel.

3.6.6.2 Suitable means shall be provided for locking the valves in the open and close positions. Provision is not required for locking individual radiator valves.

3.6.6.3 Each valve shall be provided with the indicator to show clearly the position of the valve.

3.6.6.4 All valves flanges shall have machined faces.

3.6.6.5 All valves in oil line shall be suitable for continuous operation with transformer oil at 115 deg C.

3.6.6.6 The oil sampling point for main tank shall have two identical valves to be put in series .Oil sampling valve shall have provision to fix rubber hose of 10 mm size to facilitate oil sampling.

3.6.6.7 A valve or other suitable means shall be provided to fix (in future) on line dissolved gas monitoring system to facilitate continuous dissolved gas analysis. The location & size of the same shall be finalised during detail engineering stage

3.6.6.8 After testing, inside surface of all cast iron valves coming in contact with oil shall be applied with one coat of oil resisting paint/varnish with two coats of red oxide zinc chromate primer followed by two coats of fully glossy finishing paint conforming to international standards. Outside surface except gasket setting surface of butterfly valves shall be painted with two coats of red oxide zinc chromate conforming to International Standards followed by two coats of fully glossy finishing paint.

3.6.6.9 All hardware used shall be cadmium plated/electro galvanised steel.

3.6.6.10 For estimation purpose of spares one set of valves would mean one valve of each type used in Transformer.

3.7 Tap Changing Equipment

Each transformer shall be provided with Off load tap / On Load Tap changing equipment as specified elsewhere.

3.7.1 Off load tap Changer equipment (if applicable)

The off load / Off Circuit tap changer (OCTC) equipment shall be handle operated with a locking arrangement along with tap position indicator. The external handle shall be situated in an unobstructed position. The contacts are positively self-locating in each tapping position without constraint from the operating mechanism. The rating of the contacts shall be suitable to carry maximum current of the transformer. For three phase transformer the tap change switch shall simultaneous switch the similar taps on the three phases. A warning plate indicating that OCTC shall be operated only when the transformer is de-energized, shall be fitted.

3.7.2 ON Load Tap Changing (OLTC) Equipment

The On Load Tap Changer (OLTC) shall be of high speed resistor type with vacuum technology include the following:

3.7.2.1 Main OLTC Gear Mechanism

3.7.2.1.1 Each single / three phase transformer shall be provided with voltage control equipment of the tap changing type for varying its effective transformation ratio whilst the transformers are on load.

3.7.2.1.2 OLTC shall be motor operated suitable for local as well as remote operation. The diverter switch or arcing switch shall be designed so as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc. To meet any contingency which may result in incomplete operation of the diverter switch, adequate means shall be provided to safeguard the transformer and its ancillary equipment. The current diverting contacts shall be housed in a separate vacuum interrupter chamber not communicating with the oil in main tank of the transformer. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contacts shall be replaceable. Electrical arcing took place in a vacuum interrupter only.

3.7.2.1.3 Necessary safeguards shall be provided to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under overload conditions of the transformer.

3.7.2.1.4 Tap changer shall be so mounted that bell cover of transformer can be lifted without removing connections between windings and tap changer

3.7.2.2 Local OLTC Control Cabinet (Drive Mechanism Box)

Each transformer unit of OLTC gear shall have following features:

3.7.2.2.1 OLTC shall be suitable for manually handle operated and electrically motor operated. For local manual operation from Local OLTC Control cabinet (Drive Mechanism Box), an external handle shall be provided.

3.7.2.2.2 OLTC's Local control cabinet shall be mounted on the tank in accessible position. The cranking device/handle for manual operation for OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with the following:

- Mechanical tap position indicator which shall be clearly visible from near the transformer.
- A mechanical operation counter of at least five digits shall be fitted to indicate the number of operations completed and shall have no provision for resetting. Mechanical stops to prevent over- cranking of the mechanism beyond the extreme tap positions.
- The manual control considered as backup to the motor operated on load tap changer control shall be interlocked with the motor to block motor start-up during manual operation.
- The manual operating mechanism shall be labeled to show the direction of operation for raising the voltage and vice-versa.
- An electrical interlock to cut-off a counter impulse for reverse step change being initiated during a progressing tap change and until the mechanism comes to rest and resets circuits for a fresh position.

3.7.2.2.3 For electrical operation from local as well as remote, motor operated mechanism shall be provided. It shall not be possible to operate the electric drive when the manual operating gear is in use. It shall not be possible for any two controls to be in operation at the same time. Transfer of source in the event of failure of one AC supply shall not affect the tap changer. Thermal device or other means shall be provided to protect the motor and control circuit.

3.7.2.2.4 The Local OLTC Drive Mechanism Box shall house all necessary devices meant for OLTC control and indication. It shall be complete with the followings:

i. A circuit breaker/contactor with thermal overload devices for controlling the AC Auxiliary supply to the OLTC motor
ii. Emergency Push Button to stop OLTC operation
iii. Cubicle light with door switch
iv. Provided with anti-condensation metal clad heaters to prevent condensation of moisture
v. Padlocking arrangement for hinged door of cabinet
vi. All contactors relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.
vii. The cabinet shall be tested at least IP55 protection class.

3.7.2.2.5 All relays and operating devices shall operate correctly at any voltage within the limits specified in Chapter-GTR. Incase auxiliary power supply requirement for OLTC DM Box is different than station auxiliary AC supply, then all necessary converters shall be provided by the Contractor.

3.7.2.2.6 Operating mechanism for on load tap changer shall be designed to go through

one step of tap change per command only, until the control switch is returned to the off position between successive operations/repeat commands.

3.7.2.2.7 Limit switches shall be provided to prevent over running of the mechanism and shall be directly connected in the control circuit of the operating motor provided that a mechanical de-clutching mechanism is incorporated. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. An interlock to cut-out electrical control when it tends to operate the gear beyond either of the extreme tap positions.

3.7.2.2.8 OLTC local control cabinet shall be provided with tap position indication for the transformer. Drive Mechanism shall be equipped with a fixed resistor network capable of providing discrete voltage steps or provide 4-20mA transducer outputs for tap position indication in CMB (for single phase unit) and input to Digital RTCC/SCADA system.

3.7.2.2.9 'Local-remote' selector switch shall be provided in the local OLTC control cabinet. In Local mode, all electrical commands from remote (i.e. from CMB, Digital RTCC, SCADA etc.) shall be cut-off/blocked. Electrical operations to change tap positions shall be possible by using raise/lower push buttons under local mode from DM Box. In remote mode electrical commands from CMB/Digital RTCC/SCADA etc. shall be executed. The remote-local selector switch shall be having at-least two spare contacts per position.

3.7.2.2.10 Following minimum contacts shall be available in DM Box, which shall be wired to CMB for single phase unit. Further these contacts shall be wired to Digital RTCC panel:

a. INCOMPLETE STEP which shall not operate for momentary loss of auxiliary power.
b. OLTC motor overload protection
c. Supply to DM Motor fail
d. OLTC INPROGRESS
e. Local / Remote Selector switch position
f. OLTC upper/lower limits reached

3.7.2.2.11 All relays, switches, fuses etc. shall be mounted in the OLTC local control cabinet and shall be clearly marked/labeled for the purpose of identification.

3.7.2.2.12 A permanently legible lubrication chart if required shall befitted within the OLTC local control cabinet.

3.7.2.3 OLTC Control from Common Marshalling Box (CMB)

3.7.2.3.1 It shall be possible to monitor, control/operate, the OLTC of all the three 1- phase transformers of a transformer bank from Common Marshalling Box. The control and monitoring terminations of a spare transformer unit shall be brought to CMB. The necessary switching arrangement through male-female plug-in TB assembly shall be provided for replacing spare unit with any one of the faulty phase unit for monitoring & control from CMB.

3.7.2.3.2 'Independent-combined-remote selector switch, raise/lower switch and emergency

stop Push Button shall be provided in the common marshalling box for OLTC control.

3.7.2.3.3 When the selector switch is in independent position, the OLTC control shall be possible from individual Local OLTC Control Cabinet (DM Box) only.

3.7.2.3.4 In '**combined position'**, raise-lower switch (provided in the CMB), shall be used to operate for bank of three single phase transformers from CMB.

3.7.2.3.5 In **'remote position'** control of OLTC shall be possible from Digital RTCC/SCADA etc.

3.7.2.3.6 From CMB, the operation of OLTC shall be for 3-phases of transformer units without producing phase displacement. Independent operation of each single phase transformer from CMB/Digital RTCC/SCADA will be prevented.

3.7.2.3.7 Following minimum **LED indications** shall be provided in CMB:

a. INCOMPLETESTEP
b. OLTC motor overload protection
c. Supply to DM Motor fail
d. OLTC IN PROGRESS
e. Local / Remote Selector switch positions of DM
f. OLTC upper/lower limits reached
g. 400V Main AC supply ON
h. 400V Standby AC supply ON

Following **contacts** shall be wired to TBs in CMB for further wiring to C & R Panels.

i. 400V Main AC supply Fail
j. 400V Standby AC supply Fail

Following **contacts** shall be wired to TBs in CMB for further wiring to digital RTCC Panel:

a. INCOMPLETESTEP
b. OLTC motor overload protection
c. Supply to DM Motorfail
d. OLTC INPROGRESS
e. Local / Remote Selector switch positions of DM
f. OLTC upper/lower limits reached
g. 'Independent-combined-remote' selector switch positions of CMB

Further, OLTC Tap position Digital indications for all three 1-PhTransformer units either separately or through selector switch shall be provided in CMB. The same shall also be wired to Digital RTCC Panel to display tap positions for all three 1-ph unit separately.

3.7.3 Digital RTCC Panel

3.7.3.1 The digital RTCC panel shall have Automatic Tap Changer control and monitoring

relay with Automatic Voltage Regulating features (referred as **Digital RTCC relay**) to remotely control and monitor OLTC. The relay shall be offered from the manufacturer who has already supplied Digital RTCC relay, which is in operation for at-least 2 years for transformer OLTC application.

3.7.3.2 Digital RTCC relay shall be microprocessor based adopting the latest state of the art design & technology within-built large display for ease of programming and viewing. The unit supplied shall be field programmable so that in the event of change in transformer / location, it could be customized to site conditions without sending back to works. The programming shall be menu driven and easily configurable. If it is designed with draw out type modules, it should take care of shorting all CT inputs automatically while drawing out. The CT/VT ratio shall be field programmable and Relay shall display the actual HV Voltage and current considering suitable multiplying factors. The system shall be self-sufficient and shall not require any additional devices like parallel balancing module etc. All Digital RTCC Relays shall be of same make for smooth integration of these relays for parallel operations of all transformers in the substation.

3.7.3.3 The digital RTCC Panel shall be provided with digital RTCC relay having Raise/Lower push buttons, Manual/ Automatic mode selection features, Master / Follower/ Independent/ off mode selection features and emergency stop Push Button for control of OLTC. Touch screen option in the relay, instead of electrical push button/switch is also acceptable.

3.7.3.4 **In Manual Mode**: In this mode, power system voltage based automatic control from digital RTCC relay shall be blocked and commands shall be executed manually by raise/lower push buttons.

3.7.3.5 **In Auto Mode:** In Auto mode, digital RTCC relay shall automatically control OLTC taps based on power system voltage and voltage set points. An interlock shall be provided to cut off electrical control automatically upon recourse being taken to the manual control in emergency.

3.7.3.6 Master/Follower/Independent/Off mode

Master Position: If the selector switch is in master position, it shall be possible to control the OLTC units of other parallel operating transformers in the follower mode by operation from the master unit.

Follower Position: If the selector switch is in Follower position control of OLTC shall be possible only from panel where master mode is selected.

Independent Position: In independent position of selector switch, control of OLTC shall be possible only from the panel where independent mode is selected. Suitable interlock arrangement shall be provided to avoid unwanted/ in consistent operation of OLTC of the transformer

3.7.3.7 **Raise/Lower control:** The remote OLTC scheme offered shall have provision to raise or lower taps for the complete bank of three 1-phase transformers/3-Phase Transformers. Individual 1-phase OLTC operation shall not be possible from the

remote control panel.

3.7.3.8 Digital RTCC relays shall communicate with SCADA using IEC 61850 protocols to monitor, parameterize & control the OLTC. Any software required for this purpose shall be supplied. The supplied software shall not have restriction in loading on multiple computers for downloading and analyzing the data. Software shall indicate the current overview of all measured parameters of the connected transformer in real time. The digital RTCC Relay shall have multiple selectable set point voltages and it shall be possible to select the set points from SCADA, with a facility to have the possibility of additional set points command from SCADA. Communication between the Digital RTCC relays to execute the commands for parallel operation shall be implemented using required communication protocol. IEC-61850 GOOSE messaging between Digital RTCC relays for OLTC parallel operation is not permitted. Suitable communication hardware shall be provided to communicate upto distance of 1km between digital RTCC relays. Scope shall also include communication cables between digital RTCC relays. Cables as required for parallel operation of OLTCs of all transformers (including existing transformers wherever required) from Digital RTCC relays shall be considered included in the scope of bidder.

3.7.3.9 The Digital RTCC relay shall have programmable Binary Inputs (minimum 7 Nos.) and Binary outputs (minimum 7 Nos.) for Employer's future use. It shall be possible to have additional module for Binary Input/output as well as Analogue input module depending upon requirement.

3.7.3.10 The relays shall ensure positive completion of lowering/raising of the OLTC tap, once the command is issued from the relay."Step-by-Step" operation shall be ensured so that only one tap change from each tap changing pulse shall be effected. If the command remains in the "operate" position, lock-out of the mechanism is to be ensured.

3.7.3.11 Following minimum indications/alarms shall be provided in Digital RTCC relay either through relay display panel or through relay LEDs:

a. INCOMPLETE STEP alarm
b. OLTC motor overload protection alarm
c. Supply to DM Motor fail alarm
d. OLTC IN PROGRESS alarm
e. Local/Remote Selector switch positions in DM Box
f. OLTC upper/lower limits reached alarm
g. OLTC Tap position indications for transformer units
h. 'Independent-combined-remote selector switch positions of CMB

3.7.3.12 In case of parallel operation or 1-PhaseTransformer unit banks OLTC out of step alarm shall be generated in the digital RTCC panel for discrepancy in the tap positions.

3.8 Auxiliary Power Supply of OLTC, Cooler Control and Power Circuit

3.8.1 Two auxiliary power supplies, 400 volt, three phase four (4) wire shall be provided by the Employer at cooler control cabinet for OLTC and cooler control and power circuit.

3.8.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in the cooler control cabinet for on load tap changer control and cooler circuits.

Design features of the transfer switch shall include the following:

a) Provision for the selection of one of the feeder as normal source and other as standby.

b) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to standby sources.

c) Indication to be provided at cooler control cabinet for failure of normal source and for transfer to standby source and also for failure to transfer.

d) Automatic re-transfer to normal source without any intentional time delay following re-energization of the normal source.

e) Both the transfer and the re-transfers shall be dead transfers and AC feeders shall not be paralleled at any time.

3.8.3 Power Supply for OLTC Circuits

a) AC feeder shall be brought to the local OLTC control cabinet by the Contractor after suitable selection at cooler control cabinet for which description is given in 3.10.2 above, for control power circuit of OLTC.

b) The Contractor shall derive AC power for OLTC control circuitry from the AC feeder as mentioned above by using appropriately rated dry type transformers. If the control circuit is operated by DC supply, then suitable main and standby converters shall be provided by the Contractor to be operated from AC power source.

3.8.4 Power Supply for Cooler Circuits

3.8.4.1 Control and power supplies are to be given for Cooler circuits after the selection as mentioned above.

3.8.4.2 The Contractor shall derive AC power for Cooler Control Circuitry by using appropriately rated dry type transformer in case of using supply voltage different from the Employer's auxiliary supply. If the control circuit is operated by DC supply then suitable main and standby convertors shall be provided by the Contractor, to be operated from AC power source.

3.8.5 Necessary isolating switches and MCBs/MCCBs shall be provided at suitable points as per Employer's approved scheme**.**

3.9 Constructional features of Cooler Control Cabinet/ Individual Marshalling Box/Common Marshalling Box and Digital RTCC Panel

3.9.1 Each transformer unit shall be provided with local OLTC Drive Mechanism Box, cooler control cabinet/individual marshalling box. Digital RTCC panel and common marshalling (for a bank of three 1-phase units) shall be provided.

3.9.2 The cooler control cabinet, Individual Marshalling Box, Common Marshalling Box, shall be made of stainless steel sheet of at least 1.6mm thick. Digital RTCC panel

shall be CRCA sheet of minimum thickness of 2.5mm and shall be painted suitably as per **Annexure–E**.

3.9.3 The degree of protection shall be IP: 55 for outdoor and IP: 43 for indoor in accordance with IS: 13947/IEC: 60947.

3.9.4 All doors, removable covers and plates shall be gasketed all around with suitably profiled. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion to make a tight seal. For Control cubicle / Marshalling Boxes etc. which are outdoor type, all the sealing gaskets shall be of EPDM rubber or any better approved quality, whereas for all indoor control cabinets /Digital RTCC panel, the sealing gaskets shall be of neoprene rubber or any better approved quality. The gaskets shall be tested in accordance with approved quality plan, IS: 1149 and IS: 3400.

3.9.5 Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh of brass. All the control cabinets shall be provided with suitable lifting arrangement. Thermostat controlled space heater and cubicle lighting with ON-OFF switch shall be provided in each panel.

3.9.6 The size of Common marshalling box shall not be less than 1600mm (front) X 650mm (depth) X 1800mm (height). All the cabinets except common marshalling box & Digital RTCC shall be tank mounted. All the separately mounted cabinets and panels shall be free standing floor mounted type and have domed or sloping roof for outdoor application.

4 Fittings

4.1 The following fittings shall be provided with each three phase transformer covered in this specification.

4.1.1 Conservator for main tank with oil filling hole and cap, air cell, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating silicagel breather.

4.1.2 Pressure relief devices with alarm/trip contacts.

4.1.3 Buchholz relay double float/reed type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.

4.1.4 Air release plug.

4.1.5 Inspection openings and covers.

4.1.6 Bushing with metal parts and gaskets to suit the termination arrangement.

4.1.7 Winding temperature indicators for local and remote mounting. One remote winding temperature indicator with a four point selector switch shall be provided for the three windings for three phase unit to have selection of any of the three windings.

4.1.8 Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.

4.1.9 Protected type mercury or alcohol in glass thermometer.

4.1.10 Bottom and top filter valves with threaded male adaptors, bottom sampling valve and drain valve.

4.1.11 Rating and diagram plates on transformers and auxiliary apparatus.

4.1.12 Flanged bi-directional wheels/Trolley for movement

4.1.13 Cooler cabinet.

4.1.14 Off load / On load tap changing gear.

4.1.15 Cooling equipment

4.1.16 Bushing current transformers.

4.1.17 Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

4.1.18 Terminal marking plates.

4.1.19 Valves schedule plates.

4.1.20 Oil temperature indicator for local and remote mounting
.

4.1.21 Oil flow indicator

4.1.22 Marshalling box/Common Marshalling box

4.1.23 Suitable galvanized iron or stainless steel tray for cabling on main tank for better aesthetics.

4.1.24 Terminal clamp & connector

4.1.25 The fittings listed above are only indicative and other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

4.1.26 One set of hand tools of reputed make packed in a carry bag/box broadly comprising of double ended spanners (open jaws, cranked ring, tubular with Tommy bar each of sizes 9mm to 24mm, one set each), adjustable wrenches (8 &12 inch one set), gasket punches (of different sizes as used in the reactor one set), pliers (flat nose, round nose & side cutting one of each type), hammer with handle (one), files with handle (two), knife with handle (one), adjustable hacksaw (one), and cold chisel (one) shall be supplied per Substation.

4.2 NITROGEN INJECTION FIRE PROTECTION CUM EXTINGUISHING SYSTEM (NIFPES) FOR 45 and 63 MVA POWER TRANSFORMER

The contractor shall provide the nitrogen injection fire protection cum extinguishing system. The fire protection system using nitrogen as fire quenching medium is required for the 45 MVA & 63 MVA, 132/66kV & 132/11kV transformer NIFPES shall act as fire preventer by preventing transformer oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc, it shall act as a fast and effective fire fighter.

NIFPES shall accomplish its role as fire preventer and extinguisher without employing water and/or carbon dioxide. Fire shall be put out within max. 3 minutes of system activation and within max. 30 seconds of commencement of nitrogen injection.

4.2.1 **Activation of NIFPES**

Mal-functioning of fire prevention/extinguishing systems is their major shortcoming which leads to interruption in power supply. The contractor shall ensure that the chances of malfunctioning of NIFPES are practically nil. To achieve this objective, the contractor shall work out his scheme of activating signals which, while preventing mal-operation, should not be too rigorous to make the operation of NIFPES impracticable in case of actual need. Transformer isolation shall be the mandatory pre-requisite for activation of the system in automatic mode or remote mode in the control room. In addition, at least following electrical-signals shall be provided in series for activating NIFPES.

4.2.2 **Auto Mode**

a) For prevention of fire:

i) Differential relay operation

ii) Buchholz relay paralleled with pressure relief valve

iii) Tripping of all connected breakers is a pre-requisite for initiation of system activation.

b) For extinguishing fire:

i) Fire detector

ii) Buchholz relay paralleled with pressure relief valve

iii) Tripping of all connected breakers is a pre-requisite for initiation of system activation.

Manual Mode (Local/Remote): Tripping of all connected breakers is pre- requisite for initiation of system activation.

Manual Mode (Mechanical): Tripping of all connected breakers is a pre- requisite for initiation of system activation.

4.2.3 **General description of NIFPES**

Schematic of the system

NIFPES should be a standalone dedicated system for oil filled transformer. It should have a fire extinguishing (F.E.) cubicle placed on a plinth at a distance of 6-10 mtrs from the transformer. The F.E. cubicle may be connected to the transformer oil tank (near its top) and to the oil pit (of capacity approx. equal to 10% of transformer oil tank) from its bottom through oil pipes with gate valves. The F.E. cubicle should house a pressurized nitrogen cylinder connected to the transformer oil tank (near its bottom). Cable connections are to be provided from signal box placed on the transformer to the control box in the control room and from control box to F.E. cubicle. Fire detectors placed at the top of transformer are to be connected in parallel to the signal box. The signal box may be connected to a

Pre-stressed non-return valve fitted between the conservator tank and Buchholz relay. Control box is also to be connected to relay panel in control room for system activation signals.

4.2.4 **Operation**

On receipt of all activating signals, drain of pre-determined quantity of oil commences thus removing high temp top oil layer. Simultaneously nitrogen is injected under high pressure at a pre-fixed rate, stirring the oil thus bringing the temperature of top oil layer down. Nitrogen occupies the space created by oil drained out and acts as an insulating layer between the tank oil and fire on top cover. Pre-stressed non-return valve blocks oil flow from conservator tank, thus isolating it & preventing aggravation of fire.

4.2.5 **System components**

Broadly, NIFPES shall consist of the following components. It is emphasized that all components, irrespective of their exclusion in the details given below, necessary for fast reliable and effective working of NIFPES shall be considered within the scope of supply.

4.2.6 **Fire extinguishing cubicle**

It shall be made of 3 mm thick steel sheet, painted dark red from inside and outside with hinged split doors fitted with high quality tamper proof lock. It shall be complete with the base frame and the following:-

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer. 12
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system.
- Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.
- Panel lighting (CFL type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil pit.

4.2.7 **Control box**

Control box for monitoring system operation, automatic control and remote operation, with following alarms indication, light switches, push buttons, audio signal, line fault detection suitable for tripping and signaling on 110V DC supply.

- System on
- PNRV open
- Oil drain valve closed
- Gas inlet valve closed

- PNRV closed
- Fire detector trip
- Buchholz relay trip
- Oil drain valve open
- Extinction in progress
- Cylinder pressure low
- Differential relay trip
- PRV operated
- Transformer trip
- System out of service
- Line fault fire detector
- Line fault differential relay
- Line fault buchholz relay
- Line fault PRV
- Line fault transformer trip
- Line fault PNRV
- Auto / Manual/Off
- Extinction release on
- Extinction release off
- Lamp test
- Visual/Audio alarm
- Visual/Audio alarm
- Visual/audio alarm for DC supply fail

4.2.8 **Pre-stressed non return valve (PNRV)**

PNRV is to be fitted in the conservator pipe line between conservator and Buchholz relay. It shall have the proximity switch for remote alarm, indication and with visual position indicator the valve will not isolate conservator during, normal flow of oil during filtration or filling, Locking plates shall be provided with handle for pad locking to ensure no movement for valve position during service and filter position . The PNRV should be of the best quality because malfunction of PNRV shall be of serious consequence as its closing leads to stoppage of breathing of transformer.

4.2.9 **Fire detectors**

The system shall be complete with adequate number of fire detectors fitted on the top of oil tank, OLTC/OFF circuit tap changer for heat sensing each fitted with two no. cable glands (water proof/weather proof).

4.2.10 **Signal box**

It shall be fitted on the transformer for terminating cable connections form PNRV and fire detectors and for further connection to the control box.

4.2.11 **Cables**

Fire survival copper cables, able to withstand 750 degree C, Fire retardant low smoke (FRLS) cable 12 core x 1.5 mm sq. for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used. Fire retardant low smoke cable 4 core x 1.5mm sq. for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal Box/marshalling box to pre-stressed non return valve connection on transformer shall be used.

4.2.12 **Pipes**

Pipes, complete with connections, flanges, bends tees etc. shall be supplied alongwith the system.

4.2.13 **Other items**

A. Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.

B. Flanges with dummy piece in conservator pipe between Buchholz relay and conservator tank for fixing PNRV.

C. Fire detector brackets on transformer top cover.

D. Spare potential free contacts for system activating signals i.e. differential relay buchholz relay, pressure relief valve, transformer isolation (master trip relay).

E. Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

F. Cabling on transformer top cover for fire detectors to be connected in parallel and inter cabling between signal box to control box and control box to fire extinguishing cubicle.

G. Mild steel oil tank with moisture proof coating and sheet thickness of minimum 5 mm, with watertight cover, to be placed in the oil pit. This tank shall be provided with the manhole, air vent pipe through silica gel breather, drain valve and a spare gate valve at the top.

H. The capacity of tank shall be 10,000 liters and shall be provided as each Substation. The location of the tank shall be approved by the employer. All the Transformers to be fitted with NISPEF at that Substation. shall be connected through suitable piping arrangement to this common tank.

I. DC-DC converter 220-110V DC (optional, incase 110V, supply is not available.)

J. Gate valves on oil drain pipe and nitrogen injection pipe should be able to withstand full vacuum. A non-return valve shall also be fitted on nitrogen injection pipe between transformer and gate valve.

K. The F.E. cubicle shall be painted with post office red color (shade 538 of IS-5). All the exposed parts i.e. pipes, supports, signal box etc shall be painted with enameled paint.

L. Civil works of Fire extinguishing cubicle

4.2.14 **Interlocks**

It shall be ensured that once the NIFPES gets activated manually or in auto mode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PNRV shall get closed only if all the connected breakers are open.

Technical particulars

I.	Fire extinction period	
On commencement of nitrogen injection		Max. 30 Seconds
II.	From the moment of system activation to	Max. 3 Minutes
III.	Complete cooling	14
IV.	Fire detectors heat sensing temperature	141Deg C
V.	Heat sensing area	800mm radius
VI.	Pre-stressed non return valve setting	Minimum 40 liter per minute for normal operation and minimum 60 liter per minute for abnormal operation
VII.	Min. Capacity of nitrogen cylinder	10 m^3 gas at pressure of 150kg/cm^3 upto 60000 litre oil capacity of tank and 20m^3 gas at pressure of 150kg/cm^2 above 60000 liter.
VIII.	Power Source (Control Box)	110V DC
IX.	Fire extinguishing cubicle for lighting	230V AC

5 Inspection and Testing

The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the equipment. An indication of inspection envisaged by the Employer is given under Clause 5.1. This is however not intended to form a comprehensive programme as it is Contractor's responsibility to draw up and carry out such a programme in the form of detailed quality plan duly approved by Employer for necessary implementation.

5.1 Inspection

5.1.1 Tank and Conservator

5.1.1.1 Certification of chemical analysis and material tests of plates.

5.1.1.2 Check for flatness.

5.1.1.3 Electrical interconnection of top and bottom by braided tinned copper flexibles.

5.1.1.4 Welder's qualification and weld procedure.

5.1.1.5 Testing of electrodes for quality of base materials and coatings.

5.1.1.6 Inspection of major weld preparation.

5.1.1.7 Crack detection of major strength weld seams by dye penetration test.

5.1.1.8 Measurement of film thickness of :

i) Oil insoluble varnish.

ii) Zinc chromate paint.

iii) Finished coat.

5.1.1.9 Check correct dimensions between wheels, demonstrate turning of wheels through 90 deg C and further dimensional check.

5.1.1.10 Check for physical properties of materials for lifting lugs, jacking pads, etc. All load bearing welds including lifting lug welds shall be subjected to NDT.

5.1.1.11 Leakage test of the conservator.

5.1.1.12 Certification of all test results.

5.1.2 **Core**

5.1.2.1 Sample testing of core materials for checking specific loss, bend properties, nameled tion characteristics and thickness.

5.1.2.2 Check on the quality of varnish if used on the stampings :

i) Measurement of thickness and hardness of varnish on stampings.

ii) Solvent resistance test to check that varnish does not react in hot oil.

iii) Check over all quality of varnish by sampling to ensure uniform shining colour, no bare spots, no over burnt varnish layer and no bubbles on varnished surface.

5.1.2.3 Check on the amount of burrs.

5.1.2.4 Bow check on stampings.

5.1.2.5 Check for the overlapping of stampings. Corners of the sheet are to be part.

5.1.2.6 Visual and dimensional check during assembly stage.

5.1.2.7 Check for interlaminar insulation between core sectors before and after pressing.

5.1.2.8 Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

5.1.2.9 High voltage test (2 kV for one minute) between core and clamps.

5.1.2.10 Certification of all test results.

5.1.3 **Insulation Material**

5.1.3.1. Sample check for physical properties of materials.

5.1.3.2 Check for dielectric strength.

5.1.3.3 Visual and dimensional checks.

5.1.3.4 Check for the reaction of hot oil on insulating materials.

5.1.3.5 Dimension stability test at high temperature for insulating material.

5.1.3.6 Tracking resistance test on insulating material

5.1.3.7 Certification of all test results.

5.1.4 **Winding**

5.1.4.1 Sample check on winding conductor for mechanical properties and electrical conductivity.

5.1.4.2 Visual and dimensional checks on conductor for scratches, dent marks etc.

5.1.4.3 Sample check on insulating paper for pH value, bursting strength and electric strength.

5.1.4.4 Check for the reaction of hot oil on insulating paper.

5.1.4.5 Check for the bonding of the insulating paper with conductor.

5.1.4.6 Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.

5.1.4.7 Check for absence of short circuit between parallel strands.

5.1.4.8 Check for brazed joints wherever applicable.

5.1.4.9 Measurement of voltage ratio to be carried out when core/yoke is completely restacked and all connections are ready.

5.1.4.10 Conductor enamel test for checking of cracks, leakage and pin holes.

5.1.4.11 Conductor flexibility test

5.1.4.12 Heat shrink test for anameled wire.

5.1.4.13 Certification of all test results.

5.1.5 **Checks Before Drying Process**

5.1.5.1 Check condition of insulation on the conductor and between the windings.

5.1.5.2 Check insulation distance between high voltage connections, cables and earth and other live parts.

5.1.5.3 Check insulating distances between low voltage connections and earth and other parts.

5.1.5.4 Insulation of core shall be tested at 2 kV/minute between core to bolts and core to clamp plates.

5.1.5.5 Check for proper cleanliness and absence of dust etc.

5.1.5.6 Certification of all test results.

5.1.6 **Checks During Drying Process**

5.1.6.1 Measurement and recording of temperature, vacuum and drying time during vacuum treatment.

5.1.6.2 Check for completeness of drying by periodic monitoring of IR and Tan delta.

5.1.6.3 Certification of all test results.

5.1.7 **Assembled Transformer**

5.1.7.1 Check completed transformer against approved outline drawings, provision for all fittings, finish level etc.

5.1.7.2 Test to check effective shielding of the tank.

5.1.7.3 Jacking test with oil on all the assembled transformers.

5.1.7.4 Dye penetration test shall be carried out after the jacking test.

5.1.8 **Bought Out Items**

5.1.8.1 The makes of all major bought out items shall be subject to Employer's approval.

5.1.8.2 The Contractor shall also prepare a comprehensive inspection and testing programme for all bought out/sub-contracted items and shall submit the same to the Employer for approval. Such programme shall include the following components:

a) Buchholz Relay.

b) Axles and wheels.

c) Winding temperature indicators for local and remote mounting.

d) Oil temperature indicators.

e) Bushings.

f) Bushing current transformers.

g) Cooler cabinet.

h) ON Load / Off Load Tap change gear.

i) Oil pumps.

j) Terminal connectors.

k) Pressure relief device relay

l) Cables used for interconnecting Turret CT, equipment relays (exposed), with marshalling box.

The above list is not exhaustive and the Contractor shall also include other bought out items in his programme.

5.1.9 **Pre-Shipment Checks at Manufacturer's Works**

5.1.9.1 Check for interchangeability of components of similar transformers for mounting dimensions.

5.1.9.2 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

5.1.9.3 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

5.1.9.4 Gas tightness test to confirm tightness and record of dew point of gas inside the tank.

5.1.9.5 Derivation of leakage rate and ensure the adequate reserve gas capacity.

5.1.9.6 Measure and record the dew point of dry air /Nitrogen at the time of filling and after 24 hours in the transformer tank. Dew point of dry air / nitrogen at the time of transformer dispatch should be better than (-) 30 deg C. Also the dew point of dry air / nitrogen cylinders attached for make up during transportation should of the order of (-) 50 deg C.

5.1.9.7 Functioning of impact recorder(s) at their works before installing on the tank.

5.2 Factory Tests

The manufacturer shall be fully equipped to perform all the required tests as specified. Bidder shall confirm the capabilities of the proposed manufacturing plant in this regard when submitting the bid. Any limitations shall be clearly stated in. The contractor shall bear all additional costs related to tests which are not possible to carry out at his own works. Procedure for some of tests is given at annexure-I.

The contractor shall submit an Inspection and test plan (ITP) for approval. A typical test plan is indicated below.

No.	Item	Test Category
1.	Measurement of winding resistance	Routine

2.	Voltage ratio measurement	Routine
3.	Polarity & Vector group test	Routine
4.	No-load loss and current measurement	Routine
5.	Impedance voltage and load loss measurement	Routine
6.	Measurement of insulation resistance & Polarization Index	Routine
7.	Measurement of insulation power factor and capacitance between winding and earth	Routine
8.	Measurement of insulation power factor and capacitance of bushings	Routine
9.	Lightning impulse test	Routine
10a	Short duration induced AC withstand Test (ACSD) with PD measurement	Routine
11.	Separate source voltage withstand test	Routine
12.	On-load tap changer test (Ten complete cycle before LV test)	Routine
13.	Gas-in-oil analysis	Routine
14.	Core assembly dielectric and earthing continuity test	Routine
15.	Oil leakage test on transformer tank	Routine
16.	Appearance, construction and dimension check	Routine
17.	Magnetic balance test	Routine
18.	Measurement of no load current & Short circuit impedance with 400 V, 50 Hz AC.	Routine
19.	High voltage with stand test on auxiliary equipment and wiring after assembly	Routine
20.	Tank vacuum test	Routine
21.	Tank pressure test	Routine
22.	Frequency response analysis (Soft copy of test report in sfra format to be submitted to site along with O & M manual)	Routine
23.	Temperature rise test	*Type
24.	Measurement of harmonic level in no load current	*Type
25.	Measurement of acoustic noise level	*Type
26.	Measurement of Zero seq. reactance	*Type
27.	Measurement of power taken by fans and oil pumps	*Type

All tests shall be done in line with IEC: 60076 and as per “Annexure-A”. Complete test report shall be submitted to purchaser after proper scrutiny and signing on each page by the test engineer of the manufacturer. * Type test shall be carried out at first unit manufactured against the LOA at each manufacturing plant.

5.2.1 Measurement of capacitance and tan delta to determine capacitance between winding and earth. Tan delta value shall not be more than 0.5% at ambient temperature.

5.2.2 Measurement of capacitance and tan delta of OIP bushings. Tan delta value shall not be more than 0.4% at ambient temperature.

5.2.3 Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings as per the clause no. 9.0 of the Chapter2 – GTR. The list of fittings and the type test requirement is:

1. Bushing (Type Test as per IEC: 60137, including snap back/seismic test)

2. Buchholz relay (Type Test as per IEC and IP-55 Test on terminal box)

3. OLTC (Temperature Rise of contact, Short circuit current test, Mechanical test and Dielectric Test as per IEC: 60214 and IP-55 test on driving mechanism box).

4. Cooling fan and motor assembly – Free air delivery, Temperature rise, sound level, running at reduced voltage, IP-55 degree of protection for terminal box.

5. Air Cell (Flexible air separator) – Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per BS: 903.

6. Cooler Control cabinet (IP-55 test)

7. Pressure Relief device Test

The pressure Relief Device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test above.. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released.

The terminal box / boxes of PRD should conform to degree of protection as per IP-55.

8. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.

9. OTI & WTI – Switch setting & operation, switch differential, switch rating.

5.2.4 **Pre-Shipment Checks at Manufacturer's Works**

5.2.5 Check for interchangeability of components of similar transformers for mounting dimensions.

5.2.6 Check for proper packing and preservation of accessories like radiators, bushings, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.

5.2.7 Check for proper provision for bracing to arrest the movement of core and winding assembly inside the tank.

5.2.8 Gas tightness test to confirm tightness and record of dew point of gas inside the tank.

5.2.9 Derivation of leakage rate and ensure the adequate reserve gas capacity.

5.2.10 Measure and record the dew point of dry air /Nitrogen at the time of filling and after 24 hours in the transformer tank. Dew point of dry air / nitrogen at the time of transformer despatch should be better than (-) 30 deg C. Also the dew point of dry air / nitrogen cylinders attached for make up during transportation should of the order of (-) 50 deg C.

5.3 **Inspection and Testing at Site**

The Contractor/Manufacturer shall carry out a detailed inspection and testing programme for field activities covering areas right from the receipt of material

stage upto commissioning stage. An indicative programme of inspection as envisaged by the Employer is given below. Pre commissioning Procedures and Formats for equipments shall be contractor's responsibility to draw up and carry out such a programme.

5.3.1 **Receipt and Storage Checks**

5.3.1.1 Check and record condition of each package, visible parts of the transformer etc. for any damage.

5.3.1.2 Check and record the gas pressure in the transformer tank as well as in the gas cylinder. Measure and record the dew point of dry air /nitrogen in the transformer tank.

5.3.1.3 Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.

5.3.2 **Installation Checks**

5.3.2.1 Inspection and performance testing of accessories like tap changers etc.

5.3.2.2 (i) Check the direction of rotation of fans .

(ii) Check the bearing lubrication.

5.3.2.3 Check whole assembly for tightness, general appearance etc.

5.3.2.4 Oil leakage test

5.3.2.5 Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.

5.3.2.6 Leakage test on bushing before erection.

5.3.2.7 Measure and record the dew point of nitrogen/dry air in the main tank before assembly. Manufacturer shall submit dew point acceptable limits along with temperature correction factor and shall form part of instruction manual. In case dew point values are not within permissible limit suitable drying out process shall be applied for dry out of active part in consultation with the Manufacturer.

5.3.2.8 **Oil filling.**

5.3.2.8.1 Oil impregnation or drying under vacuum at site shall be done with the transformer and oil at a temperature not exceeding 70 deg C.

5.3.2.8.2 The duration of the vacuum treatment shall be demonstrated as adequate by means of water measurement with a cold trap or other suitable method. The vacuum shall be measured on the top of the transformer tank and should be less than 1mbar.

5.3.2.8.3 Vacuum shall not be broken until the transformer is oil filled up to the Buchholz relay. Whenever the active insulation or any paper insulated HV connections, especially those from the windings to the bushings are exposed, these shall be re-impregnated under vacuum along with the complete transformer. For this purpose the transformer shall first be drained to expose all insulation material.

5.3.2.8.4 The minimum safe level of oil filling (if different from the Buchholz level) to which the transformer shall be oil filled under vacuum, shall be indicated in the manual.

5.3.2.8.5 Procedures for site drying, oil purification, oil filling etc shall be submitted for approval and complete instructions shall form part of the manual.

5.3.3 **Commissioning Checks**

5.3.3.1 Check the colour of silicagel in silicagel breather.

5.3.3.2 Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.

5.3.3.3 Check the bushing for conformity of connection to the lines etc,

5.3.3.4 Check for correct operation of all protection devices and alarms :

(i) Buchholz relay.

(ii) Excessive winding temperature.

(iii) Excessive oil temperature.

(iv) Low oil flow.

(v) Low oil level indication.

(vi) Fan and pump failure protection.

5.3.3.5 Check for the adequate protection on the electric circuit supplying the accessories.

5.3.3.6 Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:

(i) Control wiring.

(ii) Main windings.

5.3.3.7 Check for cleanliness of the transformer and the surroundings.

5.3.3.8 Continuously observe the transformer operation at no load for 24 hours.

Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.

5.3.3.9 Phase out and vector group test.

5.3.3.10 Ratio test on all taps.

5.3.3.11 Magnetising current test.

5.3.3.12 Capacitance and Tan delta measurement of winding and bushing.

5.3.3.13 DGA of oil just before commissioning and after 24 hours energisation at site.

5.3.3.14 Frequency response analysis (FRA) at site by the equipment to be provided by the bidder.

5.3.3.15 Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to Employer for future record.

6.0 Technical Parameters

Technical Particulars / Parameters of Transformers
(132/22(11) kV, 3-Phase Transformer)

Cl. No.	Description	Unit	TECHNICAL PARAMETERS
1.1	**Rated Capacity**		
	HV	MVA	31.5/45
	LV	MVA	31.5/45
1.2	Rated Voltage ratio (HV/LV) (Line to line)	kV	132/11
1.3	Single / Three Phase Design		Three
1.4	Applicable Standard		IEC 60076
1.5	Frequency	Hz	50
1.6	Cooling		ONAN / ONAF
1.7	Rating at different cooling	%	70/100
1.8	Type of Transformer		Constant Ohmic impedance type (Refer Note1)
1.9	**HV-LV Impedance at 75 Deg C at**		
i)	Max. Voltage tap	%	
ii)	Principal tap	%	> 11
iii)	Min. Voltage tap	%	
1.10	Service		OUTDOOR
1.11	Duty		Continuous
1.12	Overload Capacity		IEC 60076-7
1.13	**Temperature rise over 50 deg C Ambient Temp**		
i)	Top oil measured by thermometer	Deg C	50
ii)	Average winding measured by resistance method	Deg C	55
1.14	**Windings**		
i)	System Fault level		
	HV	kA	31.5
	LV	kA	25
ii)	Lightning Impulse withstand Voltage		
	HV	kVp	550
	LV	kVp	75
	HV Neutral	kVp	95
	LV Neutral	kVp	75
iii)	Switching Impulse withstand Voltage		
	HV	kVp	460
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	230
	LV	kVrms	28
	HV Neutral	kVrms	38
	LV Neutral	kVrms	28
v)	Neutral (HV & LV)		Solidly grounded
vi)	Insulation		
	HV		GRADED
	LV		UNIFORM
vii)	Tan delta of winding at ambient Temperature	%	<0.5%
1.15	Vector Group		YNyn0

	(unless specified differently elsewhere)		
1.16	**Tap Changer**		OLTC vacuum
i)	Tap range & No. of steps		–10% to +10% in the step of 1.25% for HV variation, 16 steps
ii)	Location of Tap Winding		Neutral end of HV winding
iii)	Design		Constant flux voltage variation type as per cl. 6.2 of IEC 60076 part-I
iv)	Tap control		Full capacity on load tap changer suitable for group/independent, remote /local electrical and local manual operation and bi-directional power flow.
1.17	**Bushings**		
i)	Rated voltage		
	HV	kV	145
	LV	kV	12
	Neutral (HV)	kV	36
	Neutral (12 LV)		12
ii)	Rated current (Min.)		
	HV	A	800
	LV	A	3150
	Neutral (HV & LV)	A	3150
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	650
	LV	kVp	75
	Neutral (HV)	kVp	170
	Neutral (LV)		75
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	305
	LV	kVrms	28
	Neutral (HV)	kVrms	77
	Neutral (LV)	kVrms	28
v)	Minimum total creepage distances		
	HV	mm	3625
	LV	mm	25 mm / kV
	Neutral (HV)	mm	900
	Neutral (LV)	mm	25 mm / kV
vi)	Tan delta of bushing at ambient Temperature		
	HV	%	<0.4%
vii)	Max Partial discharge level at U_m		
	HV	pC	10
1.18	Max Partial discharge level at 1.5Um/√3	pC	100
1.19	Max Noise level at rated voltage and at principal tap on full load and all cooling active	dB	70
2.20	Bushing Current Transformer		
2.20.1	HV / HV N	A	200/1A
2.20.2	LV / LV N	A	2400-1200/1A

Notes:

1. For parallel operation with existing transformer, percentage impedance, OLTC connection & range, vector group and the winding configuration (if necessary) is to be matched.

2. No external or internal Transformers / Reactors are to be used to achieve the specified HV/LV impedances.

3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.

4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**

Notes:

1. For parallel operation with existing transformer, the impedance, OLTC connection & range and the winding configuration (if necessary) is to be matched.
2. No external or internal Transformers / Reactors are to be used to achieve the specified HV/LV impedances.
3. Tan delta of Winding & Bushing shall be measured at ambient temperature. No temperature correction factor shall be applied.
4. The criteria for Transformer losses shall be "**Copper Loss (Load Loss) > Iron Loss (No Load Loss) > Cooler Loss (Auxiliary Loss)".**
5. **Cooler Loss (Auxiliary Loss)".**

7.0 Bushing Current Transformer

7.1 Current transformers shall comply with IEC-60185.

7.2 It shall be possible to remove the turret mounted current transformers from the tank without removing the tank cover. Necessary precautions shall be taken to minimize eddy currents and local heat generated in the turret.

7.3 Current transformer secondary leads shall be brought out to a weather proof terminal box near each bushing. These terminals shall be wired out to cooler control cabinet/ marshalling box using separate cables for each core.

7.4 Bushing Current transformer parameters indicated in this specification are tentative and liable to change within reasonable limits. The Contractor shall obtain Employer's approval before proceeding with the design of bushing current transformers.

7.5 Technical Parameters for Bushing CT

7.5.1 Technical Parameters of Current Transformers (for 45 MVA, 132/11kV 3-Ph Transformers)

Description	Current Transformer Parameters (Transformer)			
	HV Side	HV Neutral Side	LV Side	LV Neutral Side
(a) Ratio				
CORE 1	200/1	200/1	2400/1	1600/1
CORE 2	200/1	-	2400/1	-
(b) Minimum knee point voltage or burden and accuracy class				
CORE 1	200V, TPS	200V, TPS	2400V, TPS	2400V, TPS

CORE 2	0.2 Class 10VA ISF ≤ 5	-	0.2 Class 10VA ISF ≤ 5	-
(c) Maximum CT Secondary Resistance				
CORE 1	1.5 Ohm	1.5 Ohm	1.5 Ohm	1.5 Ohm
CORE 2		-	-	-
(d) Application				
CORE 1	Restricted Earth Fault	Restricted Earth Fault	Metering	Restricted Earth Fault
CORE 2	Metering			-
(e) Maximum magnetization current (at knee point voltage)				
CORE 1	100mA	100 mA	100 mA	100 mA
CORE 2		-	-	-

NOTE: The CT ratio and ratings will be finalized during detail engineering.

NOTE:

i) For TPS class CT's, Dimensioning parameter "K", Secondary VA shall be considered 1.5 and 20 respectively. Class (for the relevant protection and duties) as per IEC 60185.

ii) Rated continuous thermal current rating shall be 200% of rated primary current.

iii) Parameters of WTI CT for each winding shall be provided by the contractor.

iv) For estimation of spares, one set of CTs shall mean one CT of each type used in transformer.

v) The CT used for REF protection must have the identical parameters in order to limit the circulating current under normal condition for stability of protection.

vi)

8.0 Oil Storage Tank

8.1 General

This specification is for oil storage tank. Oil Storage tank shall be supplied if specified in Bid Price schedule.

8.2 Standard

The oil storage tank shall be designed and fabricated as per relevant standards.

8.3 Specifications

Transformer oil storage tanks shall be towable on pneumatic tyres and rested on manual screw jacks of adequate quantity & size. The tank shall be cylindrical in shape and mounted horizontally and made of mild steel plate of adequate thickness. Size of the storage tank shall be as follows:

Diameter	:	1.5 meter (For 10 cubic meter capacity) 2.0 meter (For 20 cubic meter capacity)
Minimum Capacity	:	As mentioned in BPS

The tank shall be designed for storage of oil at a temperature of 100°C.

8.3.1 The Bidder may further note that maximum height of any part of the complete assembly of the storage tank shall not exceed 4.0 metres above road top.

8.3.2 The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatic tyres.

8.3.3 The tank shall also fitted with manhole, outside & inside access ladder, silicagel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. Bidder shall indicate the engine capacity in horse power to pull one tank completely fitted with oil. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the tank. Suitable arrangement shall also be provided to prevent overflow in the tank. Solenoid valve (Electro-mechanically operated) with centrifugal pump shall be provided at bottom inlet so that pump shall be utilized both ways during oil fill up and draining. Suitable arrangement shall also be provided to prevent overflow and drain from the tank/

8.3.4 The following accessories shall form part of supply along with each Oil storage tank.

i) Four numbers of suitable nominal bore rubber hoses for transformer oil application upto temperature of 100°C, full vacuum and pressure up to 2.5 Kg/ cm2 with couplers and unions each not less than 10 metre long shall be provided.

ii) Two numbers of suitable nominal bore vacuum hoses, suitable for full vacuum without collapsing and kinking, with couplers and unions each not less than 10 metre long shall also be provided.

(iii) One number of digital vacuum gauge with sensor capable of reading up to 0.001 torr, operating on 230V 50Hz AC supply shall be supplied. Couplers and unions for sensor should block oil flow in the sensor. Sensor shall be provided with atleast 8 meter cable so as to suitably place the Vacuum gauge at ground level.

8.3.5 The painting of oil storage tank and its control panel shall be as per clause no 3.1.1.8.

8.3.6 The tank shall contain a self mounted centrifugal oil pump with inlet and outlet valves, with couplers -suitable for flexible rubber hoses and necessary switchgear for its control. There shall be no rigid connection to the pump. The pump shall be electric motor driven, and shall have a discharge of not less than 3.0 (For 10 cubic meter capacity) / 6.0 kl/hr (For 20 cubic meter capacity) with a discharge head of 8.0m. The pump motor and the control cabinet shall be enclosed in a cubical with IP-55 enclosure.

9.0 OIL SAMPLING BOTTLE

9.1 Oil sampling bottles shall be suitable for collecting oil samples from transformers and shunt reactors, for Dissolved Gas Analysis. Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

9.2 Oil sampling bottles shall be made of stainless steel having a capacity of one litre.

9.3 Oil Sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

9.4 The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

9.5 An impermeable oil-proof, transparent plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

Annexure -A

All tests shall be carried out as per IEC: 60076 on transformer.

1) Magnetic Circuit Test

After assembly each core shall be tested for 1 minute at 2000 Volts between all bolts, side plates and structural steel work.

2) Tank Tests

(i) Oil Leakage Test

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air or oil of a viscosity not greater than that of insulating oil conforming to IEC-60296 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/Sq.m (5 psi) measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air during which time no leak shall occur.

(ii) Vacuum Test

All transformer tank of each size shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/Sq.m absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below:

Horizontal Length of flat plate (in mm)	**Permanent deflection (in mm)**
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(iii) Pressure Test

All transformer tank of each size, its radiator, conservator vessel and other fittings together or separately shall be subjected to an air pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m2 whichever is lower measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified above for vacuum test.

3) **Measurement of capacitance and tan delta** to determine capacitance between winding and earth. Tan delta value shall not be more than 0.5% corrected at 20deg C. Temperature correction factor table shall be given by the Contractor and shall form the part of test results.

4) **Temp. Rise Test (as per IEC 60076)**

Gas chromatographic analysis on oil shall also be conducted before and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567. For the evaluation of the gas analysis in temperature rise test the procedure shall be as IEC: 60567 and results will be interpreted as per IEC -61181. The DGA results shall generally conform to IEC/IEEE guidelines.

The temperature rise test shall be conducted at a tap for the worst combination of loading on the three windings of the transformer. The Contractor before carrying out such test shall submit detailed calculations showing alternatives possible, on various taps of the transformer and shall recommend the combination that results in highest temperature rise for the test.

6) Type Tests on fittings:

All the following fittings shall conform to type tests and the type test reports shall be furnished by the contractor along with the drawings of equipment/ fittings. The list of fittings and the type test requirement is:

a. Bushing (Type Test as per IEC: 60137)
b. Buchholz relay (Type Test and IP-55 Test on terminal box)
c. Marshalling box (IP-55 test)
d. Pressure Relief device Test

The pressure Relief Device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in transformer tank pressure test. The operating pressure shall be recorded. The device shall seal off after excess pressure has been released. The terminal box / boxes of PRD should conform to degree of protection as per IP-55.

e. Magnetic Oil Level gauge & Terminal Box for IP-55 degree of protection.
f. Air Cell (Flexible air separator) –Oil side coating, Air side under Coating, Air side outer coating and coated fabric as per BS: 903.
g. OTI & WTI – Switch setting & operation, switch differential, switch rating.

7) Inspection and Testing at Site

The Contractor/Manufacturer shall supervise testing & commissioning at site. Testing & commissioning shall be carried out by the owner (MOEP-2). Contractor shall submit a detailed procedure for Testing & Commissioning at site including receipt, storage & installation checks as mentioned below.

a) Receipt and Storage Checks

- Check and record condition of each package, visible parts of the transformer etc. for any damage.
- Check and record the gas pressure in the transformer tank as well as in the gas cylinder.
- Visual check for wedging of core and coils before filling up with oil and also check conditions of core and winding in general.
- Check and record reading of impact recorder at receipt and verify the allowable limits as per manufacturer's recommendations.

b) Installation Checks

- Check whole assembly for tightness, general appearance etc.
- Oil leakage test
- Capacitance and tan delta measurement of bushing before fixing/connecting to the winding, contractor shall furnish these values for site reference.
- Leakage check on bushing before erection.
- Measure and record the dew point of nitrogen/dry air in the main tank before assembly. Manufacturer shall submit dew point acceptable limits along with temperature correction factor and shall form part of instruction manual. In case dew point values are not within permissible limit suitable drying out process shall be applied for dry out of active part in consultation with the Manufacturer.

c) Oil filling

Oil impregnation or drying under vacuum at site shall be done with the transformer and oil at a temperature not exceeding 70°C.

The duration of the vacuum treatment shall be demonstrated as adequate by means of water measurement with a cold trap or other suitable method but shall generally not be less than 72 hours. The vacuum shall be measured on the top of the transformer tank and should be less than 1mbar.

Vacuum shall not be broken until the transformer is oil filled up to the Buchholz relay. Whenever the active insulation or any paper insulated HV connections, especially those from the windings to the bushings are exposed, these shall be re-impregnated under vacuum along with the complete transformer. For this purpose the transformer shall first be drained to expose all insulation material.

The minimum safe level of oil filling (if different from the Buchholz level) to which the transformer shall be oil filled under vacuum, shall be indicated in the manual.

Procedures for site drying, oil purification, oil filling etc shall be submitted for approval and complete instructions shall form part of the manual.

d) Commissioning Checks

- Check the colour of silicagel in silicagel breather.
- Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.
- Check the bushing for conformity of connection to the lines etc,
- Check for correct operation of all protection devices and alarms:
  - (i) Buchholz relay.
  - (ii) Excessive winding temperature.
  - (iii) Excessive oil temperature.
  - (iv) Low oil level indication.
- Check for the adequate protection on the electric circuit supplying the accessories.
- Check resistance of all windings on all steps of the tap changer. Insulation resistance measurement for the following:
  - (i) Control wiring.
  - (ii) Main windings.
- Check for cleanliness of the transformer and the surroundings.
- Continuously observe the transformer operation at no load for 24 hours.
- Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise and noise level etc.
- Phase out and vector group test.
- Ratio test on all taps.
- Magnetising current test.
- Capacitance and Tan delta measurement of winding and bushing.
- DGA of oil just before commissioning and after 24 hours energisation at site.

TECHNICAL SPECIFICATION FOR
Indoor Switchgear (VCB Type)

1.00 TECHNICAL REQUIREMENT OF EQUIPMENT

1.01 The manufacturer, whose Indoor switch gear panels are offered should have designed, manufactured, type tested as per relevant IEC, supplied and commissioned the Panels of similar voltage rating.

1.02 In addition to the requirements above, the Vacuum circuit breaker, CT, PT and relays should have been designed, manufactured and type tested as per relevant IEC and should have been in satisfactory operation.

2.00 GENERAL REQUIREMENTS

2.01 The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which are necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment / accessories shall be supplied without any extra cost. Also all similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.

2.02 Equipment shall be installed in a neat workman-like-manner so that it is leveled, plumbed, squared and properly aligned and oriented. Tolerances shall be as established on Contractor's drawings or as stipulated by Employer. No equipment shall be permanently bolted down / tag welded to foundation until the alignment has been checked and found acceptable by the Engineer. Contractor shall furnish all supervision labor, tools, equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time, required to completely install, test and commission the equipment.

2.03 Manufacturer's and Employer's instructions and recommendations shall be correctly followed in handling, erection, testing and commissioning of all equipment.

2.04 Contractor shall move all equipment into the respective rooms through the regular door or openings specifically provided for this purpose. No parts of structure shall be utilized to lift or erect any equipment without prior permission of Engineer.

2.05 Switchgear shall be installed on finished surfaces, concrete or steel sills. Contractor shall be required to install and align any channel sills which form part of foundations. Minor modifications to foundations shall be carried out by the Contractor at no extra cost. Power bus enclosure, ground and control splices of conventional nature shall be cleaned and bolted together with torque wrench of proper size or by other approved means. Tape or compound shall be applied where called for in drawings. Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments and relays are supplied loose along with switchgear, they shall be mounted only after the associated switchgear panels have been erected and aligned. The blocking materials, employed for safe transit of instrument and relays shall be removed after ensuring that panels have been completely installed and no further

movement of the same would be necessary. Any damage shall be immediately reported to Engineer.

3.00 CODES AND STANDARDS

3.01 All work shall be carried out as per the relevant standards, specification and codes of practices, referred to herein & in Section GTR, shall be the latest editions including all applicable official amendments and revisions as on the date of opening of bid.

3.02 Equipment conforming to any other internationally accepted standards will also be considered if they ensure performance and constructional features equivalent or superior to the standards listed above.

4.00 EQUIPMENT SPECIFICATION

4.01 Switchgear Panel

a) The switchgear boards shall have a single front, Double tier, fully compartmentalized, metal enclosed construction complying with clause No. 3.102 of IEC 62271-200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main bus-bars and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets except in bus-bar compartments where insulated barriers shall be provided to segregate adjacent panels. The Service Class Continuity of Switchgears shall be LSC 2B-PM (as per IS/IEC 622771-200). However, manufacturer's standard switchgear designs without inter panel barriers in bus-bar compartment may also be considered.

b) The circuit breakers shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the later arrangement is offered, suitable trolley shall be provided by the Bidder for withdrawal and insertion of the truck from and into the panel. Testing of the breaker shall be possible in Isolated position by keeping the control plug connected.

c) The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position also, so that the switchgear retains its specified degree of protection. While switchboard designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear manufacturers where the truck front serves as the compartment cover may also be considered provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position. In case the later arrangement is offered, the Bidder shall ensure that proper sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his offer.

d) The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets. **However, Panels which are type tested for IP-4X as per IEC/IS, without any gasket arrangement are also acceptable.**

e) All louvers, if provided, shall have very fine brass or GI mesh screen. Tight fitting gourmet / gaskets are to be provided at all openings in relay compartment. Numerical Relays shall be fully flush mounted on the switchgear panels at a suitable height.

f) **11kV indoor** Switchgear shall have an Internal Arc Classification of IAC FLR **25 KA**, 1 sec. The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially designed to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. Contractor shall submit the type test report for satisfactory operation of pressure relief device in line with IEC 62271-200 Annexure – A.

g) Enclosure shall be constructed with rolled steel sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.0 mm or higher thickness. Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for non magnetic material it shall be 3.0 mm.Thickness of explosion vent shall be as per manufacturer's standard design.

h) The switchgear shall be cooled by natural air flow.

i) Total height of the switchgear panels **shall be finalized during detail engineering in line with building design**. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800 mm and shall not be generally less than 700 mm.

Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or lever arrangement shall preferably be provided for smooth and positive movement of truck between Service and Isolated positions. **Suitable locking arrangement should be provided for the racking mechanism.**

j) Safety shutters complying with IEC 62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. In case, insulating shutters are provided, these shall meet the requirements of IEC 62271-200 and necessary test report shall be submitted as per IEC 62271-200 Clause 5.103.3.3. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and tie connections which could be energized from other end.

k) Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar/

cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position.

l) The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors. Busbar and cabling compartments provided on the rear side shall have separate bolted covers with self retaining bolts for easy maintenance and safety. Breaker compartment doors shall have locking facility. Suitable interlock shall be provided, which will ensure that breaker is OFF before opening the back doors. For Incomer/ Bus-coupler/ Bus-Section panels, suitable interlock shall be provided to prevent opening of any compartment doors which has any of the MV (11kV) equipment, in case the incoming supply is ON.

m) In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.

n) Suitable base frames made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done, welding of base frame to the insert plates shall be in Bidder's scope. The bidder may offer panels with built in base frame ready for dispatch and suitable for installation on indoor cable trenches.

o) The switchboard shall have the facility of extension on both sides. Any adopter panels and dummy panels as required to meet the various busbar arrangements, cable / bus duct termination and layouts shall be included in Bidder's scope of work.

p) Thermostatically controlled space heater for each chamber (CB, Bus bar, cable, PT/CT chamber etc as applicable) along with common MCB shall be provided.

q) **Cassette type design for VCB Panels shall also be acceptable.**

4.02 Circuit Breakers (VCB Type)

a) The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.

b) Outgoing breakers shall be suitable for switching transformers at any load.

c) Circuit breaker shall be re-strike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.

d) During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact

at the end of opening stroke.

e) Plug and socket isolating Contacts for main power circuit shall be silver plated, of self aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.

f) All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation of the breaker and the mechanism.

g) The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.

h) Mechanical indicators shall be provided on the breaker trucks / **front** to indicate OPEN / CLOSED conditions of the circuit breaker, and CHARGED / DISCHARGED conditions of the closing spring. An operation counter shall also be provided. These shall be visible without opening the breaker compartment door.

i) The rated control supply voltage shall be as mentioned elsewhere under Technical parameters. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between **85-110% of the rated voltage**. The shunt trip coil shall operate satisfactorily under all operating conditions of the circuit breaker upto its rated short circuit breaking current at all values of control supply voltage **between 70-110% of the rated voltage.** The trip coil shall be so designed that it does not get energized when its healthiness is monitored by indicating lamps (Red) and trip coil supervision relay.

j) The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor, a continuous sequence of closing and opening operations shall be possible. One open-close- open operation of the circuit breaker shall be possible after failure of power supply to the motor. Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession without exceeding acceptable winding temperature when the control supply voltage is anywhere between **85-110% of rated voltage**. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with Over load protection.

k) Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate.

l) Circuit breaker shall be provided with inter pole barriers of insulating materials. The use of inflammable materials like Hylam shall not be acceptable.

m) **Circuit breaker pole shall be with epoxy encasing / epoxy encapsulation to** safe guard against mechanical impact and climatic condition such as moisture, humidity and dust.

4.03 **Control and Interlocks**

a) The circuit breaker will normally be controlled remotely from SAS/SCADA system through closing and shunt trip coils. However, it shall also be designed to locally control from Indoor Switchgear panel. Suitable mimic on Panel shall be provided.

b) Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

c) Each panel shall have two separate limit switches, one for the Service position and the other for isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions.

d) Auxiliary Contacts of breaker may be mounted in the fixed portion or in the withdrawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker operating mechanism.

e) Auxiliary contacts mounted in the fixed portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion, and dedicated for Employer's use shall be wired out in series with a contact denoting breaker service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing. There shall be at lease Six (2) NO and Six (2) NC breaker auxiliary contacts made available for Employer's future use.

f) The contacts of all limit switches and all breaker auxiliary contacts located on truck portion and fixed portion shall be rated to make, carry and break 1.0A, 240V DC (Inductive) / 10A, 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously.

g) Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it.

h) Closing of the breaker shall be possible only when truck is either in ISOLATED or in SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary circuits to breaker truck have been connected up, and closing spring is fully charged.

i) It shall be possible to easily insert breaker of one typical rating into any one of the panels meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type or rating.

j) Indications shall be provided in display unit of the relay flush mounted on the panel front as brought out in the specification elsewhere. It shall be

possible to easily make out whether the truck in SERVICE OR ISOLATED POSITION even when the compartment door is closed.

4.04 **Busbars and Insulators**

a) All busbar and jumper connections shall be of high conductivity aluminium alloy / Copper of adequate size and bus bar size calculation / **supporting type test report** shall be submitted for approval. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents.

b) Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

c) Contact surfaces at all joints shall be silver plated or properly cleaned and non-oxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminum to copper connections.

d) Busbar insulators shall be of arc and track resistant, high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100pico coulomb at rated Voltage X 1.1/$\sqrt{3}$. Use of insulators and barriers of in-flammable material such as Hylam shall not be accepted.

e) All busbars shall be color coded for phase identification.

f) The temperature of the busbar and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant Indian Standards, duly considering the specified ambient temperature (50 deg. C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall be in line with IEC at 50 deg. C ambient.

4.05 **Earthing and Earthing Devices**

a) A copper / galvanized steel earthing bus shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.

b) The earth bus shall have sufficient cross section to carry the momentary short-circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.

c) Suitable arrangement shall be provided at each end of the earth bus for bolting to Employer's earthing conductors. All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.

d) All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting.

e) The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

f) All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.

g) VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

h) Separate earthing trucks shall be provided by the Contractor for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing / incoming cables or bus ducts. The trucks shall have a voltage transformer / **Voltage Presence Indicator (VPI)** and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual/ audible annunciation to warn the operator against earthing of live connections.

As an alternative to separate earthing trucks the Bidder may also offer built-in earthing facilities for the busbars and outgoing / incoming feeders, in case such facilities are available in their standard proven switchgear design. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have suitable facility for locking in the earthed condition.

i) The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO + 4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.

j) All hinged doors shall be earthed through flexible earthing braid.

k) Interlocks shall be provided to prevent :

1) Closing of the earthing switch if the associated circuit breaker truck is in Service position.

2) Insertion of the breaker truck to Service position if earthing switch is in closed position.

4.06 Painting

All sheet steel work shall be pretreated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder coating specification). Finishing paint shade for complete panels shall be RAL7032 for all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

4.07 Instrument Transformers

a) All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.

b) All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.

c) The parameters of instrument transformers specified in this specification are tentative and shall be finalized by the Employer in due course duly considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him, he shall offer instrument transformer of adequate ratings.

d) All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.

e) Current transformers shall be located in the cable termination compartment. All CT/VT shall be single phase type. VT mounting shall be fixed/ withdrawable type.

f) All voltage transformers shall have suitable HRC current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted suitably on the fixed / withdrawable portion.

4.08 Numerical Protection Relays (IEDs)

4.08.01 Indoor switchgear panels shall have communicable numerical protection relays (IEDs) complying with IEC-61850 on all feeders which shall be networked on Ethernet to communicate with substation SAS/SCADA system on IEC-61850. These IEDs shall also be used for control & monitoring the switchgear from SAS.

In addition to status of devices (CBs/Isolators) and equipment alarms, Metering data shall also be made available to SAS/SCADA station from protection IEDs. Further, multifunction meters with Modbus protocol are also envisaged, which will be connected in daisy-chain-link to communicate to station SAS. Modbus to IEC 61850 converter shall be provided for integration with SAS.

The Bidder's scope shall include the followings:

a) Communicable Numerical Protection Relays (with IEC 61850) in each of the feeders & Bus-section

b) IED's / Numerical Relays shall have Graphical Display to facilitate settings, relay operations and to view measurement, event and alarm etc.

c) Relays shall have built in Local/Remote Switch.

d) Cat5e Ethernet cable for connection of Numerical Relays (IEDs) to Ethernet switches. Optical cable shall be used between Ethernet switch (for indoor switch gear IEDs) and ring/ redundant network of Substation LAN switch.

e) Required number of Ethernet switches mounted in Indoor Switchgear panels for communication with IEDs on IEC 61850 protocol.

f) The SAS/SCADA system has been envisaged as part of main substation. Bidder shall facilitate in successful Integration of Numerical Relays to the SAS/SCADA system through Ethernet switches.

4.08.02 All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer.

4.08.03 All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

4.08.04 All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per approved scheme. These I/O points shall be used for wiring of status of devices (CBs/Isolators) and equipment alarms etc. Heavy duty binary output contacts of IEDs shall be suitable for CB closing / tripping directly and no separate master trip relay shall be used.

4.08.05 Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

4.08.06 Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Event records & alarms shall be stored

in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

4.08.07 All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

4.08.08 All numerical relays shall have provision of both current (CT) and voltage (VT) inputs as required for protection & measurement purposes using protection cores.

4.08.09 All numerical relays shall have key pad / keys to allow relay setting from relay front. Relay to be self or hand reset type which shall be software selectable. Manual resetting shall be possible from remote.

4.08.10 Relays shall have suitable output contact for circuit breaker failure protection (LBB) logic.

4.08.11 Relays shall have self diagnostic feature with continuous self check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure.

4.08.12 Contractor shall submit applicable Type Test reports for Numerical relays as per IEC including report for IEC 61850 protocol from accredited lab.

4.09 **Control & Protection System**

All numerical relays shall communicate to station SCADA / SAS on IEC-61850 communication protocol. It is envisaged that these protection IEDs shall be used for CB control & monitoring of bay equipments.

4.09.01 **Numerical Transformer Protection Relay**

a) The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b) The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current and high set setting 500-2000%.

c) The relay shall have selectable directional & non-directional feature

d) The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current (IDMT) and high set 100-1000%.

e) For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.

f) The relay shall allow higher setting during transformer charging (inrush) and lower setting during normal operating condition.

g) Transformer troubles like Buchholz, Winding temperature, Oil temperature & Pressure Relief Device trips (as applicable) shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.

h) Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.09.02 **Numerical Line Protection Relay**

a) The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b) The over current element should have the minimum setting adjustable between **20**-200% of CT secondary rated current.

c) The relay shall have selectable directional & non-directional feature

d) The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

e) Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.09.03 **Numerical Bus Coupler/Bus-Section Protection Relay**

a) The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b) The over current element should have the minimum setting adjustable between **20**-200% of CT secondary rated current.

c) The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

d) Bus no volt signal shall be configured in the relay for use in control logics and other Protections and Control functions in the Relays.

e) Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

4.09.04 Other Control and Protections features

a) Control of breakers shall be carried out from the station HMI of SAS/SCADA system through the LAN and the numerical relays.

b) The HMI shall have a graphical dynamic Plant Key Single Line Diagram to view the complete system status. This shall include the status of the switchgears, measurement values, operation counters, graphical alarm representation, etc. Spontaneous changes of a state, typically opening of a circuit breaker from a protection, shall have a specific colour code. All the Breakers with the status shall be clearly displayed along with values of currents, voltages, and frequency, active and reactive powers etc.

c) Separate Master trip (86) relay with self-reset type for Line protection and Electrical reset type for Transformer shall be provided. Electrical reset shall be possible through IED & Substation SAS.

d) Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer functions shall be as required for the application. Timer functions shall be configurable for on & off delays as per requirement.

e) The numerical relay shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with

a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

f) At least 250 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.

g) Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be shall be provided. The results of the self reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be shall be available on the user interface

h) The alarm/status of each individual protection function and trip operation shall be communicated to the SAS/SCADA system.

i) Sequence of events shall have 1ms resolution at device level.

j) Measurement accuracy shall be 1% for rated RMS Current and voltage (20-120% of Rated primary).

k) It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.

5.00 ETHERNET SWITCH

a) Ethernet switches shall be 'substation hardened', and shall comply with IEC61850 for communications with IEDs. The Ethernet switches shall be of managed type with two (2) No. of Fiber optic cable ports and at least Sixteen (16) Copper ports to achieve the LAN configuration. More no. of switches or higher ports switch can also be supplied to meet all IEDs requirements for the LAN. The Ethernet switches shall have features to support the redundant rings. These switches shall be mounted in the switchgear Panels. The FO ports shall be Single-mode 1000Mbps ports. Copper ports shall be 10/100Mbps ports.

b) Necessary software for configuration and real-time network monitoring shall be provided along with the Ethernet switches.

6.00 POWER CABLE TERMINATION

a) Cable termination compartment shall receive the stranded Aluminium /copper conductor, XLPE insulated, shielded, armored, PVC jacketed, single core / three core, unearthed / earthed grade power cable(s).

b) Adequate clearance shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Inter-phase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for Employer's approval during detail engineering.

c) Cable termination compartment shall have provision for termination of power cables of sizes indicated in the bidding documents with removable undrilled gland plates. For all single core cables gland plates shall be of non-magnetic material. Cable entry shall generally be from the bottom; however, this shall be finalized during detail engineering.

7.00 CONFIGURATION OF INDOOR VCB PANELS

Sl. No.	Equipment	IP1 I/C	IP2 O/G	IP3 LT TR	IP4 B/S
1.	VCB as per spec	1	1	1	1
2.	CB Spring charge indicator (Mechanical)	1	1	1	1
3.	Mechanical ON/OFF indicator for CB	1	1	1	1
4.	Operation counter for CB	1	1	1	1
5.	CT (1-Phase)	3	3	3	3
6.	VT (1-Phase)	-	-	-	6
7.	Multi Function Meter	1	1	1	1
8.	Control switch for breaker(T-N-C)	1	1	1	1
9.	Green Indicating lamp for CB Open	1	1	1	1
10.	Red indicating lamp for CB Close	1	1	1	1
11.	DC healthy lamp (white)	1	1	1	1
12.	Trip circuit healthy lamp	1	1	1	1
13.	Mimic to represent SLD	1	1	1	1
14.	Voltmeter with selector switch	-	-	-	2
15.	Numerical protection relay (IED)	1	1	1	1
16.	Master Trip Relay (86)	1	1	1	1
17.	Semaphore Indicator for Line Isolator & Line Earth Switch	-	2	-	-
18.	LAN Switches and LAN/FO Cables	AS per requirement			

Notes:

1. IP1: Panel for Transformer Incomer feeder (I/C)
2. IP2: Panel for outgoing Line Feeder (O/G)
3. IP3: Panel for LT Transformer feeder (LT TR)
4. IP4: Panel for Bus Sectionaliser (B/S)
5. Location of VT (I/C or B/S Module) shall be decided during detail engineering.
6. Numerical protection relay (IED) for all type of VCB module shall preferably be interchangeable to optimize mandatory spares.

8.00 TESTS

8.01 Type Tests

The contractor shall submit the reports for the following type tests on the equipment to be supplied under the contract:

A. Switchgear Panel (with Circuit Breaker installed)
   a. Short circuit duty test
   b. Short time and peak withstand current test
   c. Power frequency withstand test
   d. Lightning impulse withstand test
   e. Temperature rise test
   f. Internal Arc Test as per IEC 62271-200 (for 1 second)
   g. Measurement of resistance of main circuit
   h. Test to verify pressure relief operation of the panel **(During internal arc test)**
   i. Cable charging test
   j. Short circuit withstand test of earthing device (truck / switch).

B. Circuit Breaker

a. Mechanical Endurance Test

C. Current Transformer
a. Short time current test
b. Temperature rise test
c. Lighting Impulse voltage withstand test

D. Potential Transformer
a. Temperature rise test
b. Lighting Impulse voltage withstand test

E. Switchgear Panel
a. IP 4X test

8.02 **Routine Tests**

All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price.

The manufacturer shall furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

8.03 **Commissioning Checks / Tests**

After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / panels and correctness of all equipment in all respects. In addition, the Contractor shall carry out all other checks and tests recommended by the manufacturers.

8.03.01 General

a. Check name plate details according to specification.
b. Check for physical damage
c. Check tightness of all bolts, clamps and connecting terminals
d. Check earth connections.
e. Check cleanliness of insulators and bushings
f. Check heaters are provided
g. H.V. test on complete switchboard with CT & breaker in position.
h. Check all moving parts are properly lubricated.
i. Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators.
j. Check for interchangeability of breakers.
k. Check continuity and IR value of space heater.
l. Check earth continuity for the complete switchgear board.

8.03.02 Circuit Breaker

a. Check alignment of trucks for free movement.
b. Check correct operation of shutters.

c. Check control wiring for correctness of connections, continuity and IR values.
d. Manual operation of breakers completely assembled.
e. Power closing / opening operation, manually and electrically
f. Closing and tripping time.
g. Trip free and anti-pumping operation.
h. IR values, resistance and minimum pick up voltage of coils.
i. Simultaneous closing of all the three phases.
j. Check electrical and mechanical interlocks provided.
k. Checks on spring charging motor, correct operation of limit switches and time of charging
l. All functional checks.

8.03.03 Current Transformers

a. Megger between windings and winding terminals to body.
b. Polarity tests.
c. Ratio identification checking of all ratios on all cores by primary injection of current.
d. Magnetization characteristics & secondary winding resistance.
e. Spare CT cores, if any to be shorted and earthed.

8.03.04 Voltage Transformers

a. Insulation resistance test.
b. Ratio test on all cores.
c. Polarity test.
d. Line connections as per connection diagram.

8.03.05 Cubicle Wiring

a. Check all switch developments.
b. It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.
c. All the wires shall be meggered to earth.
d. Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment.
e. Check terminations and connections.
f. Wire ducting.
g. Gap sealing and cable bunching.

8.03.06 Relays

a. Check internal wiring.
b. IR of all terminal body.
c. IR of AC to DC terminals
d. Check operating characteristics by secondary injection.
e. Check operation of electrical/ mechanical targets.
f. Relay settings.

9.00 SYSTEM PARAMETERS:

1	Nominal System voltage	22 kV	11 kV
2	Highest System voltage	24 kV	12 kV
3	Rated Frequency	50 Hz	50 Hz
4	Number of phases/ poles	Three	Three
5	System neutral earthing	As per Vector Group of Transformers	As per Vector Group of Transformers
6	One minute power frequency withstand voltage	50	28
7	1.2/50 microsecond Impulse withstand voltage	150 kV (peak)	75 kV (peak)
8	Short time rating for bus bars, CB, CT and switchgear Assembly..	31.5/40kA (rms) for one (1) sec.	31.5/40kA (rms) for one (1) sec.
9	Dynamic withstand rating	62.5 kA (peak)	62.5 kA (peak)
10	IAC Rating	25kA, 1.0 Sec	25kA, 1.0 Sec
11	Control supply voltage		
12	- Trip and closing coils	As per Station DC Supply	As per Station DC Supply
	- Spring charging motor	As per Station DC Supply	As per Station DC Supply
13	Maximum ambient air temperature	50 deg. C	50 deg. C

a)	**CIRCUIT BREAKERS**		
1.	Rated Voltage	22 kV	11 kV
2.	CB rated Current		3150 A
a)	Incomer & Sectionaliser Breaker	3150 A	3150 A
b)	Outgoing feeder Breaker	1250A	1250A
3.	Short circuit breaker Current		
a)	A.C. component	31.5/40kA	31.5/40kA
b)	D.C. component	As per IS: 13118 or IEC-62271	As per IS: 13118 or IEC-62271
4.	Short Circuit making current	62.5 kA(peak)	62.5 kA(peak)
5.	Out of phase breaking Current capacity	As per IEC	As per IEC
6.	Rated line/cable charging Interrupting current at 90° Leading power factor angle	As per IEC	As per IEC
7.	Maximum allowable switching Over voltage under any switching Condition	As per IEC	As per IEC
8.	Rated small inductive current Switching capability with over Voltage less than 2.3 pu	As per IEC	As per IEC
9.	First pole to clear factor	1.5	1.5

10	Operating Duty	**0-0.3 Sec-CO-3 Min-CO**	**0-0.3 Sec-CO-3 Min-CO**
11	Total break time	Not more than 4 cycles	Not more than 4 cycles
12	Total make time	Not more than 5 cycles	Not more than 5 cycles
13	Reclosing	3 phase auto reclosing	3 phase auto reclosing
14	Max. difference in the instants of closing/opening contacts between poles at rated control Voltage and rated operating and quenching media pressures	As per IEC	As per IEC
15	Auxiliary contacts	2NO+2NC for Employers future use besides scheme requirement	2NO+2NC for Employers future use besides scheme requirement
16	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271	Motor wound spring charged stored energy type as per IEC-62271
Current Transformer			
1.	Rated primary voltage	**22kV**	**11kV**
2.	Rated primary current	**As per SLD & DDE**	**As per SLD & DDE**
3.	Type of CT	1-Phase	1-Phase
4.	Max temp rise	As per IEC:60044-1	As per IEC:60044-1
5.	Class of Insulation	Class E or better	Class E or better
6.	One minute power frequency withstand voltage between secondary terminal & earth	2kV	2kV
7.	No. of Secondary cores	3	3
1.	Rated primary voltage	**22kV**	**11kV**
2.	Rated primary current	**As per SLD & DDE**	**As per SLD & DDE**
3.	Max temp rise	As per IEC:60044-1	As per IEC:60044-1
4.	Class of Insulation	Class E or better	Class E or better
5.	One minute power frequency withstand voltage between secondary terminal & earth	2kV	2kV
6.	Nos. of Secondary cores	2	2
1.	Rated primary Voltage	**22kV**	**11kV**
2.	Rated primary current	**As per SLD & DDE**	**As per SLD & DDE**

3.	Max temp rise	As per IEC:60044-1		As per IEC:60044-1	
4.	Class of Insulation	Class E or better		Class E or better	
5.	One minute power frequency withstand voltage between secondary terminal & earth	2kV		2kV	
6.	Nos. of Secondary cores	2		2	
1.	Rated primary Voltage	22kV		11kV	
2.	Type	1-Phase		1-Phase	
3.	Voltage ratio (kV)	(11/√3)/(0.11/√3)		(11/√3)/(0.11/√3)	
4.	Rated Voltage Factor	1.2 continuous and 1.5 for 30 seconds		1.2 continuous and 1.5 for 30 seconds	
5.	Nos. of Secondary cores	2		2	
6.	Accuracy of Secondary core	Protn	Metering	Protn.	Metering
		3P	0.5	3P	0.5
7.	Class of insulation	Class E or better		Class E or better	
8.	Rated output burden (Minimum)	15VA		15VA	

Notes: The ratings indicated for instrument transformers are tentative only and may be changed to meet the functional requirements.

10.00 INPUT SIGNAL TO SAS SYSTEM

The following digital input of 11kV Indoor switchgear bays shall be provided through IEDs in the SAS system:

i) Status of CB, Isolator, Earth switch
ii) CB trouble
iii) CB operation/closing lockout
iv) Trip circuit faulty
v) Bus VT FUSE Fail
vi) Back-up overcurrent & earth fault protection Operated
vii) DC source fail

11.00 MULTIFUNCTION METER

The Multifunction meter shall have feature to measure KV, I, MW, MVAr, PF, MWhr, MVAr-hr with accuracy class of 0.5S. Further, multifunction meter shall have bi-directional feature to register/record MWhr values.

REQUIREMENT FOR 11kV CURRENT TRANSFORMERS

(INCOMER / BUS COUPLER FEEDER)

	Metering	O/C & E/F Protn.	Diff. Protn.
Current ratio	As per SLD &	As per SLD & DDE	As per SLD &

	DDE		DDE
Accuracy class	0.5S class	5P20	PS
Knee point voltage (at minimum ratio)	-	-	1200V
Rated burden	7.5VA	-	-

REQUIREMENT FOR 11KV CURRENT TRANSFORMERS (LINE FEEDER)

	Metering	**O/C & E/F Protn.**
Current ratio	As per SLD & DDE	As per SLD & DDE
Accuracy class	0.5S class	5P20
Knee point voltage (at minimum ratio)	-	-
Rated burden	7.5VA	-

REQUIREMENT FOR 11KV CURRENT TRANSFORMERS (LT TRANSFORMER FEEDER)

	Metering	**O/C & E/F Protn.**
Current ratio	As per SLD & DDE	As per SLD & DDE
Accuracy class	0.5S class	5P20
Knee point voltage (at minimum ratio)	-	-
Rated burden	7.5VA	-

SECTION 22: EHV XLPE POWER CABLE

1 CABLE CONSTRUCTION DETAILS

1.1 The XLPE insulated EHV cable shall conform to the requirements of IEC 60502-2 (applicable clauses only) for construction and IEC 60840/IEC 62067 (as applicable) for testing. The terminating accessories shall conform to IEC 60840/ IEC 62067 (as applicable). The offered cables and its terminating accessories shall be compatible with each other.

1.2 The EHV grade cable shall be single core, unarmoured, stranded, compacted **Aluminium/Copper (as specified in BPS)** conductor, core screening by a layer of semiconducting tape followed by a layer of semiconducting compound, cross linked polyethylene (XLPE) dry cured insulation, insulation screening with semiconducting compound extruded directly over the insulation, longitudinal sealing by a layer of non-woven tape with water swellable absorbent over insulation screen, followed by radial sealing (Metal sheath of seam welded/extruded corrugated aluminium), metallic screening by concentric layer of plain copper wire (if required) to meet short time current requirement, followed by an open helix of copper & overall HDPE sheathed & graphite coated and conforming to the technical particulars of specification. Bidder may offer necessary layers such as separation tape, binder tapes etc additionally as per their manufacturing practices for meeting required performance of the offered cable.

1.3 The cable shall be suitable for laying under the climate conditions (as specified in Section-Project) and underground buried installation with uncontrolled back fill and chances of flooding by water.

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

1.5 Progressive sequential marking of the cable length (in metres), at every one metre, shall be provided on the outer sheath of the cable.

1.6 Repaired cables shall not be accepted.

1.7 Allowable tolerance on the overall diameter of the cables shall be $\pm$ 2 mm.

1.8 CONDUCTOR

The conductor shall be of **Copper/Aluminium** wires as specified in the Bid Price Schedule **(BPS)**. The shape of conductor shall be compacted segmental having high compactness and smooth surface finish.

1.9 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. The conductors screen (non-metallic semi-conductive) shall be extruded in a single one-time process to ensure homogeneity and absence of voids.

1.10 INSULATION

The extruded XLPE insulation shall be applied over the conductor screen to the desired thickness in a void free manner.

1.11 INSULATION SCREEN

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

1.12 MOISTURE BARRIER

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

Radial Moisture Barrier:
This shall be of extruded/seam welded corrugated aluminium sheath.

1.13 METALLIC SCREEN:

The metal sheath shall consist of a tube of corrugated aluminium of at least 99.5% purity.
The thickness of the corrugated aluminium sheath shall be designed to meet the requirement of the system short circuit rating as specified in **the bidding documents**.

The sheath shall be continuously extruded/seam welded, of uniform thickness and homogeneous construction, close fitting, seamless and free from defects.

A thin layer of bitumen or other suitable anti-corrosion compound shall be applied over the aluminium sheath.

1.14 OUTER SHEATH

The outer sheath shall consist of extruded black coloured HDPE with graphite coating. The outer sheath shall be suitably designed by the addition of chemicals in the outer sheath for protection against termite and rodent attack and shall be coated with graphite.

1.15 RATING

The contractor/ manufacturer shall declare current rating of cable for maximum conductor temperature of 90 degree C under continuous operation and 250 degree C during short-circuit condition. The contractor/ manufacturer shall also declare over load curve with duration for conductor temperature of 105 Deg C. A complete set of calculation made in arriving at the current rating shall be furnished, for laying condition envisaged under the project, during detailed engineering for Employer/Employer's reference.

1.16 CABLE JOINTING ACCESSORIES

4.16.2 The cable jointing accessories shall include all the straight through joints, Cross bonding, earth continuity cables, Link boxes, Sheath Voltage Limiters (SVLs) etc as required for entire cable route. Bidder shall arrange all special tools and tackles required for making these joints at his own cost. **Unless specified separately** in BPS, **cable end terminating kits** shall be deemed included as part of cable jointing accessories.

4.16.3 The straight through joint shall preferably be built up from the same material as the main cable and shall have electrical and mechanical withstand capabilities same as or better than the main cable. The joints shall be suitable for tropical conditions as specified in **Section-Project**.

4.16.4 The straight through joints and cable end terminations shall be of proven design and should have been type tested as per relevant IEC. A list of supply of cable jointing accessories which are in successful operation in projects, shall be furnished.

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

4.16.6 The cable end terminations shall be of anti-fog type and shall be of Polymer type/Porcelain type suitable for withstanding the climatic conditions with required Creepage distance as specified in **bidding documents**. The cable end terminals for terminating the cables shall be complete with accessories & fully compatible with the cables to be supplied. The terminations shall also be capable to withstand mechanical forces during normal and short circuit operations.

4.16.7 The cable end terminations envisaged for **mounting on Transmission Line (T/L) Towers** shall necessarily be of Composite Polymer type to reduce the weight on T/L towers. The cable end terminations envisaged for **GIS interface,** shall comply to IEC 60840. It will be the responsibility of the contractor to ensure smooth interface with GIS equipment.

2 CABLE DRUMS

2.1 Cables shall be supplied in returnable steel drums of heavy construction of suitable size and packed conforming to applicable standards.

2.2 Standard drum lengths for manufacturing shall be finalised during detailed engineering. Each drum shall carry the manufacturer's name, the employer's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

2.3 Packing shall be sturdy and adequate to protect the cables from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PE/Rubber caps so as to eliminate ingress of water during transportation and erection.

3 TESTS ON CABLES

All XLPE insulated EHV cables shall conform to all Type, Routine and Acceptance tests listed in the relevant IEC & shall submit the type test reports for Employer's approval. If specified in Section-Project, Type tests shall be carried out on the EHV cable as per relevant standard.

4 TESTS ON ACCESSORIES

Contractor shall submit type test reports for accessories, as per IEC 60840:1999/ IEC 62067 for Employer's acceptance. Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for Employer's acceptance.

5 TESTS AFTER INSTALLATION

All tests on cable system as prescribed in IEC 60840:1999/IEC 62067 (as applicable) shall be performed after installation.

HDPE PIPES FOR XLPE Cable

a) General

The flexible/HDPE conduit pipe of suitable size, shall be used for installation of XLPE power cable. The pipe shall be buried before the cable installation and, then the cables shall be pulled in.

b) Requirement

The conduit pipe shall be of polyethylene and shall be strong enough to withstand the compression force from heavy trucks or lorries when it is buried more than 80 cm below the ground level and temperature rise up to 800 degree Celsius.
The pipe's projected cross section shall be practically rounded.
The colour of the pipes shall be black.

C) Accessories

The conduit pipe shall be provided with necessary accessories, such as joints and sealing material etc. The straight joint sleeve shall be made of high density polyethylene black coloured and to be so designed as to be screwed on to flexible pipe.
Bell mouth shall be fixed to the end of pipe to facilitate cable pulling in. The bell mouth shall be so designed as to screwed into the pipe. It shall be made of hard density polyethylene and colored black.
Water proof materials for pipes in manhole shall be mounted to an outlet of duct to keep the water tightness.
The waterproof materials shall be comprised the components such as sand-proof seal, sealing tape, neo seal compound, VUL-CO tape, PVC tape and other necessary materials to complete the specified scope of works.

6 LAYING AND INSTALLATION

6.1 The bidder is advised to visit the site and acquaint themselves with the topography, infrastructure etc. The contractor shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the erection and successful commissioning of XLPE cables in all respects.

6.2 Cables shall be laid in the trench throughout the route. Further, as per requirement of the field, the cables shall also have to be laid in the followings (with prior approval of employer):

a. In ducts
b. In HDPE pipes (pipes to be filled with sand/suitable material after cabling)
c. In air at terminations
d. At varying depths due to obstructions
e. As per approved drawings

6.3 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.

6.4 Concrete trenches with precast covers may be used in exceptional cases in smaller portions, wherever bending of cables are involved and HDPE pipes can't be laid.

6.5 The arrangement of laying the cable en-route shall be submitted by contractor during detailed engineering for Employer's acceptance.

7 TRENCHING

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

7.2 The trench shall be excavated using manual /mechanical modes as per field conditions. Most main roads are of asphalt surface and some of the roads with cement concrete surface. The sides of the excavated trenches shall wherever required, be well shored up.

7.3 Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored. The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

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

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

8 TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation **(as per bidding documents)** for entire route. The contractor shall submit drawings and arrangements for Employer approval.

9 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 surfaces, 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 accordance with acceptable standard practices/statutory requirements.

10 DAMAGE TO PROPERTY

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the Employer. The contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

11 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 approved drawings.

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

The marker should incorporate the relevant information such that the name of the Employer, voltage, circuit and distance of cable from the marker.

12 DEPTH OF LAYING OF CABLES

Depth of laying shall be as per drawing enclosed with Specification. Laying at varying depths due to obstructions/site conditions may be accepted in extreme cases with prior approval of Employer during detailed engineering.

13 PAYING OUT THE CABLE

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 at 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 monitored by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed as recommended by manufacturer.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position.

14 SAND BEDDING

The cable shall be completely surrounded by well-compacted cable sand to such a thickness and of such size that the cable is protected against damage (applicable where cables are not to be laid in pipes).

15 SNAKING

Snaking shall be done at necessary places recommended by manufacturer with prior approval of Employer.

16 THERMAL BACKFILL

If specifically mentioned in Section-Project, Thermal Backfilling shall be carried out based on the evaluation of soil thermal resistivity along the cable route and after approval from the Employer the contractor shall design, specify, supply, lay and monitor the installation of thermal backfill surrounding the cables. Thermal back fill shall be of thermal resistivity of 1.20 Km/W or better.

17 IMMEDIATE ENVELOPE TO CABLE

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

18 BACK FILLING

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

19 WARNING TAPE

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

20 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.

21 ROAD, RAIL & CANAL CROSSINGS

21.1 The road cutting, whether cement concrete asphalt or macadam road surface; Railway track crossing and canal crossing shall be taken after obtaining approval for cutting/crossing from the concerned authorities i.e. civic authorities, traffic police, telephone authorities, Railway authorities, Irrigation dept etc., and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned during night or light traffic periods. HDPE pipes shall be used for crossing. HDPE pipes diameter should not be less than 1.5 times the cable diameter.

21.2 **Trenchless Digging**:

It is envisaged that trenchless digging shall be used for crossing the National highways, Railway tracks and Canals etc. and the same shall be in the scope of bidder. Trenchless digging shall also be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of underground cables. The trenchless digging methods shall generally conform to ITU-T L.38. The various methods of trenchless digging such as hand/ manual auguring (up to 15m), impact moling (from 16m to about 40-50m), HDD (above 40-50m) shall be adopted based on the soil/site conditions and the requirement. The exact method for trenchless digging shall be finalised during detail engineering as per actual site/soil condition. The equipment used for HDD shall be capable of drilling at least 100m at one go. The contractor shall propose the exact methods and procedures for implementation of trenchless digging at various crossings taking into consideration the following guidelines, for approval by the Employer.

a) Excavation and backfilling of trial pits and verification of soil condition
b) Excavation of entry and Exit pits
c) Erection of drill machine for Drilling of pilot hole
d) Placement and driving hand augur

e) Placement and carrying out impact moling
f) Reaming and widening of bore holes in steps (if required)
g) Pulling of product pipe

22 FOOTPATH CUTTING

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

23 REINSTATEMENT

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

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

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

24 MANHOLES

Manholes shall be provided at every proposed joint location for jointing bays. The bidder shall identify the location of the joint bays after carrying out detailed survey of the cable route and excavation of the trial pits. The delivery lengths of the cables shall match the location.

The Contractor shall get inspected, by a representative of the Employer, all manholes before carrying out the backfilling. Pipe & cable sealing, installation of joint box and cable service loops as per approved drawings shall be visually inspected and checked for tightness.

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

25 TOOLS AND PLANTS

The successful bidder shall arrange, at his own cost, all necessary tools, plant and equipment to carry out the survey and cable installation work. The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

26 BENDING RADIUS

The minimum bending radius of XLPE insulated cables shall be 20XD where “D” means the Outer diameter of the cable.

27 JOINTING AND TERMINATION OF CABLES

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

Jointing of cables in carriage ways, drive ways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables and water mains should be avoided whenever possible.

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

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

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

27.1 SUMPHOLES

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

27.2 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.

27.3 PRECAUTIONS BEFORE MAKING A JOINT

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

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

27.4 MEASUREMENT OF INSULATION RESISTANCE

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

27.5 IDENTIFICATION

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

27.6 MAKING A JOINT

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 EHV XLPE cables.

28 CABLE LAYING & TERMINATIONS

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

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

(i) A sufficient length of spare cable shall be left in the ground, for future needs.
(ii) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
(iii) The cable shall be properly fastened using non-metallic clamps.
(iv) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.
(v) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.
(vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.
(vii) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to IS–3043:1987 (Code of practice for earthing)/ or equivalent International standards.

29 BONDING OF SCREEN/ SHEATH

The screens/sheath shall be cross-bonded under each segment of specified route in accordance with IS-3043 (Code of practice for earthing) or applicable International codes & practices. The bidder shall offer complete cable system in order to limit maximum sheath voltage in accordance with relevant standards and furnish complete set of calculations in support of the same. The screen/sheath shall be connected to the earth stations/ earth pits through disconnecting type link boxes & through Sheath Voltage Limiter (SVL) as required.

All required materials used in the Cross bonding, termination of earth continuity cable, Link box, SVL etc to comply with specification/statutory requirements shall be in the scope of bidder and should be of good quality and compatible with the cable.

30 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.

31 CABLE TERMINATING STRUCTURES

31.1 The terminating structure being supplied, should be designed as per the project requirement for the cable end terminations i.e. for Standalone Outdoor AIS

terminations, GIS end terminations and Transmission line Tower end terminations as per requirement specified in BPS.

31.2 The mounting structure shall be fixed on the reinforced cement concrete foundation, the design & drawings of which shall be submitted to Employer for review & acceptance during detailed engineering.

31.3 The mounting structure includes the supports for cable end boxes, link boxes and any other item 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. The steel for mounting structure shall confirm to IS-2062 (latest).

31.4 In case of cable terminations on transmission line towers, the cable termination kit, LA, Link Box, SVL etc shall be fixed suitably on the tower for which necessary interface details shall be coordinated for Tower design during detailed engineering. After fixing the end terminations, the cable shall be suitably fixed to the tower members, with non-magnetic material clamps to the required height securely. The cable in air shall be suitably protected using HDPE pipes up to certain height.

31.5 In case of GIS end terminations, the structure & foundations shall be suitably designed in coordination with GIS terminations during detailed engineering.

32 MEASUREMENT (for Civil Works)

The buried cable trench shall be measured in the running meters including excavation, back filling, thermal back filling (if applicable), compaction, laying of concrete/ reinforcement, placing of warning tap markers, dewatering as required as per the drawing & specification & any other job required for successful completion of work.

33 DISTRIBUTED TEMPERATURE MONITORING SYSTEM (DTS) (NOT APPLICABLE)

The bidder shall include and provide separate “Distributed Temperature Monitoring System (DTS)” for entire route for EHV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of conductor temperature profile and to provide load predictions. The offered system should be able to provide maximum possible transmission capacity of the cable for each circuit. The distributed temperature monitoring system shall be optical fibre based, must be of proven technology and should be in operation for similar use along with EHV cables as per latest practices. The “terminal coupling equipment” and “workstation” shall preferably be microprocessor based with HMI, for displaying temperature along the length of the cable system. System shall provide potential free output contact for signalling to SCADA. The bidder shall provide brochures and catalogues for offered distributed temperature monitoring system along with the bid.

Optical fibre cables along with all jointing accessories etc required for DTS shall also be included in the scope of bidder. Optical fibre cables associated with DTS shall be laid in the same EHV cable trench.

34 OPTICAL FIBRE CABLE (For Communication Equipments)

If specified in the bidding documents, Optical fibre cable required for Communication Equipments shall also be laid in the same cable trench in separate HDPE pipe.

SECTION 23

TECHNICAL DATA SHEET

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/66kV, 63MVA
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	7	
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC	
5	**Type**		Outdoor, oil immersed, Core Type	
6	**Winding / Phase**		Two or Three	
7	**Cooling**		ONAN /ONAF1/ONAF2	
8	**Ratings**			
8.1	Rated MVA		63	
8.1.1	ONAN	MVA	51.5	
8.1.2	ONAF	MVA	63	
8.2	Rated Voltage			
8.2.1	Primary	kV	132	
8.2.2	Secondary	kV	66	
8.2.3	Tertiary (If Provided)	kV	11	
8.3	Maximum Voltage			
8.3.1	Primary	kV	145	
8.3.2	Secondary	kV	72.5	
8.3.3	Tertiary (If Provided)	kV	12	
8.4	**Number of Phases**		Three	
8.5	**Rated Frequency**	Hz	50	
9	**Noise Level**			
	On ONAN Rating	dB	<73	
	On ONAF Rating Rated Voltage	dB	<75	
10	**Temperature Rise**			
10.1	Temperature Rise above 45°C ambient			
	- In Oil by Thermometer	°C	50	
	- In Winding By Resistance	°C	55	
10.2	Hottest Spot Temperature in Winding Limited to	°C	55	
10.3	Temperature Indicators Make		KHILSTROM, Sweden or Equivalent.	
11	**Connection**			
11.1	High Voltage		Star	
11.2	Low Voltage		Star	
11.3	Tertiary(if provided)		Delta	
11.3	Vector Group Ref in accordance with IEC 76		YNyn0	
	Vector Group		YNyn0 D11	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 63MVA
12	**Taps**			
12.1	Type of Tap changer		OLTC	
12.2	Tap Step		1.25%	
12.3	Tap Range		± 10%	
12.4	Nos. of Tap		17	
13	**Cooling Equipment (For ONAF)**			
13.1	Manufacturer/ Type			
13.2	Number of Fans Connected	Nos		
13.3	Rated Operating Voltage, Vac	Vac	230/400, 50Hz	
13.4	Rated Control Voltage, V	Vdc	110	
13.5	Rated Power	KW		
14	**OLTC Gear**			
14.1	Manufacturer / Type	MR, Germany, ABB, Sweden or Equivalent		
14.2	Rating - Rated Voltage - Rated Current - Step Voltage - Numbers of Steps	 KV A V Nos	 Suitable for 132kV class 17	
14.3	Control Suitable For - Remote / Local Operation - Auto / Manual Operation - Parallel Operation - Master Slave Operation	 Yes/No Yes/No	 Remote / Local Auto / Manual Yes Yes	
14.4	Rated voltage of Drive Motor	Vac	230/400 50Hz	
15	**Guaranteed losses**			
15.1	No Load Losses at Rated Voltage and Frequency on Max. MVA Base.	kW		
15.2	Load Losses at rated Current and and at 75°C on max. MVA base	kW		
15.3	Cooler Losses for full load operation on max. MVA base	kW		
16	**Impedance at Rated Current and Frequency at 75°C Winding Temperatures on ONAF, MVA Base.** (Tolerance ±7.5% of the Declared Value)	%		
16.1	Positive Sequence Impedance at nameplate Normal tap	%	> 11	
16.2	Positive Sequence at Maximum Voltage Tap **(Tap 17)**	%		
16.3	Positive Sequence at Minimum Voltage Tap **(Tap 1)**	%		
16.4	Zero Sequence at Nameplate Tap			

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 63MVA
17	**Reactance** at rated current and Frequency at 75°C on Maximum MVA base at a nameplate tap			
18	**Efficiency at 75°C Winding Temperature at PF=0.9**			
18.1	At 100% Load	%		
18.2	At 75% Load	%		
18.3	At 50% Load	%	Above 99%	
19	**Load in Percentage** of Full Load and Power Factor at which maximum efficiency occurs.			
20	**Regulation at full Load and at 75C**			
20.1	At Unity Power Factor			
20.2	At 0.85 Power Factor Lagging			
21	**No Load Current in Percentage** of rated Current referred to HV and 50Hz.			
21.1	At 90% Rated Voltage	%		
21.2	At 100% Rated Voltage	%	<1	
21.3	At 110% Rated Voltage	%		
22	**Clearances**			
22.1	Minimum Clearances in air-HV/LV	mm		
22.2	Between Phases Between Phase and Earth	mm		
23	**Insulation Level**			
23.1	Power Frequency Withstand Voltage (1Min rms)			
23.1.1	Primary	kV	275	
23.1.2	Secondary	kV	140	
23.1.3	Tertiary (if Provided)	kV		
23.2	**Impulse Withstand Voltage**			
23.2.1	Primary	kV	650 (Crest)	
23.2.2	Secondary	kV	325 (Crest)	
23.2.2	Tertiary (if Provided)	kV		
24	**Details of Oil Preservation System**			
24.1	Type		Conservator Type	
24.2	Details of Oil Preservation System			
24.3	If Conservator Type, Urethane Air Cell provided	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 63MVA
24.4	Volume of Conservator	Cu.m		
24.5	Volume of Oil Between the highest and Lowest Levels	Ltrs		
25	**Pressure Relief Device** Min. pressure setting	Kg/cm2		
26 26.1	**Details of Bushings HV / LV / Neutral** Manufacturer / Type			
26.2	Voltage class	KV	145/72.5	
26.2	Creepage Distance	mm	25mm/kV	
26.3	Weight of Bushing	kg		
26.4	Standard Reference		IEC	
26.5	Dry Flash over Voltage	KV	275/140	
26.6	Wet Flash Over Voltage	KV	275/(140)	
26.7	Impulse Withstand Voltage	KV	650/325	
27	**Insulating Oil**			
i	**Manufacturer and Country of Origin**			
ii	**Manufacturer's type designation**			
iii	**Type**		Insulating Oil	
iv	**Applicable standard**			
v	**Technical Specifications**			
v.1	Dielectric Breakdown Strength (Min) at 2.5mm gap	kV	30	
v.2	Flash Point (Min)	°C	135	
v.3	Density at 20ºC (Max)	g/Cu.cm	0.895	
v.4	Viscosity at 40ºC (Max)	mm^2/s	12	
v.5	Viscosity at -30ºC (Max)	mm^2/s	1800	
v.6	Acidity Neutralization Value (Max)	mgKOH/g	0.01	
v.7	Sludge Value (Max)		0.1%	
v.8	Pour Point (Max)	°C	-40 C	
v.9	Corrosive Sulphur		Non-corrosive	
v.10	Water Content (Max)	ppm	40	
v.11	Dielectric Dissipation factor at 90 (Max)		0.005	
v.12	Appearance		clean free from sediment and suspended matter	
vi.	PCB Content		Not Detectable	
vii.	Approx. volume of Oil, ltrs			
Viii	Whether First filled of Oil with 5% excess provided	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
28	**Core Material**			***132/11kV, 63MVA***
28.1	Maximum flux density at rated voltage on principal tapping and rated frequency:			
	Transformer legs	T		
	Transformer yokes	T		
28.2	Maximum flux density at 110% voltage			
	Transformer legs	T	< 1.9	
	Transformer yokes	T	< 1.9	
28.3	Grade of core used	Prime core		
	Type of Core	CRGO		
	Thickness of core lamination			
	Rated Loss per kg			
29.1	Maximum current density in windings at rated output:			
	Primary (HV)	A/mm^2		
	Secondary (LV)	A/mm^2		
	Weight of copper in windings:			
	Primary (HV)			
	Secondary (LV)			
30	**Bushing Current Transformers**			
30.1	Numbers of Cores - HV - LV - Neutral	 Nos Nos Nos	 1 / phase 1 / phase 1	
30.2	Accuracy class / Burden/Ratio - HV / HV Neutral - LV / LV Neutral		 PS / 15VA/300/1 PS / 15VA/600/1	
31	**Lightning Arrestor mounted on** - HV - LV	 Yes/No Yes/No	 No No	
32	**RTCC Panel Details**			
32.1	AVR make / Model	MR, Germany, ABB, Sweden or Equivalent		
32.2	Annunciator 12 Windows provided	Yes/No	Yes	
32.3	Indicating Voltmeter	Yes/No	Yes	
32.4	Facilities and Provision as per specification provided?	Yes/No	Yes	
33	**Approximate Overall Dimension (L x W x H)**			

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 1: 63MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
34	**Approximate Weights**			
34.1	Core and Coil	Kg		
34.2	Tank and fittings	Kg		
34.3	Oil	Kg		
34.4	Total Weight	Kg		
35	Delivery of Equipment in Months, following the Award of Contract (Allowing the time for Drawing Approval)		Months	
36	Is manufacturer ISO 9001 holder?	Yes/No	Yes	
37	Type test certificate submitted?	Yes/No	Yes	
38	Has manufacturer exported units?	Yes/No	Yes	
39	User's certificate submitted?	Yes/No	Yes	
40	Technical literature / drawings submitted?	Yes/No	Yes	

NOTE: The bidder must submit the user certificate of the manufacturer of Transformer.

Deviations from technical requirements:

Signed…… As representative for……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 45MVA
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	7	
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC	
5	**Type**		Outdoor, oil immersed, Core Type	
6	**Winding / Phase**		Three	
7	**Cooling**		ONAN /ONAF	
8	**Ratings**			
8.1	Rated MVA		45	
8.1.1	ONAN	MVA	31.5	
8.1.2	ONAF	MVA	45	
8.2	Rated Voltage			
8.2.1	Primary	kV	132	
8.2.2	Secondary	kV	11	
8.2.3	Tertiary (If Provided)	kV		
8.3	Maximum Voltage			
8.3.1	Primary	kV	145	
8.3.2	Secondary	kV	12	
8.3.3	Tertiary (If Provided)	kV		
8.4	**Number of Phases**		Three	
8.5	**Rated Frequency**	Hz	50	
9	**Noise Level**			
	On ONAN Rating	dB	<73	
	On ONAF Rating Rated Voltage	dB	<75	
10	**Temperature Rise**			
10.1	Temperature Rise above 45°C ambient			
	- In Oil by Thermometer	°C	50	
	- In Winding By Resistance	°C	55	
10.2	Hottest Spot Temperature in Winding Limited to	°C	55	
10.3	Temperature Indicators Make		KHILSTROM, Sweden or Equivalent.	
11	**Connection**			
11.1	High Voltage		Star	
11.2	Low Voltage		Star	
11.3	Tertiary(if provided)		Delta	
11.3	Vector Group Ref in accordance with IEC 76		YNyn0	
	Vector Group		YNyn0 D11	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 45MVA
12	**Taps**			
12.1	Type of Tap changer		OLTC	
12.2	Tap Step		1.25%	
12.3	Tap Range		± 10%	
12.4	Nos. of Tap		17	
13	**Cooling Equipment (For ONAF)**			
13.1	Manufacturer/ Type			
13.2	Number of Fans Connected	Nos		
13.3	Rated Operating Voltage, Vac	Vac	230/400, 50Hz	
13.4	Rated Control Voltage, V	Vdc	110	
13.5	Rated Power	KW		
14	**OLTC Gear**			
14.1	Manufacturer / Type	MR, Germany, ABB, Sweden or Equivalent		
14.2	Rating - Rated Voltage - Rated Current - Step Voltage - Numbers of Steps	 KV A V Nos	 Suitable for 132kV class 17	
14.3	Control Suitable For - Remote / Local Operation - Auto / Manual Operation - Parallel Operation - Master Slave Operation	 Yes/No Yes/No	 Remote / Local Auto / Manual Yes Yes	
14.4	Rated voltage of Drive Motor	Vac	230/400 50Hz	
15	**Guaranteed losses**			
15.1	No Load Losses at Rated Voltage and Frequency on Max. MVA Base.	kW		
15.2	Load Losses at rated Current and and at 75°C on max. MVA base	kW		
15.3	Cooler Losses for full load operation on max. MVA base	kW		
16	**Impedance at Rated Current and Frequency at 75°C Winding Temperatures on ONAF, MVA Base.** (Tolerance ±7.5% of the Declared Value)	%		
16.1	Positive Sequence Impedance at nameplate Normal tap	%	> 11	
16.2	Positive Sequence at Maximum Voltage Tap **(Tap 17)**	%		
16.3	Positive Sequence at Minimum Voltage Tap **(Tap 1)**	%		
16.4	Zero Sequence at Nameplate Tap			

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 45MVA
17	**Reactance** at rated current and Frequency at 75°C on Maximum MVA base at a nameplate tap			
18	**Efficiency at 75°C Winding Temperature at PF=0.9**			
18.1	At 100% Load	%		
18.2	At 75% Load	%		
18.3	At 50% Load	%	Above 99%	
19	**Load in Percentage** of Full Load and Power Factor at which maximum efficiency occurs.			
20	**Regulation at full Load and at 75C**			
20.1	At Unity Power Factor			
20.2	At 0.85 Power Factor Lagging			
21	**No Load Current in Percentage** of rated Current referred to HV and 50Hz.			
21.1	At 90% Rated Voltage	%		
21.2	At 100% Rated Voltage	%	<1	
21.3	At 110% Rated Voltage	%		
22	**Clearances**			
22.1	Minimum Clearances in air-HV/LV	mm		
22.2	Between Phases Between Phase and Earth	mm		
23	**Insulation Level**			
23.1	Power Frequency Withstand Voltage (1Min rms)			
23.1.1	Primary	kV	275	
23.1.2	Secondary	kV	28	
23.1.3	Tertiary (if Provided)	kV		
23.2	**Impulse Withstand Voltage**			
23.2.1	Primary	kV	650 (Crest)	
23.2.2	Secondary	kV	75 (Crest)	
23.2.2	Tertiary (if Provided)	kV		
24	**Details of Oil Preservation System**			
24.1	Type		Conservator Type	
24.2	Details of Oil Preservation System			
24.3	If Conservator Type, Urethane Air Cell provided	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132/11kV, 45MVA
24.4	Volume of Conservator	Cu.m		
24.5	Volume of Oil Between the highest and Lowest Levels	Ltrs		
25	**Pressure Relief Device** Min. pressure setting	Kg/cm2		
26 26.1	**Details of Bushings HV / LV / Neutral** Manufacturer / Type			
26.2	Voltage class	KV	145/12	
26.2	Creepage Distance	mm	25mm/kV	
26.3	Weight of Bushing	kg		
26.4	Standard Reference		IEC	
26.5	Dry Flash over Voltage	KV	275/28	
26.6	Wet Flash Over Voltage	KV	275/(28	
26.7	Impulse Withstand Voltage	KV	650/75	
27	**Insulating Oil**			
i	**Manufacturer and Country of Origin**			
ii	**Manufacturer's type designation**			
iii	**Type**		Insulating Oil	
iv	**Applicable standard**			
v	**Technical Specifications**			
v.1	Dielectric Breakdown Strength (Min) at 2.5mm gap	kV	30	
v.2	Flash Point (Min)	°C	135	
v.3	Density at 20ºC (Max)	g/Cu.cm	0.895	
v.4	Viscosity at 40ºC (Max)	mm^2/s	12	
v.5	Viscosity at -30ºC (Max)	mm^2/s	1800	
v.6	Acidity Neutralization Value (Max)	mgKOH/g	0.01	
v.7	Sludge Value (Max)		0.1%	
v.8	Pour Point (Max)	°C	-40 C	
v.9	Corrosive Sulphur		Non-corrosive	
v.10	Water Content (Max)	ppm	40	
v.11	Dielectric Dissipation factor at 90 (Max)		0.005	
v.12	Appearance		clean free from sediment and suspended matter	
vi.	PCB Content		Not Detectable	
vii.	Approx. volume of Oil, ltrs			
Viii	Whether First filled of Oil with 5% excess provided	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
28	**Core Material**			***132/11kV, 45MVA***
28.1	Maximum flux density at rated voltage on principal tapping and rated frequency:			
	Transformer legs	T		
	Transformer yokes	T		
28.2	Maximum flux density at 110% voltage			
	Transformer legs	T	< 1.9	
	Transformer yokes	T	< 1.9	
28.3	Grade of core used	Prime core		
	Type of Core	CRGO		
	Thickness of core lamination			
	Rated Loss per kg			
29.1	Maximum current density in windings at rated output:			
	Primary (HV)	A/mm^2		
	Secondary (LV)	A/mm^2		
	Weight of copper in windings:			
	Primary (HV)			
	Secondary (LV)			
30	**Bushing Current Transformers**			
30.1	Numbers of Cores - HV - LV - Neutral	 Nos Nos Nos	 1 / phase 1 / phase 1	
30.2	Accuracy class / Burden/Ratio - HV / HV Neutral - LV / LV Neutral		 PS / 15VA/200/1 PS / 15VA/2400/1	
31	**Lightning Arrestor mounted on** - HV - LV	 Yes/No Yes/No	 No Yes	
32	**RTCC Panel Details**			
32.1	AVR make / Model	MR, Germany, ABB, Sweden or Equivalent		
32.2	Annunciator 12 Windows provided	Yes/No	Yes	
32.3	Indicating Voltmeter	Yes/No	Yes	
32.4	Facilities and Provision as per specification provided?	Yes/No	Yes	
33	**Approximate Overall Dimension (L x W x H)**			

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 2: 45MVA POWER TRANSFORMER

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
34	**Approximate Weights**			
34.1	Core and Coil	Kg		
34.2	Tank and fittings	Kg		
34.3	Oil	Kg		
34.4	Total Weight	Kg		
35	Delivery of Equipment in Months, following the Award of Contract (Allowing the time for Drawing Approval)		Months	
36	Is manufacturer ISO 9001 holder?	Yes/No	Yes	
37	Type test certificate submitted?	Yes/No	Yes	
38	Has manufacturer exported units?	Yes/No	Yes	
39	User's certificate submitted?	Yes/No	Yes	
40	Technical literature / drawings submitted?	Yes/No	Yes	

NOTE: The bidder must submit the user certificate of the manufacturer of Transformer.

Deviations from technical requirements:

Signed…… As representative for……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.3: 315kVA STATION TRANSFORMER **Sheet 1 of 1**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
1	Manufacturer and Country of Origin			
2	Rated power	kVA	315	
3	Rated voltage		IEC	
4	Voltage rating			
	a) Primary	kV	11	
	b) Secondary	V	400	
5	Max system Voltage			
	a) Primary	kV	12	
	b) Secondary	V	440	
6	Connection -Primary / secondary		 Delta /Y	
7	Cooling		ONAN	
8	Vector group		Dyn 11	
9	Rated impedance voltage		5 %	
10	Withstand Voltage -Primary -Secondary	 kV kV	 75 3	
11	BIL of winding (primary)	kV	75	
12	Off circuit tap changer		+/- 5%	
13	Max. noise level	dB	44	
14	No load loss	W		
15	Load loss	W		
16	Applicable standard		IEC	
17	**Approximate Overall Dimension (L x W x H)**			
18	**Approximate Weights**			
18.1	Core and Coil	Kg		
18.2	Tank and fittings	Kg		
18.3	Oil	Kg		
18.4	Total Weight	Kg		
19	Delivery of Equipment in Months, following the Award of Contract (Allowing the time for Drawing Approval)		Months	
20	Is manufacturer ISO 9001 holder?	Yes/No	Yes	
22	Technical literature / drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…… As representative for……

Address…… Date ……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.4 : 132kV GIS(132kV CIRCUIT BREAKER) **Sheet 1 of 2**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132kV
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	7	
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC	
5	**Type**		GIS	
6	**Poles**		Three pole	
8	**Rated Voltage**	kV	132	
9	**Rated current**			
9.1	Continuous at 50 degree ambient	A	1250,1600, 2000 (B/C) As per PSR	
9.2	Short time for 1 sec at max. kV	kA	31.5	
10	**Frequency**	Hz	50	
11	**Temperature rise above 45 degree C ambient**		As per IEC	
11.1	Contacts	°C	65	
11.2	Terminals	°C	65	
12	**Rated short circuit breaking current**	**kA**	**31.5**	
13	**Rated short circuit making current**			
13.1	Peak	kA	80	
14	**Interrupting time at 100% capacity**			
14.1	Maximum opening time	mS		
14.2	Total interrupting time	mS		
15	**Closing time**	mS		
17	**Maximum capacitive current breaking capacity (rms)**	A		
18	**Insulation level**			
18.1	Impulse withstand voltage (crest)	kV	650	
18.2	Power frequency withstand voltage	kV	275	
19	**Operating mechanism**			
19.1	Type		Spring operated	
19.2	Number of mechanism per breaker		1	
19.3	Single/three phase auto-reclosure		3	
19.4	Operating voltage of closing and tripping coil	V DC	110	
19.5	Operaing voltage range -Closing -Tripping	% of rated voltage	 85-110% 70-110%	
19.6	Closing and tripping current	A		
19.7	Spring charging motor rating -Capacity -Rated voltage	 kW V	 110V DC	
19.8	Time required by motor to charge the spring completely	Sec	<30	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 4a : 132kV kV GIS (132kV CIRCUIT BREAKER) **Sheet 2 of 2**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
				132kV
20	Anti pumping device provided	Yes/No	Yes	
21	Trip-free feature provided	Yes/No	Yes	
22	**Number of N.C. contacts**	No.	8	
23	**Number of N.O. contacts**	No.	8	

ITEM No. 4b: 132kV DISCONNECTING SWITCH & EARTH SWITCH

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
			132kV	**132kV**
1	**Applicable standard**		IEC	
2	**Type**		3 pole group operated	
4	**Rated Voltage**			
4.1	Nominal	kV	132	
4.2	Maximum	kV	145	
5	**Rated current**			
5.1	Continuous at 50°C ambient	A	1250 /1600/ 2000 as per PSR	
5.2	Short time for 1 sec at max. kV	kA	31.5	
6	**Temperature rise above 45 degree C ambient at normal rated current**		As per IEC	
6.1	Contacts	°C		
6.2	Current carrying parts	°C		
7	**Insulation level**			
7.1	Impulse withstand voltage(peak)	kV	650	
7.2	Power frequency withstand voltage (1min, rms)	kV	275	
13	**Main contacts**			
	- Material of fixed contacts		Provide	
	- Material of moving contacts		Provide	
	- Material of the contacts of the earthing switch		Provide	
19	**Auxiliary power supply**			
19.2	Control circuit	V, DC	110DC	
19.3	Operating motor	V, phase	110DC	
22	**Number of N.C. contacts**	No.	4 min	
23	**Number of N.O. contacts**	No.	4 min	
25	**Operating mechanism**		Motor & Manual Operated	
	Operating motor	W		
26	**Types of interlocks furnished**		Electrical and manual	
27	**Earthing Switch**			
27.1	Operating Mechanism		Manual and Motor Operated	
	Operating motor	W		

27.2	Type of Interlocks		Electrical and manual	
22	**Number of N.C. contacts**	No.	4	
23	**Number of N.O. contacts**	No.	4	
24	**Operating duty cycle**		O - 0.3sec – CO - 3min – CO	

ITEM No. 4c: 132kV CURRENT TRANSFORMER				
	DESCRIPTION	**UNIT**	**NEA REQ**	**DATA to be Filled**
			132kV	**132kV**
1.	**Type**		Indoor, Metal enclosed	
2.	**Number of cores in each CT**	NO.	5 or As per PSR	
3.	**Rated Primary Voltage**			
3.1	Nominal	kV	132	
3.2	Maximum	kV	145	
4.	**Insulation level**			
4.1	Impulse withstand voltage(peak)	kV	650	
4.2.	Power frequency withstand voltage (1min, rms)	kV	275	
5.	**Short time thermal rating**	kA	31.5	
6.	**Rated Peak Short circuit Current**	kA	80	
7.	**Rated VA burden for each core**	VA	As per PSR	
8.	**Accuracy class**	5P20 for protection 0.2 for metering PS for diff / Bus		
9	**Current Ratio**	A	As per Technical Data in specification/DDE	
10.	**Overvoltage factor**		1.1	
11	**Rated continuous thermal current**		1.2x	

ITEM No. 4d: 132kV VOLTAGE TRANSFORMER					
	DESCRIPTION	**UNIT**	**NEA REQ**	**DATA to be Filled**	**DATA to be Filled**
1	1. Applicable standard		IEC		
2	2. Type		Indoor Metal enclosed		
3	3. Rated primary voltage				
	a) Nominal	kV	132/√3		
	b) Maximum voltage	kV	145/√3		
4	4. Insulation level				
	a) Impulse withstand voltage (primary)	kV	650		
	b) Power frequency withstand (1 min. rms) (primary)	kV	275		
5	5. Rating				
	a) Voltage ratio	kV	132/√3: 0.11/√3		
	b) Rated burden	VA	50		
	c) Accuracy class		3P & 0.2 for metering		
	d) Overvoltage factor				
	- Continuous		1.1		

	- 30 seconds		1.5		
	h) Number of secondary windings		*As per psr*		

ITEM No. 4e: 132 kV & 66 kV LIGHTNING ARRESTOR				
	DESCRIPTION	**UNIT**	**NEA REQ**	**DATA to be Filled**
			132kV, 66kV	**132kV**
1	**Type**		Outdoor, gapless, Metal-Oxide	
2	**Voltage rating of L.A**	kV	120, 60	
3	**Nominal discharge current**	kA	10	
4	**Surge counter with insulating base furnished**	Yes/No	Yes	
5	**Insulation level**			
	a)Impulse withstand voltage(peak)	kV	650, 325	
	b)Power frequency withstand voltage (1min, rms)	kV	275, 140	

4f: GAS INSULATED BUS				
1	**Bus arrangement formation**		Horizontal	
2	**Bus Duct Proposed**	1 or 3 Phase		
4g: GENERAL				
1	**Gas density detector provided**	Yes/No	Yes	
2	**Operation counter provided**	Yes/No	Yes	
3	**Space heater provided for cubicle**	Yes/No	Yes	
4	**Enclosure Protection**		IP55W	
5	**Number of possible operations without maintenance under:** Rated short circuit breaking current Rated normal current	 No No	 10 2000	
6	**Rated SF6 pressure**	kgf/cm2		
7	**Guaranteed SF6 losses/year**	kg	0.5% per Annum	
8	**Padlocking provision for local cubicle**	Yes/No	Yes	
9	UHF sensors for PD detection	Yes/No	Yes	
	Numbers of sensors			
10	**Total weight of the circuit breaker**	Kg		
11	**Mechanical dimension(LXWXH)**	mm x mm x mm		
12	**Delivery of equipment in months** following award of contract	(Allowing time for approval of drawing)		
13	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
14	Type test certificate submitted?	Yes/No	Yes	
15	Has manufacturer exported units?	Yes/No	Yes	
16	Technical literature / drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…….. As representative for……
Address……
Date……

TECHNICAL DATA SHEET (To Be Completed By the Tenderer) ITEM No.4: 132 kV & 66 kV LIGHTNING ARRESTOR Sheet 1 of 1					
	DESCRIPTION	**UNIT**	**NEA REQ**	**DATA to be Filled**	**DATA to be Filled**
			132kV, 66 kV	**132kV**	**66 kV**
1	**Manufacturer and Country of Origin**				
2	**Year of manufacturing experience**	Years	5		
3	**Manufacturing's Designation as per submitted catalogue**				
4	**Applicable standard**		IEC		
5	**Type**		Outdoor, gapless, Zinc-Oxide		
6	**Voltage rating of L.A**	kV	120, 60		
7	**Nominal discharge current**	kA	10		
8	**Surge counter with insulating base furnished**	Yes/No	Yes		
9	**Minimum power frequency sparkover voltage**	kV			
10	**Maximum 1/50 impulse sparkover voltage**	kV			
11	**Maximum front wave sparkover voltage**	kV			
12	**Maximum switching surge sparkover voltage**	kV			
13	**Number of section per Pole**		1		
14	**Insulation level**				
	a)Impulse withstand voltage(peak)	kV	650,325		
	b)Power frequency withstand voltage (1min, rms)	kV	275,140		
15	**Porcelain creepage distance**	mm	3300, 1600		
16	**Earth terminal with accessories provided**	Yes/No	Yes		
17	**Delivery of equipment in months** following award of contract (Allowing time for approval of drawing)	month			
18	Is manufacturer is ISO 9001 holder?	Yes/No	Yes		
20	Has manufacturer exported units?	Yes/No	Yes		
21	Technical literature/drawings submitted?	Yes/No	Yes		

Deviations from technical requirements:

Signed…… As representative for……

Address……
Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No5: 9 kV LIGHTNING ARRESTOR **Sheet 1 of 1**

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
			>11 kV	**>11 kV**
1	**Manufacturer and Country of Origin**			
2	**Year of manufacturing experience**	Years	5	
3	**Manufacturing's Designation as per submitted catalogue**			
4	**Applicable standard**		IEC	
5	**Type**		Outdoor, gapless, Zinc-Oxide	
6	**Voltage rating of L.A**	kV	9	
7	**Nominal discharge current**	kA	10	
8	**Surge counter with insulating base furnished**	Yes/No	Yes	
9	**Minimum power frequency sparkover voltage**	kV		
10	**Maximum 1/50 impulse sparkover voltage**	kV		
11	**Maximum front wave sparkover voltage**	kV		
12	**Maximum switching surge sparkover voltage**	kV		
13	**Number of section per Pole**		1	
14	**Insulation level**			
	a)Impulse withstand voltage(peak)	kV	28	
	b)Power frequency withstand voltage (1min, rms)	kV	75	
15	**Porcelain creepage distance**	mm	....	
16	**Earth terminal with accessories provided**	Yeas/No	Yes	
17	**Delivery of equipment in months** following award of contract (Allowing time for approval of drawing)	month		
18	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
19	Has manufacturer exported units?	Yes/No	Yes	
20	Technical literature/drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…… As representative for……

Address…… Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No. 6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 1 of 6

	DESCRIPTION	UNIT		DATA to be Filled
1	**CONTROL AND RELAY PANEL TYPE**	**Duplex / Simplex**		
1.1	Manufacturer and Country of Origin			
1.2	Year of manufacturing experience	Years	5	
1.3	Manufacturing's Designation as per submitted catalogue			
5	**INDICATING INSTRUMENTS**			
5.1	**Ammeter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iv.	Accuracy class		0.5	
v.	**Scale**			
	-Type of scale			
	-Range of indication (……./1 Amp CT operated)	A	As required	
	-Overload range	%	1.5	
vi.	VA Burden			
vi.	Transducer operated	Yes/No	Yes	
5.2	**Apparent Power Meter (VA)**			
i.	Manufacturer and Country of Origin			
ii	Type		Digital	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
iv	Rated current	A	……./1	
vi	Accuracy class		0.5	
vii	Scale		Centre zero	
	-Range of indication	MVA	As Required	
viii.	VA Burden Current Coil Voltage Coil			
x	Transducer operated	Yes/No	Yes	
5.3	**KWh Meter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital, 3-phase, 4 wire	
iii.	Applicable standard	IEC	IEC	
iv.	Accuracy class		0.2	
v.	Import and Export meter provided	Yes/No	Yes	
vi.	Rated voltage	kV	132/√3 : 0.11/√3	
vii.	Rated current	A	……../1	
viii.	Operating current range	A		
ix.	Operating Voltage range	A		

x.	VA Burden Current Coil Voltage Coil	VA		

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 2 of 6

	DESCRIPTION	UNIT		DATA to be Filled
xi.	Impulse contact provided	Yes/No	Yes	
xii.	Programmable at Site		Yes	
xiii.	Software and optical probe provided as per Price schedule & BOQ		Yes	
5.4	**Watt meter, MW**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iii.	Accuracy class		0.5	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
iv	Rated current	A	……/1	
	-Range of indication	MW	0-50-100	
5.6	**Annunciators**			
I	Manufacturer and Country of Origin			
ii.	Type			
iii.	Manufacturer's type designation			
iv.	Catalogue furnished	Yes/No	Yes	
vi.	Number of active points	No.	24	
vii.	Number of rows	No.	4	
viii.	Number of column	No.	6	
ix.	Type of mounting		Flush	
x.	Replacement of individual inscription plates and lamps from front panel possible	Yes/No	Yes	
xi.	Sequence of operation as per specification	Yes/No	Yes	
6	**PROTECTIVE RELAYS**			
6.1	**PHASE OVERCURRENT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Non Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple Pole	
vi.	Current setting range	% of rated current	20-200%	
vii.	Operating time at 10 times current setting	sec	3	
viii.	Reset time	mS		
ix.	Characteristics		IDMT(standard inverse)	
x.	Instantaneous unit provided -Current setting range -Operating range -NO Contacts	Yes/No % of rated current	Yes 500-2000%	

xi.	Insulating test according to IEC	Yes/No		
xii.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
xiii.	Auxiliary DC Supply	V_{dc}	110	
xiv.	Technical literature submitted	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 3 of 6

	DESCRIPTION	UNIT		DATA to be Filled
6.2	EARTH FAULT RELAYS			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical, Non-Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple	
vi.	Continuous overload capacity	x In		
vii.	Current setting range	% of rated current	10-80%	
viii.	Operating time at 10 times current setting	sec	3	
ix.	Characteristics		IDMT(standard inverse)	
x.	Instantaneous unit provided -Current setting range -Operating range -NO Contacts, Nos	Yes/No % of rated current mS	Yes 500-2000%	
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
xiii.	Auxiliary DC Supply	V_{dc}	110	
xvi.	Technical literature submitted	Yes/No	Yes	
6.3	**Directional Overcurrent Relay**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple	
vi.	Current setting range	% of rated current	20-200%	
vii.	Operating time at 10 times current setting	sec	3	
viii.	Reset time	mS		
ix.	Characteristics Characteristic Angle		IDMT(standard inverse), 45°	
x.	Instantaneous unit provided -Current setting range -Operating range	Yes/No % of rated current, mS	Yes 500-2000%	
xi.	Insulating test according to IEC	Yes/No		

xii.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
xiii.	Auxiliary DC Supply	Vdc	110	
6.4	**Directional Earth fault Relay**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Directional	
iii.	Manufacturer's type designation			

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 4 of 6

	DESCRIPTION	UNIT		DATA to be Filled
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple	
vi.	Continuous overload capacity	xIn		
vii.	Current setting range	% of rated current	10-80%	
viii.	Operating time at 10 times current setting	sec	3	
ix.	Characteristics Characteristic Angle		IDMT(standard inverse), 45°	
x.	Instantaneous unit provided -Current setting range -Operating range	Yes/No % of rated current mS	Yes 500-2000%	
xi.	Insulating test according to IEC	Yes/No		
xii.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
xiii.	Technical literature submitted	Yes/No	Yes	
6.5	Transformer Differential relay			
i.	Manufacturer / Country of Origin			
ii.	Standard Reference	IEC	IEC	
iii.	Type of Construction			
iv.	Type		Numerical	
v.	Voltage Rating	V	110/220	
vi.	Type of Mounting		Flush	
vii.	Operating Time Setting, Sec	mS	<30	
viii.	Sensitivity Setting		20-50% x In	
ix.	Bias Setting			
x.	CT Ratio Compensating Range			
xi.	Burden for Current Circuit	VA		
xii.	DC Burden	VA		
xiii.	Tripping	A		
xiv.	Making current	A		
xv.	Closing Load (At 110V DC)	A		
6.6	**AUXILIARY TRIPPING & LOCKOUT RELAYS**			
i.	Manufacturer and Country of Origin			

ii.	Type			
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Operating time	mS	<15	
vi.	Does the lockout relay reset by the manually operated or electrically operated reset device			
vii.	Is the cut-off contact provided to interrupt the operating coil ?	Yes/No		
viii.	Contact rating at 125V DC	A		
xi.	Technical literature submitted	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 5 of6

	DESCRIPTION	UNIT		DATA to be Filled
6.7	**Breaker Fail Lockout Relay, 86K**			
i.	DC Voltage Rating, V	V	110	
ii.	Nos. of Electrically separate NO & NC Contacts			
6.8	**Breaker Failure Lockout Relay, 86BF & LBB Protection**			
i.	DC Voltage Rating, V	V	110	
ii.	Nos of Electrically separate NO & NC Contacts			
v.	Technical literature submitted	Yes/No	Yes	
6.9	**BREAKER FAILURE PROTECTION RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Manufacturer's type designation			
iii.	Applicable standard	IEC	IEC	
iv.	Triple pole or single pole		Triple Pole	
v.	Current setting range	% of rated current	20-200%	
vi.	Time setting range	sec		
vii.	Reset time	mS		
viii.	Insulating test according to IEC	Yes/No		
ix.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
x.	Auxiliary DC Supply	V_{dc}	110	
xi.	Is manufacturer ISO 9001 holder?	Yes/No	Yes	
xii.	ISO certificate submitted	Yes/No	Yes	
xiii.	Technical literature submitted	Yes/No	Yes	
7	**CONSTRUCTION OF CONTROL & RELAY PANEL**			
i.	Type(Simplex/Duplex)		Duplex	
ii.	Manufacturer's type designation			
iii.	Applicable standard	IEC	IEC	
iv.	Control panels furnished as per specifications	Yes/No	Yes	
v.	Enclosure protection class	IP	IP 4X	
vi.	Thickness of sheet metal used			

	-Front and rear portion -Side, top and bottom covers -Doors	mm mm mm	>=3 >=2 >=3	
vii.	All instruments, meters, relays and control switches flush or semi-flush type		Flush	
viii.	Ground bus -Material -Size	 mm x mm	 Copper 25 X 6	
ix.	Internal Wiring - Type of Insulation - Voltage Grade of Wires - Cross Section of wire Current circuit Voltage & auxiliary Circuit	 V Sq.mm	 600	
x.	Overall dimension of control boards (LxWxH)	mm		

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.6: CONTROL AND RELAY PANEL FOR TRANSFORMER
Sheet 6 of 6

	DESCRIPTION	UNIT		DATA to be Filled
xi.	Shipping data -Size of large package -Weight of the heaviest package	 mm Kg		
xii.	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		
xiii.	Is manufacturer is ISO 9001 holder?	Yes/No	Yes	
xiv.	ISO 9001 certificate submitted?	Yes/No	Yes	
xv.	Has manufacturer exported units?	Yes/No	Yes	
xvi.	User's certificate submitted?	Yes/No	Yes	
xvii.	Technical literature/drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…….. As representative
for……

Address……
Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.7: CONTROL AND RELAY PANEL FOR LINE

	DESCRIPTION	UNIT		DATA to be Filled
1	**CONTROL AND RELAY PANEL TYPE**	**Duplex / Simplex**		
1.1	Manufacturer and Country of Origin			
1.2	Year of manufacturing experience	Years	5	
1.3	Manufacturing's Designation as per submitted catalogue			
2	**CONTROL DISCREPANCY SWITCHES**			
2.1	Manufacturer and Country of Origin			
2.2	Type		Discrepancy	
2.3	Current Rating	A		
3	**PUSH BUTTON**			
3.1	Manufacturer and Country of Origin			
3.2	Type			
3.3	Contact Rating, continuous Making Current Breaking Current	Amp Amp Amp		
4	**INDICATING LAMPS**			
4.1	Manufacturer			
4.2	Voltage Rating	V		
4.3	Wattage	W		
5	**INDICATING INSTRUMENTS**			
5.1	**Ammeter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iv.	Accuracy class		0.5	
v.	**Scale**			
	-Range of indication (……/1 Amp CT operated)	A	As Required	
	-Overload range	%	1.5	
vi.	VA Burden			
vi.	Transducer operated	Yes/No	Yes	
5.2	**Apparent Power Meter (VA)**			
i.	Manufacturer and Country of Origin			
ii	Type		Digital	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
iv	Rated current	A	……/1	
vi	Accuracy class		0.5	
vii	Scale		Centre zero	
	-Range of indication	MVA	As Required	
viii.	VA Burden Current Coil Voltage Coil			
x	Transducer operated	Yes/No	Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.7: CONTROL AND RELAY PANEL FOR LINE

	DESCRIPTION	UNIT		DATA to be Filled
5.3	**KWh Meter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital, 3-phase, 4 wire	
iii.	Applicable standard	IEC	IEC	
iv.	Accuracy class		0.2	
v.	Import and Export meter provided	Yes/No	Yes	
vi.	Rated voltage	kV	132/√3 : 0.11/√3	
vii.	Rated current	A	……../1	
viii.	Operating current range	A	1-10A	
ix.	Operating Voltage range	A	0-480V	
x.	VA Burden Current Coil Voltage Coil	VA		
xi.	Impulse contact provided	Yes/No	Yes	
xii.	Programmable at Site		Yes	
xiii.	Software and optical probe provided as per Price schedule & BOQ		Yes	
5.4	**Power Factor meter, PF**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iii.	Accuracy class		0.5	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
iv	Rated current	A	……/1	
5.5	**Voltmeter meter, V**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iii.	Accuracy class		0.5	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
iv.	-Range of indication	V	0-150	
5.6	**Frequency Meter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iii.	Accuracy class		0.5	
iii	Rated voltage	kV	132/√3 : 0.11/√3	
5.7	**Annunciators**			
I	Manufacturer and Country of Origin			
ii.	Type			
iii.	Manufacturer's type designation			
iv.	Catalogue furnished	Yes/No	Yes	
vi.	Number of active points	No.	Min 18	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.7: CONTROL AND RELAY PANEL FOR LINE

	DESCRIPTION	UNIT		DATA to be Filled
6	**PROTECTIVE RELAYS**			
6.1	**PHASE OVERCURRENT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Differential/ Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple	
vi.	Current setting range	% of rated current	20-200%	
vii.	Characteristics Characteristic Angle		IDMT(standard inverse), 45°	
viii.	Instantaneous unit provided -Current setting range -Operating range	Yes/No % of rated current, mS	Yes 500-2000%	
ix.	Auxiliary DC Supply	Vdc	110	
6.2	**Directional Earth fault Relay**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Directional	
iii.	Manufacturer's type designation			
v.	Triple pole or single pole		Triple	
vi.	Current setting range	% of rated current	10-80%	
vii.	Characteristics Characteristic Angle		IDMT(standard inverse), 45°	
x.	Instantaneous unit provided -Current setting range -Operating range	Yes/No % of rated current mS	Yes 500-2000%	
6.3	**Different /Distance Protection**			
i.	Manufacturer / Country of Origin			
ii.	Standard Reference	IEC	IEC	
iii.	Type of Construction			
iv.	Type		Numerical Non switched	
v.	Voltage Rating	V	110/220	
vi.	Type of Mounting		Flush	
vii.	Stepped Characteristic	mS	<30	
viii.	Number of Zone		3 Fw / 1 Rev	
ix.	Tripping		1 P / 3P	
x.	Weak infeed feature		Yes	
xi.	permissive under reach/ over reach/ blocking communication mode		Yes	
xii.	number of potential free contacts for Carrier aided Tripping, Auto reclosing, CB failure, Disturbance recorder & Data acquisition system		Yes	
xiii.	power swing blocking protection		Yes	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.7: CONTROL AND RELAY PANEL FOR LINE

	DESCRIPTION	UNIT		DATA to be Filled
xiv.	Fault Recorder / Disturbance Recorder		Yes	
xv.	Distance Fault Locator		Yes	
xvi	Other features as per specification		Yes	
6.4	**Auto reclosing Relay**			
i.	Manufacturer and Country of Origin			
ii.	Type			
6.5	**Breaker Failure Lockout Relay, 86BF & LBB Protection**			
i.	DC Voltage Rating, V	V	110 V	
ii.	Nos of Electrically separate NO & NC Contacts			
6.6	**AUXILIARY TRIPPING & LOCKOUT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type			
iii.	Manufacturer's type designation			
v.	Operating time	mS	<15	
viii.	Insulating test according to IEC	Yes/No		
ix.	Indication -Hand reset flags provided -Light emitting diode provided	 Yes/No Yes/No		
x.	Auxiliary DC Supply	V_{dc}	110	
xi.	Technical literature submitted	Yes/No	Yes	
7	**CONSTRUCTION OF CONTROL & RELAY PANEL**			
i.	Type(Simplex/Duplex)		Duplex	
ii.	Manufacturer's type designation			
iii.	Applicable standard	IEC	IEC	
iv.	Control panels furnished as per specifications	Yes/No	Yes	
v.	Enclosure protection class	IP	IP 4X	
vi.	Thickness of sheet metal used -Front and rear portion -Side, top and bottom covers -Doors	 mm mm mm	 >=3 >=2 >=3	
viii.	Ground bus -Material -Size	 mm x mm	 Copper 25 X 6	
x.	Overall dimension of control boards (LxWxH)	mm		
xii.	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		
xvii.	Technical literature/drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…….. As representative
for……
Address……
Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.8: CONTROL AND RELAY PANEL FOR BUSCOUPLER

	DESCRIPTION	UNIT		DATA to be Filled
1	**CONTROL AND RELAY PANEL TYPE**	**Duplex / Simplex**		
1.1	Manufacturer and Country of Origin			
1.2	Year of manufacturing experience	Years	5	
1.3	Manufacturing's Designation as per submitted catalogue			
2	**CONTROL DISCREPANCY SWITCHES**			
2.1	Manufacturer and Country of Origin			
2.2	Type		Discrepancy	
2.3	Current Rating	A		
2.3	Catalogue furnished	Yes/No	Yes	
3	**PUSH BUTTON**			
3.1	Manufacturer and Country of Origin			
3.2	Type			
3.3	Contact Rating, continuous Making Current Breaking Current	Amp Amp Amp		
4	**INDICATING LAMPS**			
4.1	Manufacturer			
4.2	Voltage Rating	V		
4.3	Wattage	W		
5	**INDICATING INSTRUMENTS**			
5.1	**Ammeter**			
i.	Manufacturer and Country of Origin			
ii.	Type		Digital	
iv.	Accuracy class		0.5	
v.	**Scale**			
	-Type of scale		Center zero	
	-Range of indication (……./1 Amp CT operated)	A	As Required	
	-Overload range	%	1.5	
vi.	Transducer operated	Yes/No	Yes	
5.2	**Annunciators**			
I	Manufacturer and Country of Origin			
ii.	Type			
iii.	Manufacturer's type designation			
iv.	Catalogue furnished	Yes/No	Yes	
vi.	Number of active points	No.	Min 18	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.8: CONTROL AND RELAY PANEL FOR BUSCOUPLER

	DESCRIPTION	UNIT		DATA to be Filled
6	**PROTECTIVE RELAYS**			
6.1	**PHASE OVERCURRENT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical Non Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Triple pole or single pole		Triple Pole	
vi.	Current setting range	% of rated current	20-200%	
vii.	Characteristics		IDMT(standard inverse)	
viii.	Instantaneous unit provided -Current setting range -Operating range -NO Contacts	Yes/No % of rated current	Yes 500-2000%	
x.	Auxiliary DC Supply	V_{dc}	110	
x.	Technical literature submitted	Yes/No	Yes	
6.2	**EARTH FAULT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type		Numerical, Non-Directional	
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
vi.	Continuous overload capacity	x In		
vii.	Current setting range	% of rated current	10-80%	
ix.	Characteristics		IDMT(standard inverse)	
x.	Instantaneous unit provided -Current setting range -Operating range -NO Contacts, Nos	Yes/No % of rated current mS	Yes 500-2000%	
xi.	Auxiliary DC Supply	V_{dc}	110	
xii.	Technical literature submitted	Yes/No	Yes	
6.3	**AUXILIARY TRIPPING & LOCKOUT RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Type			
iii.	Manufacturer's type designation			
iv.	Applicable standard	IEC	IEC	
v.	Operating time	mS	<15	

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.8: CONTROL AND RELAY PANEL FOR BUSCOUPLER

	DESCRIPTION	UNIT		DATA to be Filled
6.4	**BREAKER FAILURE PROTECTION RELAYS**			
i.	Manufacturer and Country of Origin			
ii.	Manufacturer's type designation			
iii.	Applicable standard	IEC	IEC	
iv.	Triple pole or single pole		Triple Pole	
v.	Current setting range	% of rated current	20-200%	
7	**CONSTRUCTION OF CONTROL & RELAY PANEL**			
i.	Type(Simplex/Duplex)		Duplex	
ii.	Manufacturer's type designation			
iii.	Applicable standard	IEC	IEC	
iv.	Control panels furnished as per specifications	Yes/No	Yes	
v.	Enclosure protection class	IP	IP 4X	
vi.	Thickness of sheet metal used -Front and rear portion -Side, top and bottom covers -Doors	 mm mm mm	 >=3 >=2 >=3	
vii.	All instruments, meters, relays and control switches flush or semi-flush type		Flush	
viii.	Ground bus -Material -Size	 mm x mm	 Copper 25 X 6	
x.	Overall dimension of control boards (LxWxH)	mm		
xii.	Delivery of equipment in months following award of contract (Allowing time for approval of drawing)	month		
xiii.	Technical literature/drawings submitted?	Yes/No	Yes	

Deviations from technical requirements:

Signed…….. As representative
for……

Address……
Date……

This schedule contains GTP for all the possible parameters of SCADA Equipments BCU generally have. Instead of simply confirming, the Bidder shall fill in the particulars against appropriate items in respect of each rating and type of equipment offered in the broad categories listed below along with supporting authentic technical documents.

(In the absence of GTP in the below mentioned format, the purchaser has every right to evaluate the product accordingly and bidder cannot raise any objection against any point of the technical scrutiny.)

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)
ITEM No.9: SUBSTATION AUTOMATION SYSTEM
Sheet 1 of 6

Sr. No.	Parameters	To be filled by bidder
A	**BCU**	
1	Make and Type	
2	Numerical Technology	
3	Modular design	
4	Nos of Analogue Input	
5	Nos of Digital Input	
6	Nos of Output	
7	Data Storage	
8	Self- monitoring	
9	Power supply	
10	IEC 61850 Protocol Compatibility	
11	Binary Input processing & Nos	
12	Analogue Input processing & Nos	
13	Measured value acquisition	
14	Derived values	
15	Digital Outputs	
16	Sub-station/bay inter-locking	
17	Trip Circuit Supervision	
18	Event Logging Nos	
19	Disturbance files & record of wave forms , storage capacity	
20	Gateway support	
21	Local control, Operation and Display	
22	Contact bouncing in digital inputs shall not be assumed as change of state	
23	I/O processing capacities	

TECHNICAL DATA SHEET **(To Be Completed By the Tenderer)**		
ITEM No.9: SUBSTATION AUTOMATION SYSTEM		**Sheet 2 of 6**
24	Internal Ethernet switches	
	Nos of port –	
26	Environmental conditions	
27	Mounting & design	
28	Warranty	
	Bay control functions	
	Control mode selection	
	Command supervision	
	Commands for	
32	Local communication facility through HMI	
	Local communication facility provided on front side for	
34	Compatibility with owner's SCADA for remote control	
35	Extension possibilities with additional I/O's inside the unit or via fiber-optic communication and process bus.	
B	Gateway	
1	Power supply	
2	Processor Type	
3	Chipset	
4	Memory Type	
5	Standard memory	
6	Memory slots	
	Internal hard disk drive	
	Hard disk drive speed	
	Optical drives	
	Video adapter, bus	
	Expansion slots	
	Network Interface	
	External I/O ports	
	Operating system installed.	
	Make	
	Antivirus s/w	

	TECHNICAL DATA SHEET **(To Be Completed By the Tenderer)** **ITEM No.9: SUBSTATION AUTOMATION SYSTEM**	**Sheet 3 of 6**
D	**HMI SERVER**	
1	Power supply	
2	Processor Type	
3	Chipset	
4	Memory Type	
5	Standard memory	
6	Memory slots	
7	Memory upgrade	
8	Internal hard disk drive	
9	Hard disk drive speed	
10	Optical drives	
11	Flexible disk drives	
12	Chassis type	
13	Video adapter, bus	
14	Expansion slots	
15	Audio	
16	Modem	
17	Network Interface	
18	External I/O ports	
19	Monitor	
20	Keyboard	
21	Pointing Device	
22	Operating system installed.	
23	Other	
24	Warranty	
25	UPS	
26	Make	
27	Antivirus s/w	

	TECHNICAL DATA SHEET **(To Be Completed By the Tenderer)** **ITEM No.9: SUBSTATION AUTOMATION SYSTEM**	**Sheet 4 of 6**
E	**DR WORK STATION**	
1	Power supply	
2	Processor Type	
3	Chipset	
4	Memory Type	
5	Standard memory	
6	Memory slots	
7	Memory upgrade	
8	Internal hard disk drive	
9	Hard disk drive speed	
10	Optical drives	
11	Flexible disk drives	
12	Chassis type	
13	Video adapter, bus	
14	Expansion slots	
15	Audio	
16	Modem	
17	Network Interface	
18	External I/O ports	
19	Monitor	
20	Keyboard	
21	Pointing Device	
22	Operating system installed.	
23	Other	
24	Warranty	
25	UPS	
26	Make	
27	Antivirus s/w	

	TECHNICAL DATA SHEET **(To Be Completed By the Tenderer)** **ITEM No.9: SUBSTATION AUTOMATION SYSTEM**	**Sheet 5 of 6**
F	**LINE INTERFACE UNIT**	
1	Area Network Type	
2	Power Supply	
3	Protocol/ Network	
4	Module	
5	No. of Ports	
6	Ports/Interfaces	
7	Features	
8	Make	
9	Manufacturer Warranty	
10	Suitability for Nos of F.O. Inlet/Outlet	
11	IEC 61850 Compatibility	
G	**COLOUR LASER JET PRINTER**	
1	Model	
2	Power Supply	
3	Black Print Speed	
4	Black Print Resolution	
5	Print Memory	
5	Processor	
6	Supported paper sizes	
7	Print technology	
8	Pages quantity	
9	Paper handling	
10	Connectivity	
11	Manufacturer Warranty	
12	Networking:	
13	Supporting OS	
14	Make	
15	Suitability to print all types of drafts and graphics	

	TECHNICAL DATA SHEET **(To Be Completed By the Tenderer)** **ITEM No.9: SUBSTATION AUTOMATION SYSTEM**	**Sheet 6 of 6**
H	**LASER JET PRINTER**	
1	Model	
2	Power Supply	
3	Black Print Speed	
4	Black Print Resolution	
5	Print Memory	
6	Processor	
7	Supported paper sizes	
8	Print technology	
9	Pages quantity	
10	Paper handling	
11	Connectivity	
12	Manufacturer Warranty	
13	Networking:	
14	Supporting OS	
15	Make	
16	Suitability to print all types of drafts and graphics	

Deviations from technical requirements and reasons for such deviations:

Signed…….. As representative
for……

Address……..
Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

TEM No.10: 11kV XLPE POWER CABLES

	DESCRIPTION	UNIT	NEA REQ	DATA to be Filled
1	**Manufacturer and Country of Origin**			
2	**Manufacturer's type designation**			
3	**Type**		Armoured	
4	**Applicable standard**		IEC	
5	**Voltage rating** a) Suitable for max. system voltage b) voltage grade of this cable	 kV kV	 12 6/10(12)	
	c) Rated voltage between each conductor and screen	kV	11/√ 3	
	d) Rated voltage between two conductors	kV	11	
6	**Conductor material**	Copper / Al		
7	**Insulating material**		Polyethylene	
	Thickness			
8	**Overall jacket material**		PVC	
	Thickness			
9	**Overall Cross sectional Area of the cable, Copper**	Sq.mm		
	Copper	Sq.mm		
	Aluminum for Outgoing	Sq.mm		
10	**Type of Cable**	Copper	Single Core	
		Aluminum	Three core	
11	**Continuous Current Rating at 45DegC Ambient Temperature in Duct**	A		
	3Rx1CxCopper 800 sq.mm	A		
	Aluminium 400 sq.mm	A		
	Aluminium 185 Sq.mm	A		
12	**Short Circuit Current rating**	kA	> 20	
13	**Fire Retardive**	Yes	Yes	
14	**Mositure Resistant**	Yes	Yes	
15	**Technical Leaflets provided**	Yes / No	Yes	
16	**Delivery of equipment in months** following award of contract (Allowing time for approval of drawing)	month		

Deviations from technical requirements:

Signed…… As representative for……

Address…… Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

ITEM No.11: 132 kV XLPE POWER CABLES

Sl. No	**Name of the Particulars**	**Desired Value**	
		300 sq mm for 132 kV	
1	No. of cores	1(Single)	
2	Size (in mm2)	300 sq mm for 132 kV	
3	Voltage Grade(in kV)	76/132(145) kV	
4	Type of cable		
5	Standard according to which cable has been manufactured and tested	IEC- 62067, Testing as per IEC- 60840.	
6	Permissible Voltage & Frequency variation for satisfactory operation.		
	Voltage	± 10%	
	Frequency	± 5%	
7	Maximum rated conductor temperature	90^0C	
8	Max. allowable conductor temperature during short circuit	250^0C	
9	Conductor Details		
	(a) Normal Cross-Sectional Area	300 mm^2	
	(b) Material and Grade	Copper as per Specs	
	(c) Shape of Conductor	Compacted stranded circular	
10	**Conductor Screen**		
	(a)Material	Extruded Semi-Conducting XLPE	
	(b)Nominal Thickness	1.5mm(Approx.)	
11	**Insulation**		
	(a) Material	Cross linked Polyethyle	
	(b) Nominal Thickness	18.0 mm	
12	**Insulation Screen**		
	(a) Material	Extruded Semi-Conducting XLPE (SC) layer followed by water swellable SC tapes	
	(b) Min. Thickness	1.0 mm followed by water swellable SC	
	(c) Longitudinal Water Sealing	Semiconducting water blocking tape(s) with 50% over lap	
13	**Metallic Sheath**		
	(a) Material	Seam Welded/ Corrugated Aluminum sheath with anti	
	(b) Thickness	3.0 mm	
	(c) Short Circuit current of metallic screen for 1 sec (kA)	>31.5	
14	**Outer Sheath**		
	(a) Material	Extruded HDPE	
	(b) Colour	Black	
	(c) Thickness (Nom/Min)	4.0 mm	
	(d) Conducting layer over outer sheath	Graphite Coating	

15	Standard Drum Length with Tolerance	500m±5%	
16	Minimum Bending Radius allowable during installation	20 x OD	
17	Safe Pulling force	5kg/mm^2 of CU	
20	(a) Impulse Withstand	650kVp	
21	(b) One minute Power Frequency Withstand Voltage (kV)	190kV for 30 sec	
22	Short circuit current for one second(kA)	143	
	Max conductor DC resistance at 20^{0}C		
	Approx. AC resistance at 90^{0}C		
	Max. capacitance		
23	Continuous Current Rating for cable laid in close trefoil formation	**BEB/ SPB**	
	(i) In ground at 30^{0}C ground temp, Depth of laying 1.0 m, Thermal Resistivity of soil 150°C Cm/W		
	(ii) In free air at 40^0 C Ambient Air Temperature		
	BEB: Sheath both end bonded **SPB:** Sheath single point/ Cross bonded		
	1. The following details shall be embossed/ Printed on outer sheath at regular interval not exceeding one metre. (a) Manufacturer"s Name or Trade name (b) Year of Manufacture (c) Voltage grade of Cable i.e. (d) Cable Code i.e. (e) Number of cores & cable size e.g. 1000 Sqmm (Cu) 1 core		

Deviations from technical requirements:

Signed…… As representative for……

Address…… Date……

TECHNICAL DATA SHEET
(To Be Completed By the Tenderer)

Item No 12: 132kV GIS Cable Sealing End

Item	Description	Unit	Requirement	Manufacturer's Particulars Data to
1	Manufacturer name and address			
2	Voltage rating	kV	132	
3	Current rating	amp	As per cable	
4	Type		Elastomeric stress	
5	Insulator material		Epoxy bushing	
6	Pollution severity levels		Heavy	
7	Pitch circle diameter	mm		
8	Overall length of insulator	mm		
9	Weight of bushing including sealing compound	kg		
10	Total creepage distance of shedding	mm	450mm (approx)	
11	Impulse withstand voltage (External)			
12	(a) Positive	kV	650	
	(b) negative	kV	650	
	Standards		IEC 60840	

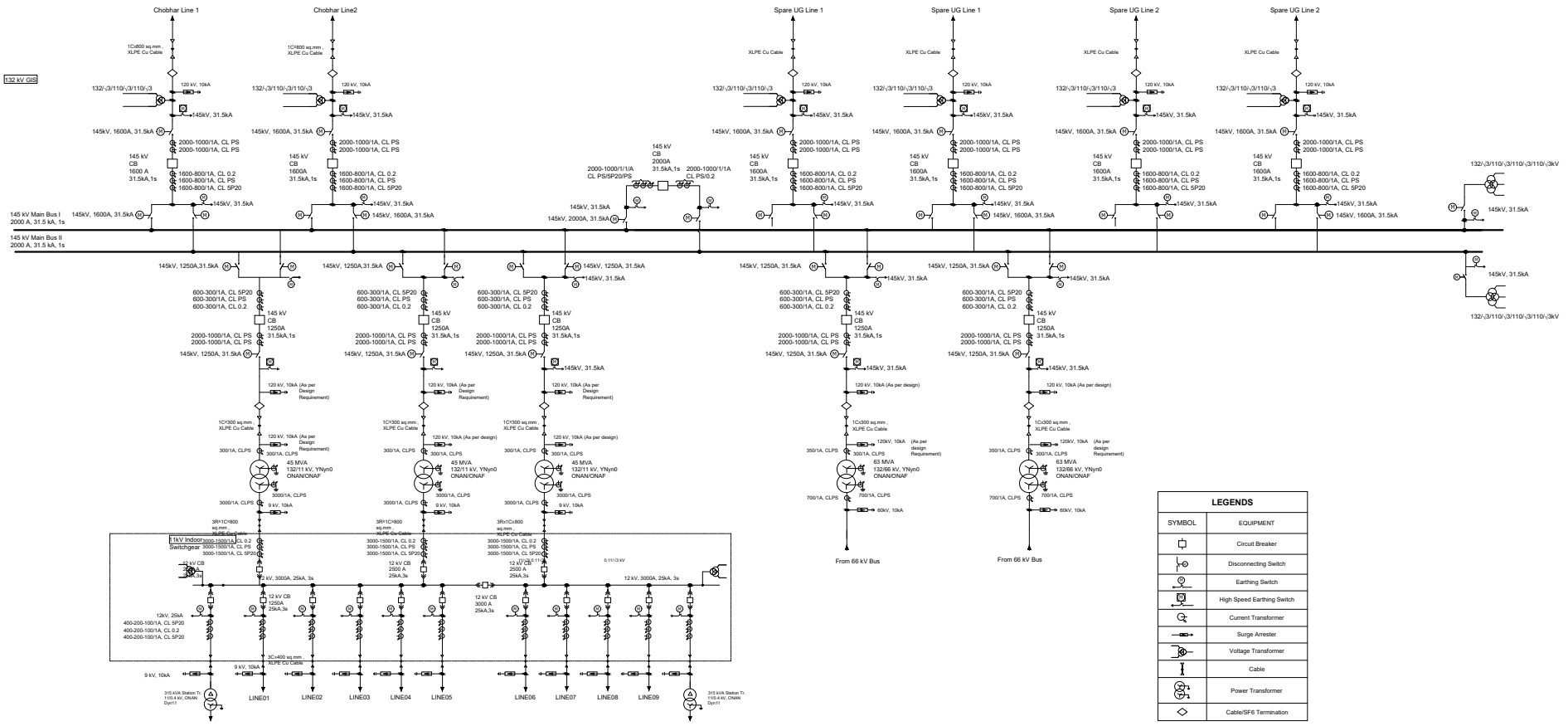
Item no 13: 132kV Outdoor Cable Sealing End

Item	Description	Unit	Requirement	Manufacturer's Particulars / Data
1	Manufacturer name and address			
2	Voltage rating	kV	132	
3	Current rating	amp	As per cable	
4	Type		Porcelain/polymeric insulator.	
5	Insulator material		Porcelain/Polymeric bushing	
6	Pollution severity levels		Heavy	
7	Pitch circle diameter	mm		
8	Overall length of insulator	mm		
9	Weight of bushing including sealing compound	kg		
10	Total creepage distance of outdoor sealing End	mm	4500mm	
11	Total creepage distance of shedding	mm	450mm (approx)	
12	Impulse withstand voltage (External)			
	(a) Positive	kV	650	
	(b) negative	kV	650	
	Standards		IEC 60840	
13	Height of steel mounting structure over the finished switchyard level	mm	2000 (min.)	

Deviations from technical requirements:

Signed…… As representative for……

Address…… Date……



LEGENDS	
SYMBOL	EQUIPMENT
	Circuit Breaker
	Disconnecting Switch
	Earthing Switch
	High Speed Earthing Switch
	Current Transformer
	Surge Arrester
	Voltage Transformer
	Cable
	Power Transformer
	Cable/SF6 Termination

Reference Drawing only for Tender Purpose

CLIENT:

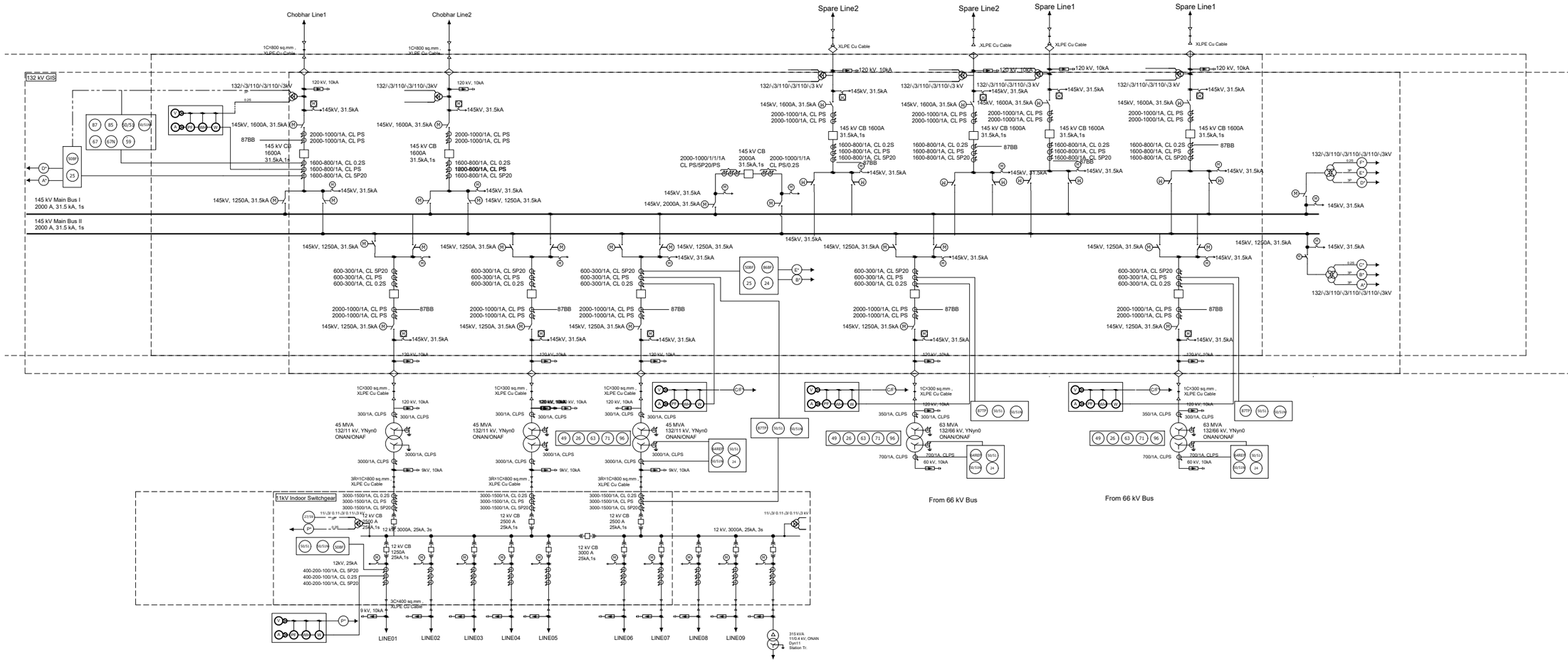
NEPAL ELECTRICITY AUTHORITY

(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

TITLE : Single Line Diagram

NOTES:
1. THIS DRAWING SHOWS TYPICAL PROTECTION OF 132 AND 66 kV LINE AND TRANSFORMER.
2. ONLY THE MOST COMMON RELAY FUNCTIONS ARE SHOWN



LEGENDS

SYMBOL	EQUIPMENT
	Circuit Breaker
	Disconnecting Switch
	Earthing Switch
	High Speed Earthing Switch
	Current Transformer
	Surge Arrester
	Voltage Transformer
	Cable
	Power Transformer
	Cable/SF6 Termination

RELAY SYMBOLS AND ABBREVIATION

BB	BUSBAR
24	OVERFLUX RELAY
25	SYNCHRO CHECK RELAY
26	APPARATUS THERMAL DEVICE
49	THERMAL RELAY
63	SUDDEN PRESSURE RELAY
71	LIQUID LEVEL SWITCH
59	OVERVOLTAGE RELAY
79	AUTORECLOSING RELAY
85	CARRIER RECEIVER RELAY
21	LINE DISTANCE RELAY
87T	TRANSFORMER DIFFERENTIAL RELAY
50BF	BREAKER FAILURE RELAY
86M	LOCKOUT RELAY
96	BUCHHOLZ RELAY
50/51	OVERCURRENT RELAY
50N/51N	NEUTRAL TIME OVERCURRENT RELAY
24	OVERFLUXING PROTECTION RELAY
64REF	RESTRICTED EARTH FAULT RELAY

Reference Drawing only for Tender Purpose

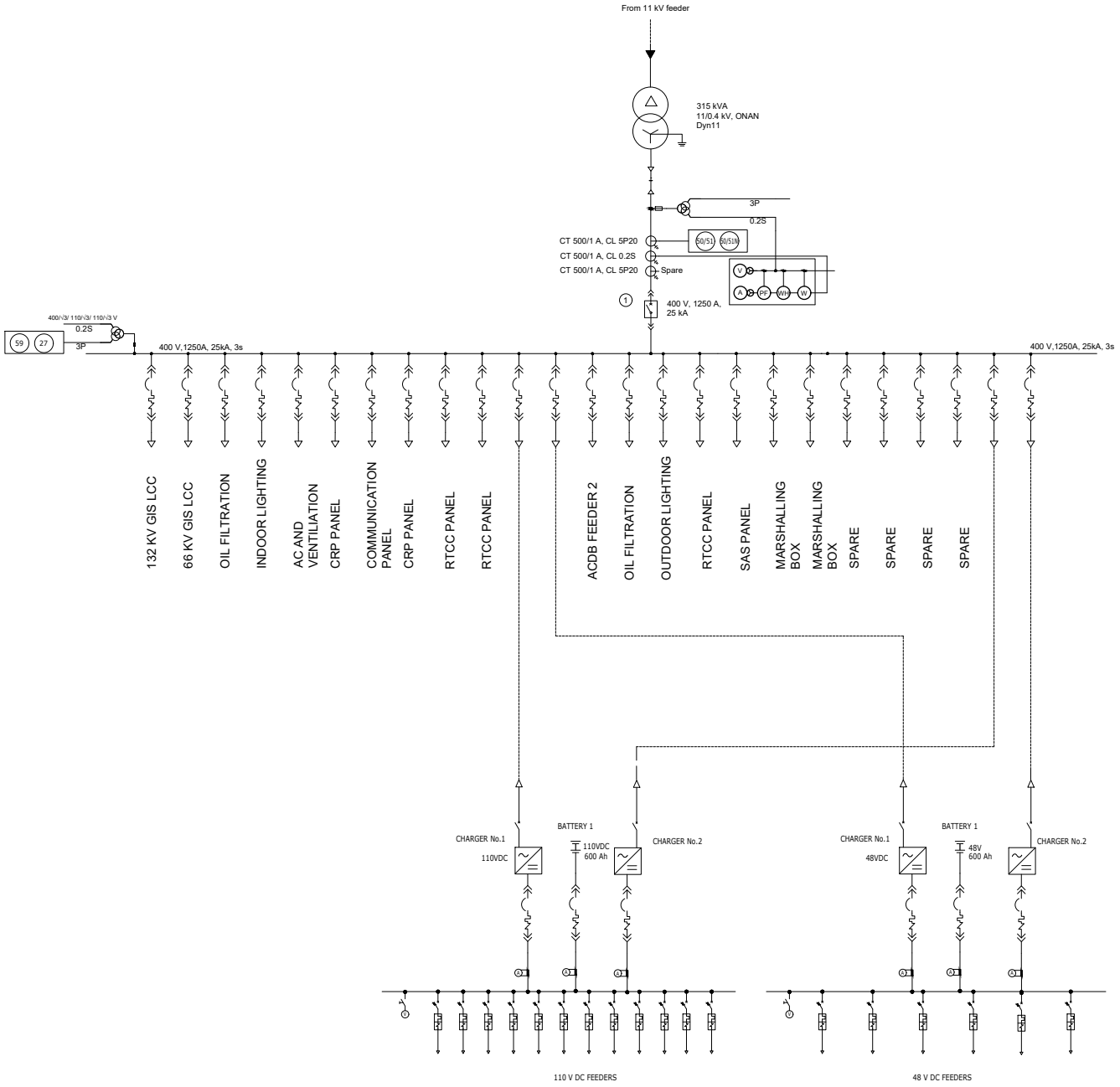
CLIENT:

NEPAL ELECTRICITY AUTHORITY

(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

TITLE : Protection Line Diagram



Reference Drawing only for Tender Purpose

CLIENT:

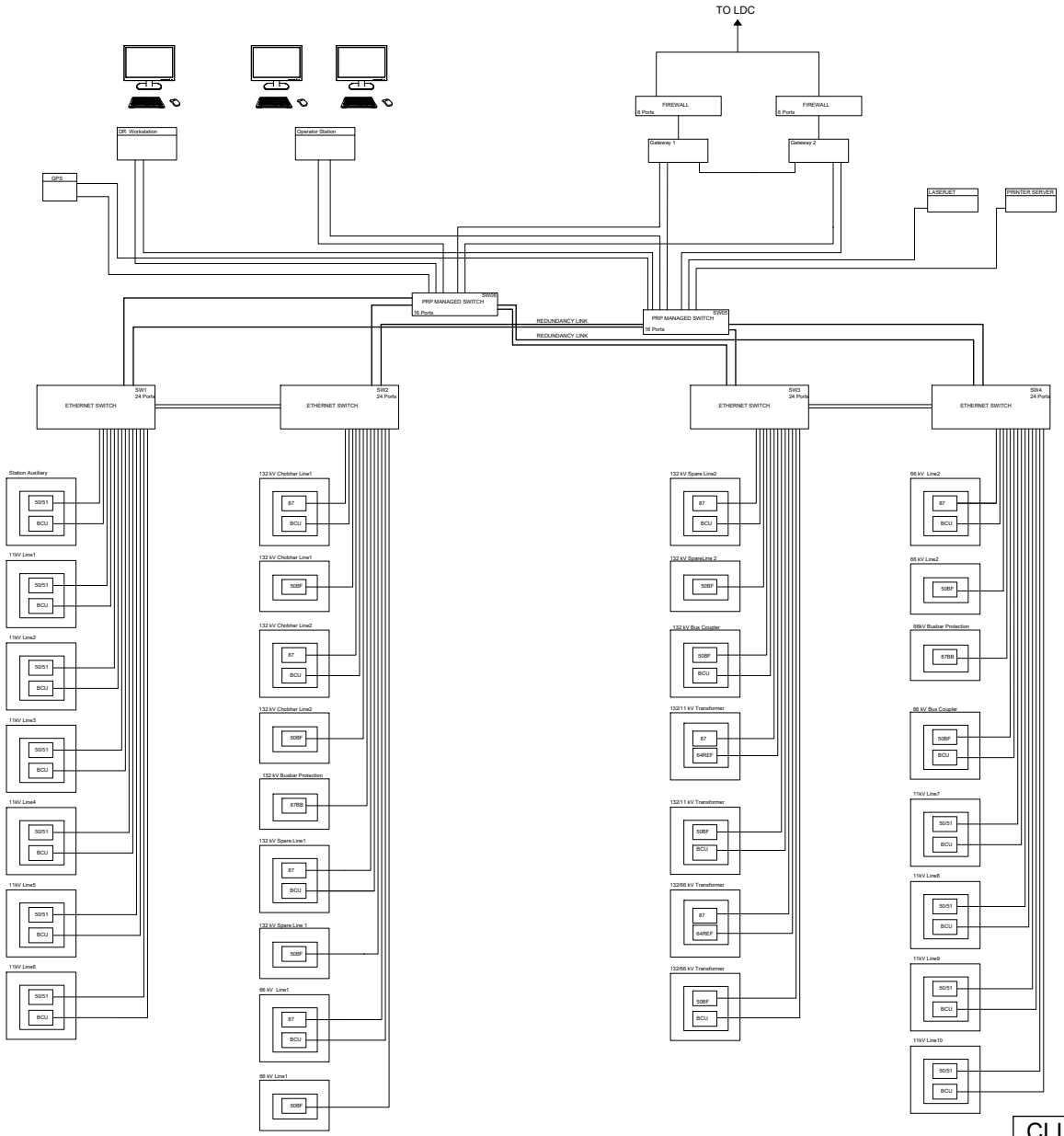
NEPAL ELECTRICITY AUTHORITY

(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

TITLE : LV Auxilliary System

SAS ARCHITECTURE



NOTES:
Typical connection are shown.

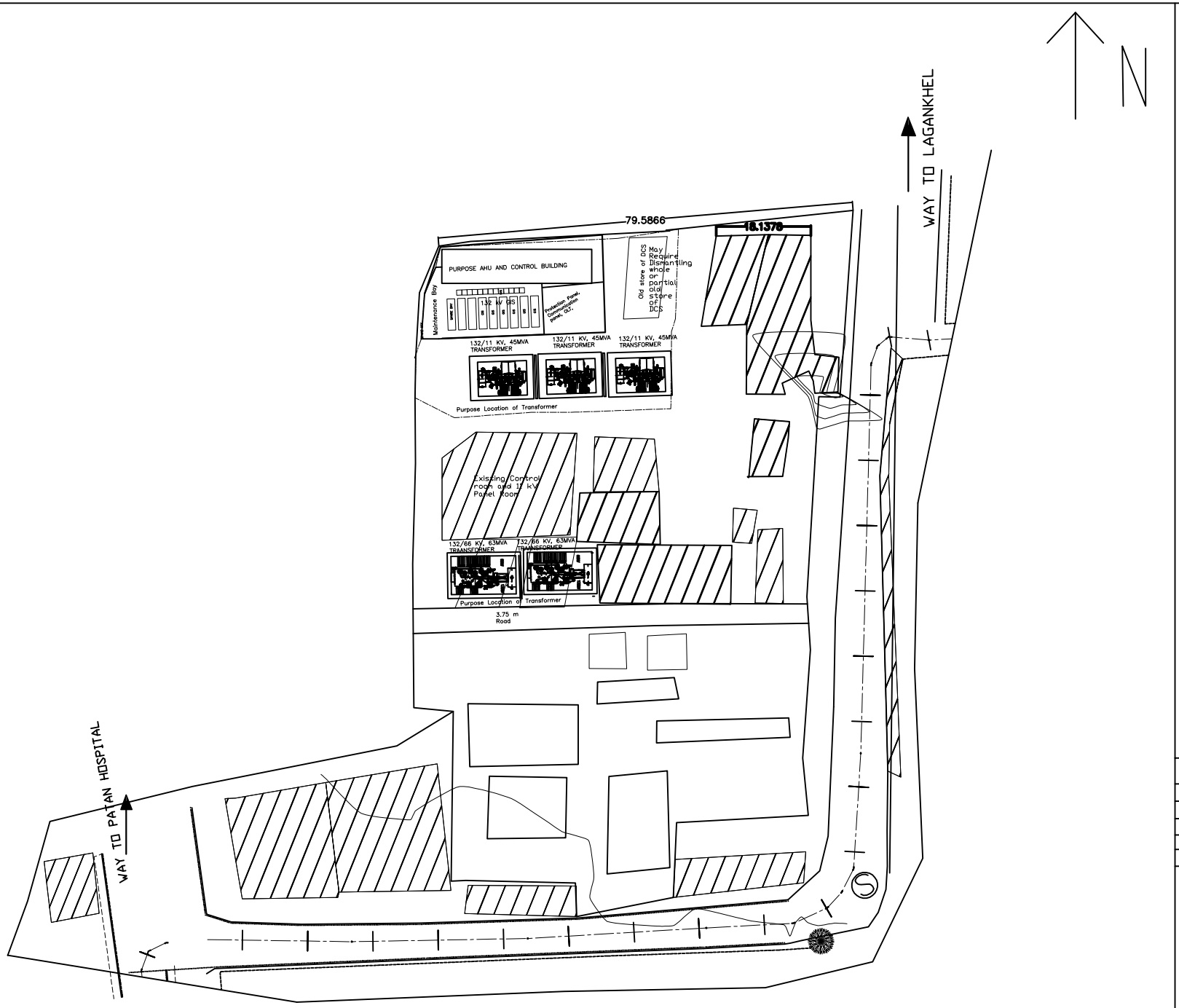
LEGENDS:
DR Disturbance Recorder
SW Switch

Reference Drawing only for Tender Purpose

CLIENT:
NEPAL ELECTRICITY AUTHORITY
(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

TITLE : SAS Architecture



REFERENCE DRAWING IS ONLY FOR TENDOR PURPOSE

REV	Date	Description			Approved

NEPAL ELECTRICITY AUTHORITY

(GoN Undertaken)

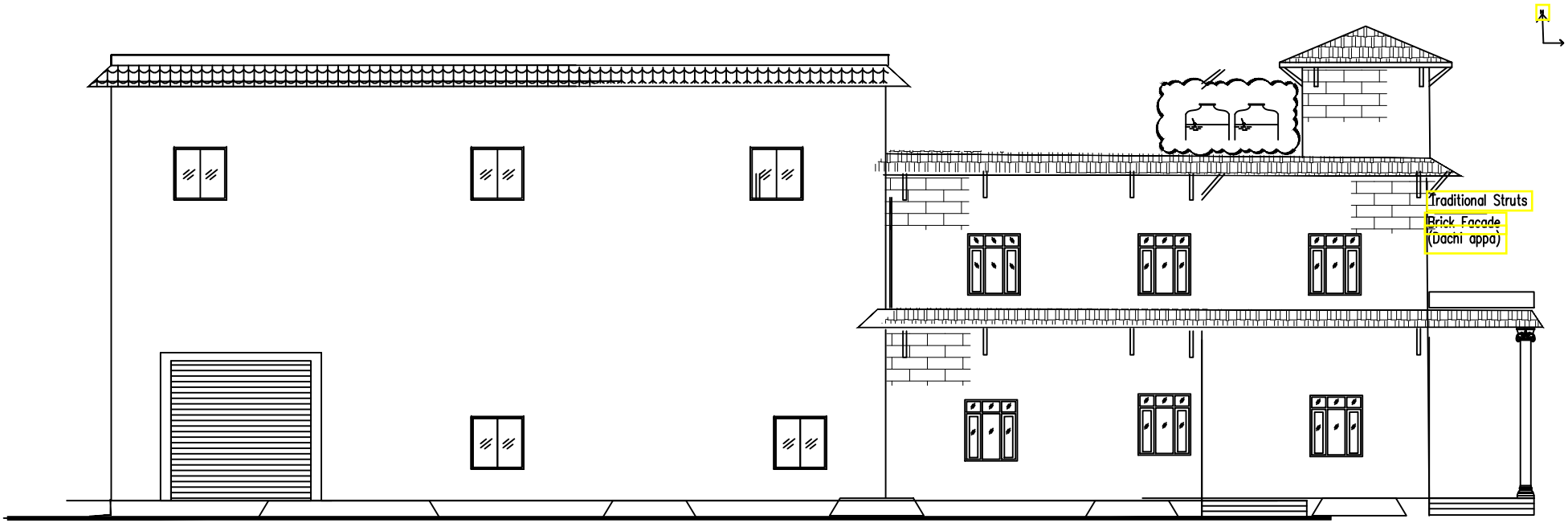
Project Management Directorate

CPC 132 KV Underground TL Project

New Patan Sub-Station Construction Project

Title:

Site plan



ELEVATION

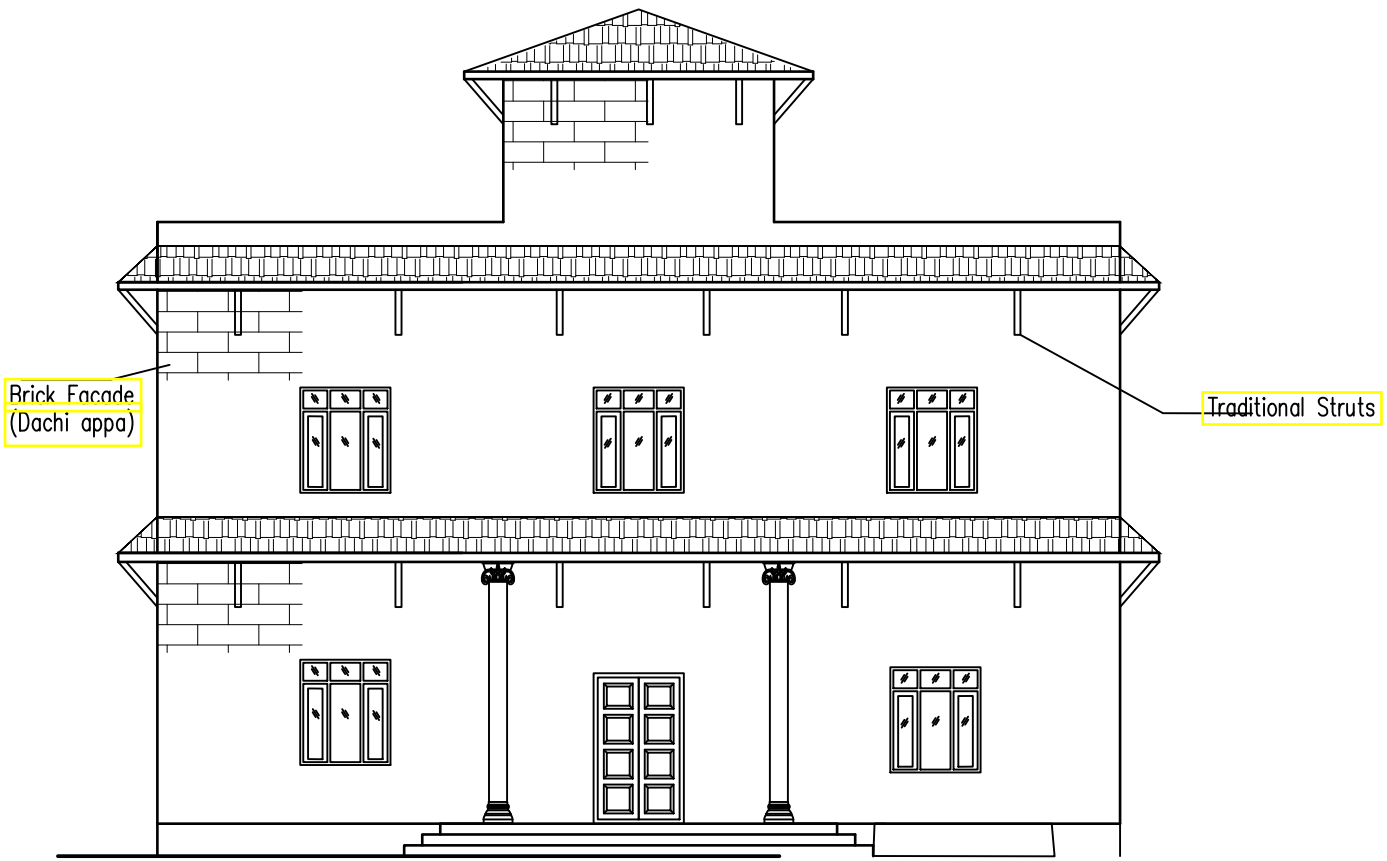
Reference Drawing only for Tender Purpose

CLIENT:

NEPAL ELECTRICITY AUTHORITY
(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

TITLE : Elevation for Control Building, GIS Building



ELEVATION

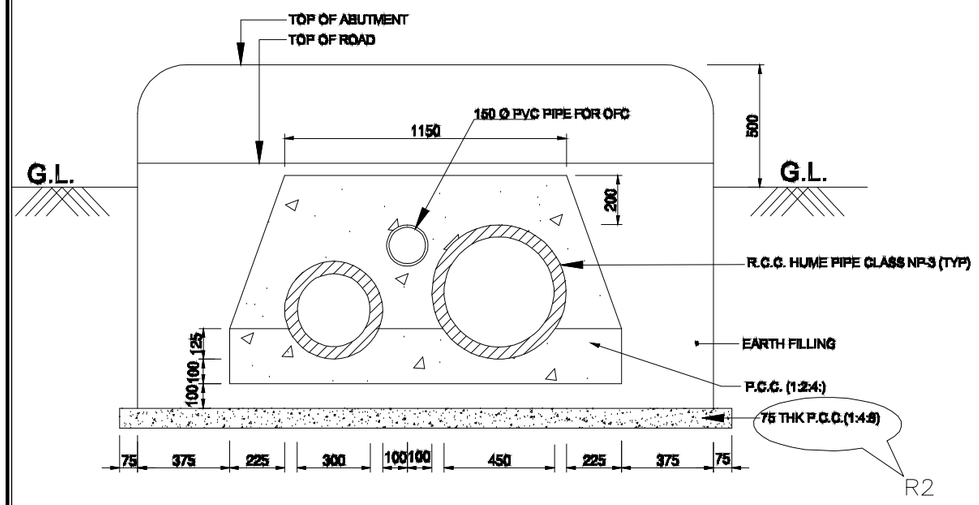
Reference Drawing only for Tender Purpose

CLIENT:

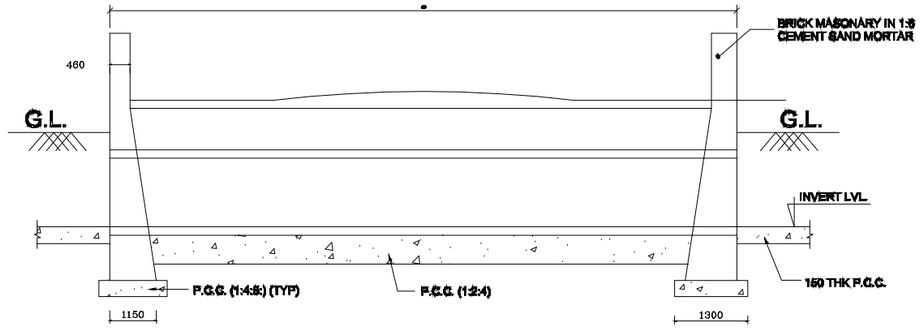
NEPAL ELECTRICITY AUTHORITY
(AN UNDERTAKING OF GOVERNMENT OF NEPAL)

PROJECT: Patan Substaton Construction Project

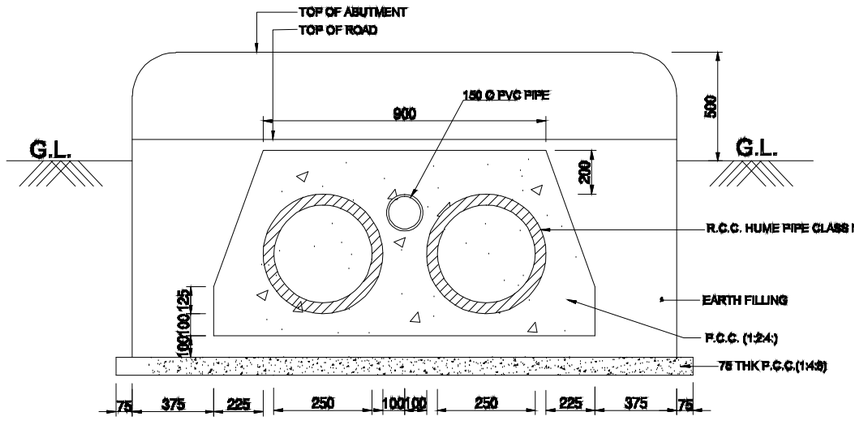
TITLE : Elevation for Control Building



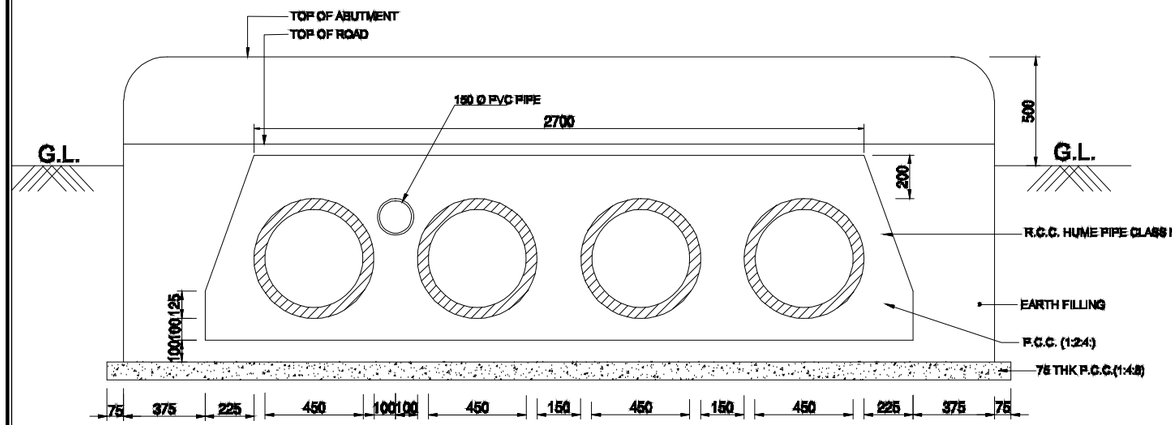
CABLE TRENCH SECTION 2-2 CROSSING ROAD



LONGITUDUNAL SECTION THROUGH CABLE TRENCH CROSSING ROAD



CABLE TRENCH SECTION 3-3 CROSSING ROAD



APPROVED BY E.D.ENGG-S/Stn & T/L VIDE NOTE SHEET
Ref:- C/ENGG/CIVIL/STD/CT-CROSSING Dated 11/06/2012

General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. F.G.L. DENOTES FINISHED GROUND LEVEL.
4. CLASS 75 BRICKS SHALL BE USED
5. CONCRETE MIX FOR COVERING RCC PIPE SHALL BE 1:2:4 (1 CEMENT; 2 COARSE SAND: 4 COARSE AGGREGATE)
6. RCC HUME PIPE SHALL BE OF GRADE NP3
7. ALL LEAN CONCRETE SHALL BE OF GRADE 1:4:8 (1 CEMENT; 4 COARSE SAND: 8 COARSE AGGREGATE)
8. BRICK MASONRY SHALL BE DONE USING CEMENT MORTAR 1:6 (1 CEMENT; 6 FINE SAND)

REFERENCE DRAWING. ONLY
FOR
TENDER PROPOSE

Rev.	Date	Description			Approved

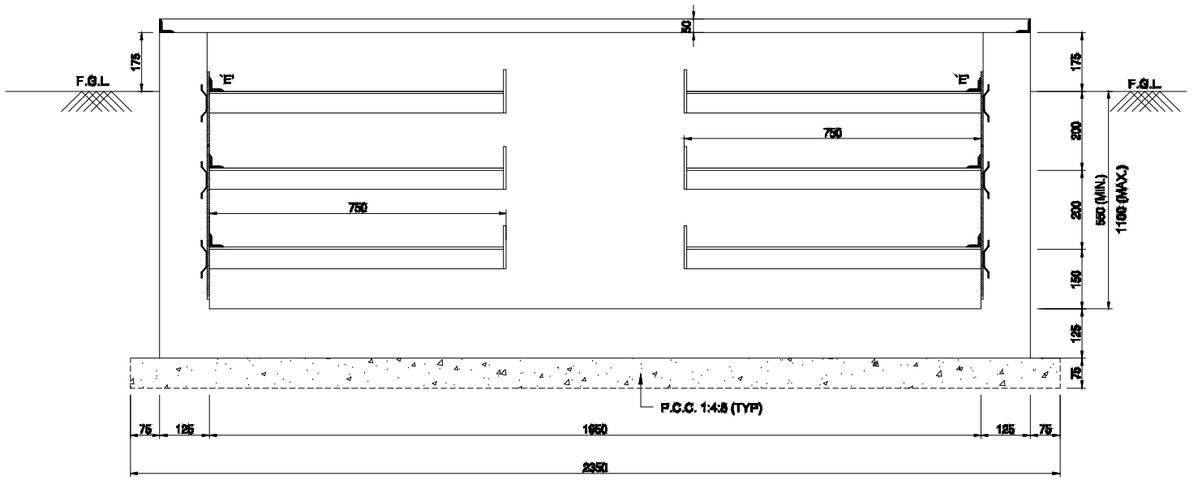
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
Project Management Directorate
CPC 132KV Underground TL Project

New Patan Sub Station
Construction Project

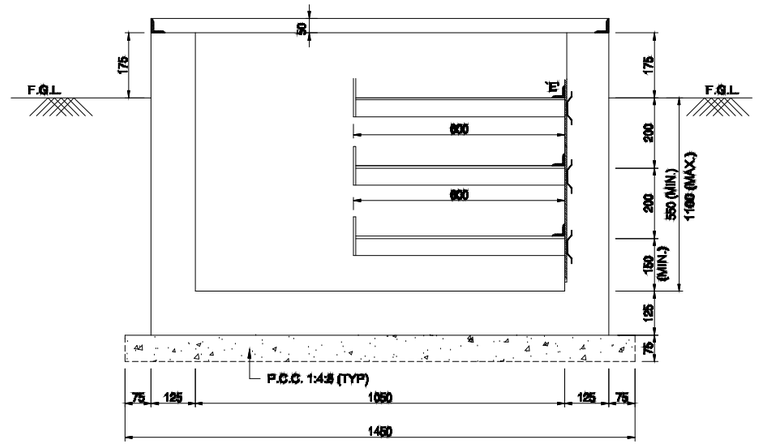
Title
CABLE TRENCH CROSSING

C:\SAMA\OM\SS-DWG-NEW

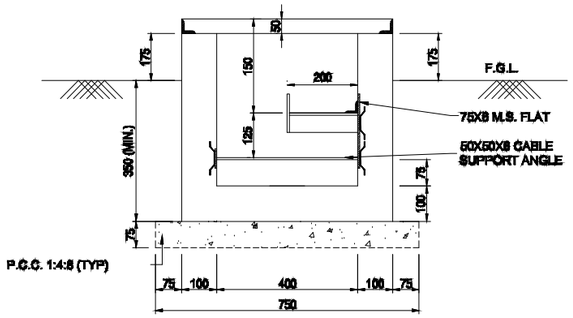
PLOT PROFILE SCALE 1:1



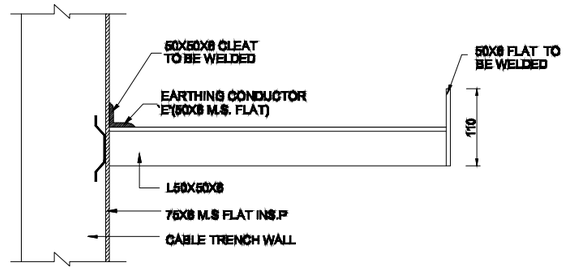
SECTION 1-1



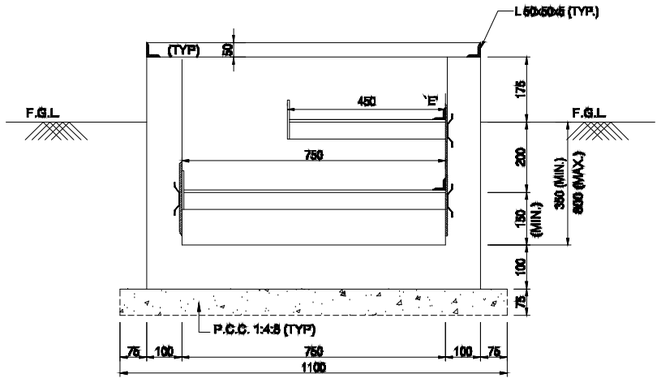
SECTION 2-2



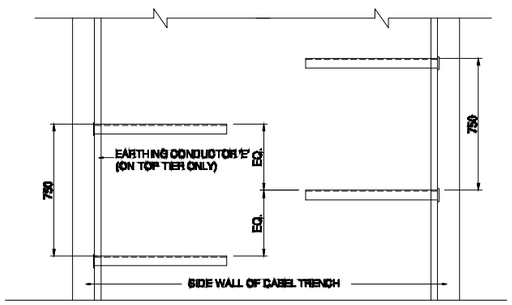
SECTION 4-4



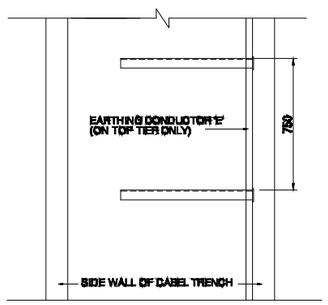
TYPICAL CABLE SUPPORT



SECTION 3-3



PLAN
CABLE TRAY SUPPORT FOR SECTION 1-1



PLAN
CABLE TRAY SUPPORT FOR SECTION 2-2 & 3-3

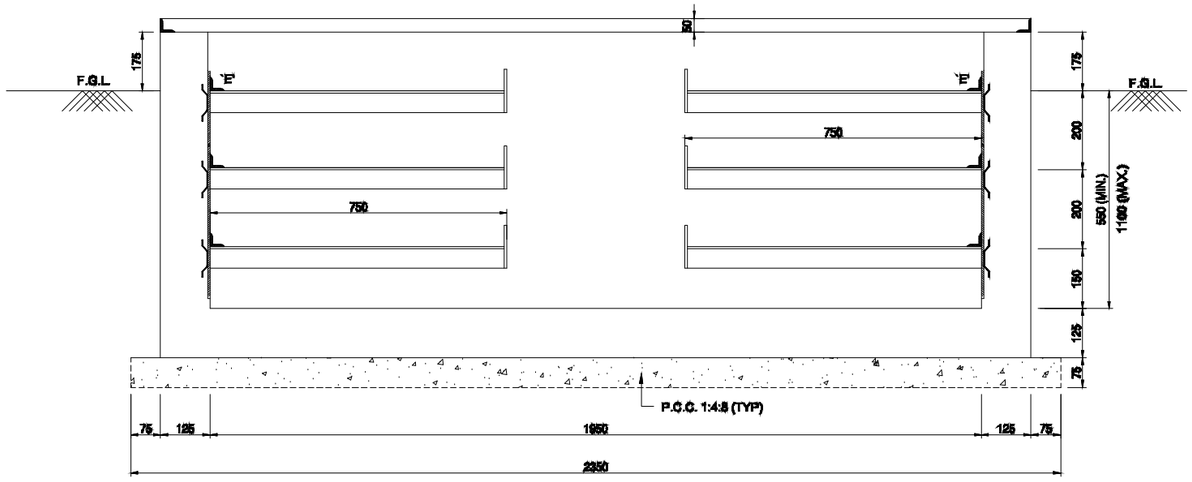
General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. LAP LENGTH SHALL BE 47 TIMES DIA OF BAR.
4. PROVIDE CLEAR COVER TO REINF.AS UNDER.
   * 25mm FOR TOP SIDE OF BOTTOM SLAB.
   * 50mm FOR OUTER SIDE OF WALL
5. ALL R.C.C SHALL BE OF GRADE M25 UNLESS NOTED OTHERWISE.
6. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
7. NECESSARY OPENINGS SHALL BE PROVIDED AT APPROPRIATE LOCATIONS TO TAKE OUT CABLES.
8. FOR ACTUAL DEPTH OF TRENCHES REFER APPROVED CABLE TRENCH LAYOUT
9. F.G.L. DENOTES FINISHED GROUND LEVEL.
10. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
11. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE
12. ALL STEEL STRUCTURES PLATES SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT OVER A COAT OF SUITABLE PRIMER BEFORE INSTALLATION OF CABLES, EARTHING CONDUCTOR SHALL BE PAINTED RED.
13. CONSTRUCTION JOINT SHALL BE PROVIDED AT 30M OR AS PER SITE REQUIREMENT BUT NOT EXCEEDING 30M.
14. ALL SUPPORT ANGLES SHALL BE 50x50x6
15. ANCHORING FLAT (75x6) SHALL BE PROVIDED AT EACH SUPPORT ANGLE POINT.
16. EARTHING CONDUCTOR 'E' SHALL BE PROVIDED ON THE TOP TIER OF EACH CABLE TRENCH SECTION.
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL. NECESSARY TREATMENT OF SOIL SHALL BE DONE AS PER RECOMMENDATION OF SOIL CONSULTANT/REPORT BEFOR PLACING THE FOUNDATIONS.
18. ALL REINFORCEMENT STEEL BARS (Φ) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

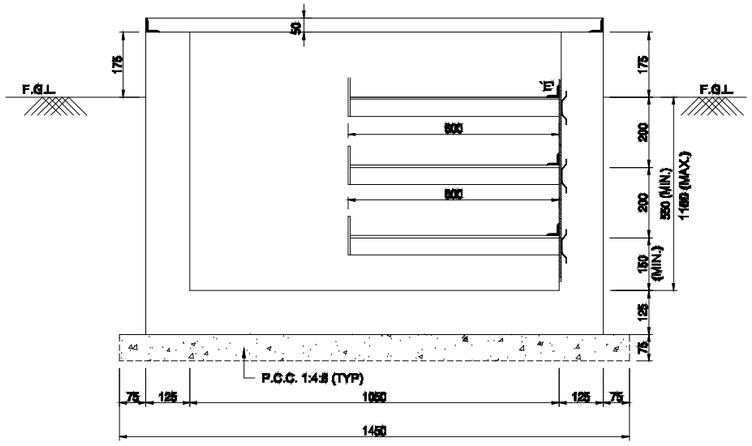
REFERENCE DRAWING. ONLY
FOR
TENDER PROPOSE

Rev.	Date	Description			Approved

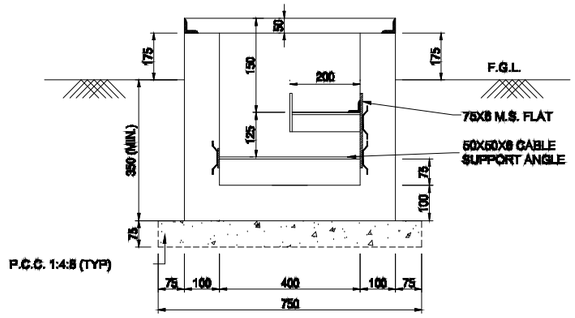
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
CABLE TRENCH DETAIL



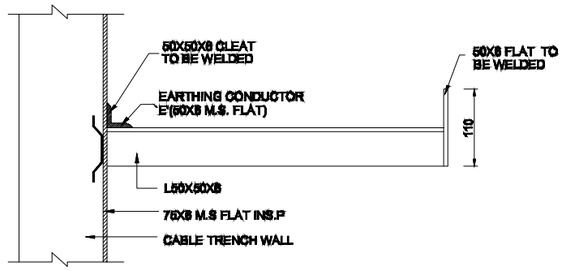
SECTION 1-1



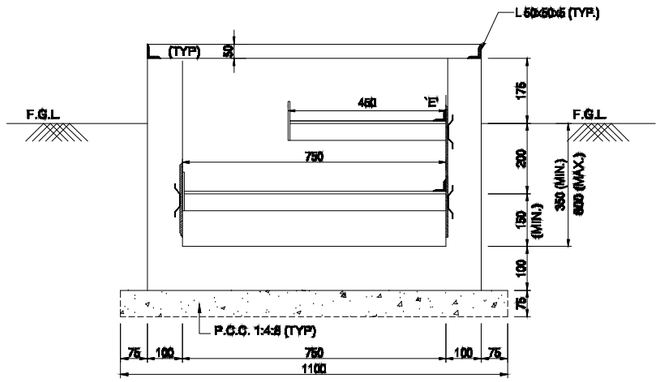
SECTION 2-2



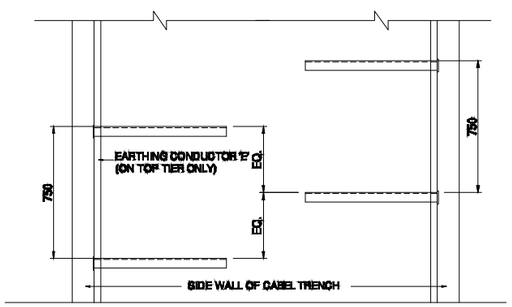
SECTION 4-4



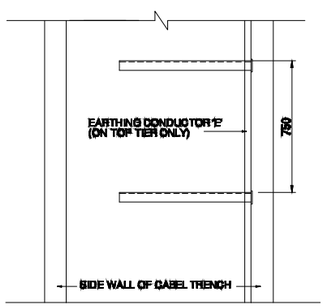
TYPICAL CABLE SUPPORT



SECTION 3-3



PLAN
CABLE TRAY SUPPORT FOR SECTION 1-1



PLAN
CABLE TRAY SUPPORT FOR SECTION 2-2 & 3-3

General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. LAP LENGTH SHALL BE 47 TIMES DIA OF BAR.
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   * 25mm FOR TOP SIDE OF BOTTOM SLAB.
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6. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
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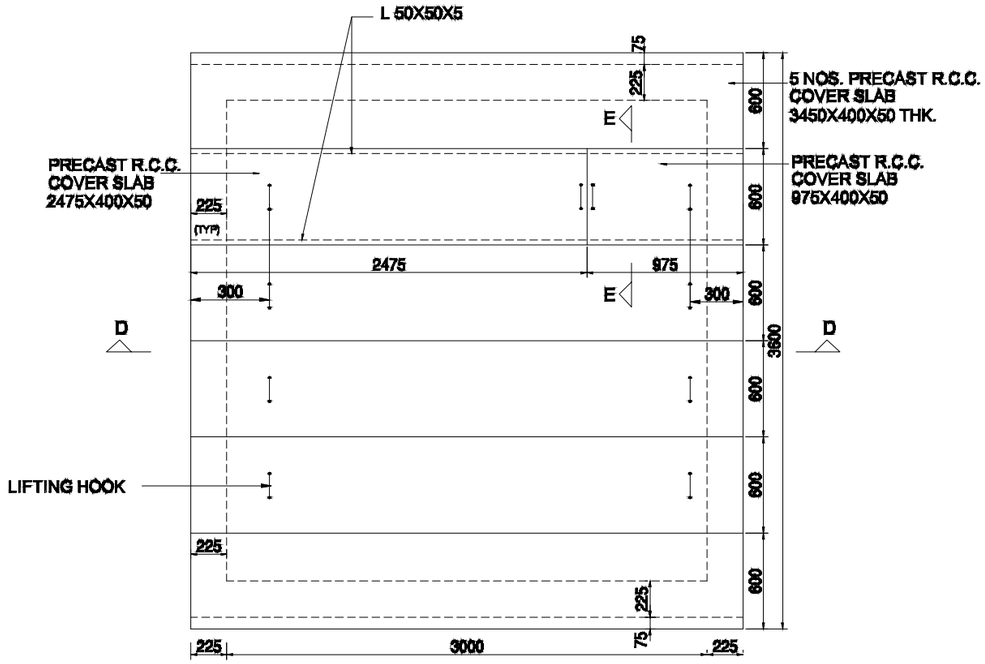
11. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE
12. ALL STEEL STRUCTURES PLATES SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT OVER A COAT OF SUITABLE PRIMER BEFORE INSTALLATION OF CABLES, EARTHING CONDUCTOR SHALL BE PAINTED RED.
13. CONSTRUCTION JOINT SHALL BE PROVIDED AT 30M OR AS PER SITE REQUIREMENT BUT NOT EXCEEDING 30M.
14. ALL SUPPORT ANGLES SHALL BE 50x50x6
15. ANCHORING FLAT (75x6) SHALL BE PROVIDED AT EACH SUPPORT ANGLE POINT.
16. EARTHING CONDUCTOR 'E' SHALL BE PROVIDED ON THE TOP TIER OF EACH CABLE TRENCH SECTION.
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL. NECESSARY TREATMENT OF SOIL SHALL BE DONE AS PER RECOMMENDATION OF SOIL CONSULTANT/REPORT BEFOR PLACING THE FOUNDATIONS.
18. ALL REINFORCEMENT STEEL BARS (TOR) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

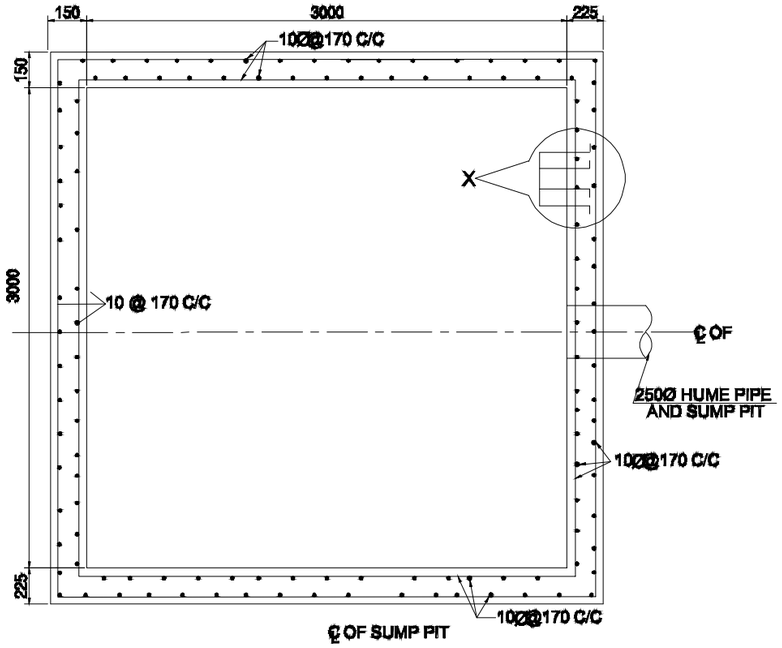
Rev.	Date	Description		Approved

NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
RCC DETAILS CABLE TRENCH

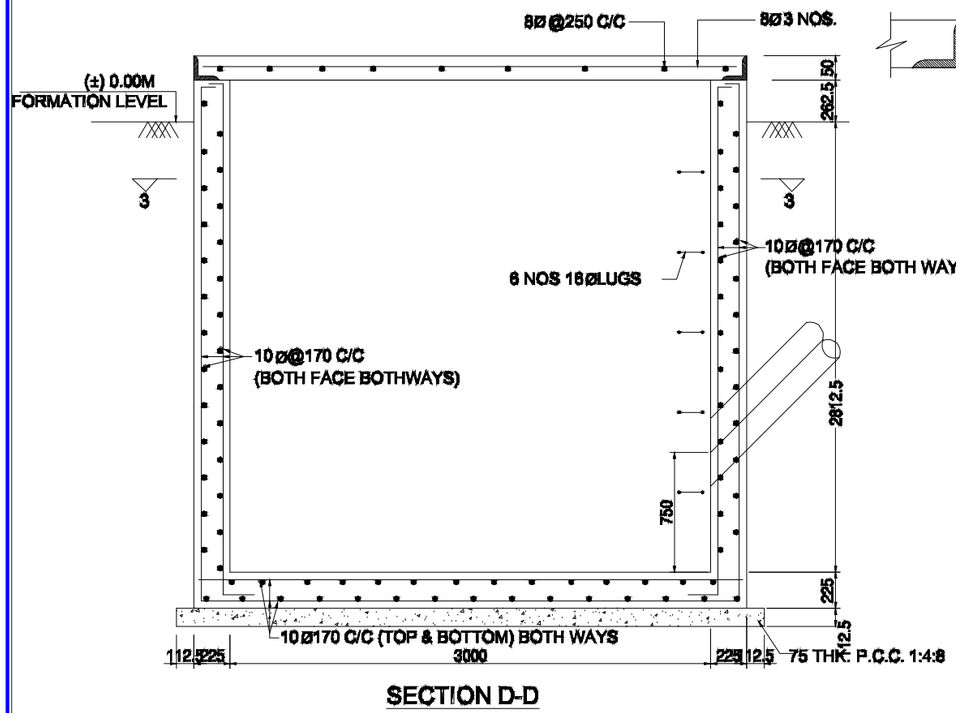
C:\SAMA\OM\SS-DWG-NEW
PLOT SCALE 1:1



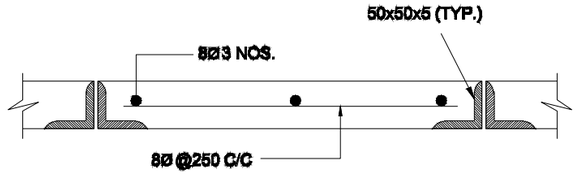
TOP PLAN OF SUMP PIT



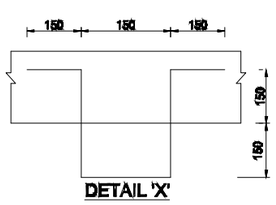
SECTION 3-3



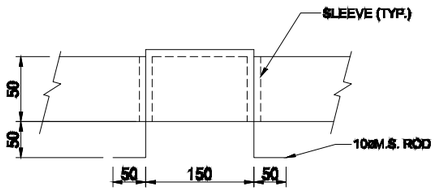
SECTION D-D



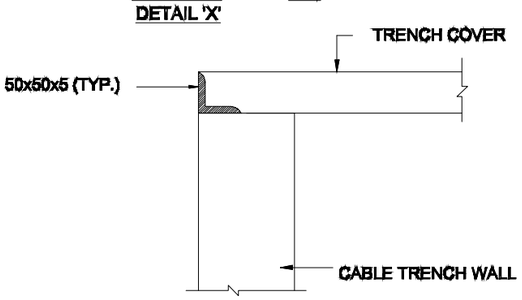
SECTION E-E



DETAIL 'X'



DETAIL OF LIFTING HOOK



TYPICAL DETAIL OF SLAB SUPPORT

General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. LAP LENGTH SHALL BE 47 TIMES DIA OF BAR.
4. PROVIDE CLEAR COVER TO REINF.AS UNDER.
   * 25mm FOR TOP SIDE OF BOTTOM SLAB.
   * 50mm FOR OUTER SIDE OF WALL
5. ALL R.C.C SHALL BE OF GRADE M25 UNLESS NOTED OTHERWISE.
6. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
7. NECESSARY OPENINGS SHALL BE PROVIDED AT APPROPRIATE LOCATIONS TO TAKE OUT CABLES.
8. FOR ACTUAL DEPTH OF TRENCHES REFER APPROVED CABLE TRENCH LAYOUT
9. F.G.L. DENOTES FINISHED GROUND LEVEL.
10. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
11. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE
12. ALL STEEL STRUCTURES PLATES SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT OVER A COAT OF SUITABLE PRIMER BEFORE INSTALLATION OF CABLES, EARTHING CONDUCTOR SHALL BE PAINTED RED.
13. CONSTRUCTION JOINT SHALL BE PROVIDED AT 30M OR AS PER SITE REQUIREMENT BUT NOT EXCEEDING 30M.
14. ALL SUPPORT ANGLES SHALL BE 50x50x6
15. ANCHORING FLAT (75x6) SHALL BE PROVIDED AT EACH SUPPORT ANGLE POINT.
16. EARTHING CONDUCTOR 'E' SHALL BE PROVIDED ON THE TOP TIER OF EACH CABLE TRENCH SECTION.
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL. NECESSARY TREATMENT OF SOIL SHALL BE DONE AS PER RECOMMENDATION OF SOIL CONSULTANT/REPORT BEFOR PLACING THE FOUNDATIONS.
18. ALL REINFORCEMENT STEEL BARS (T) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

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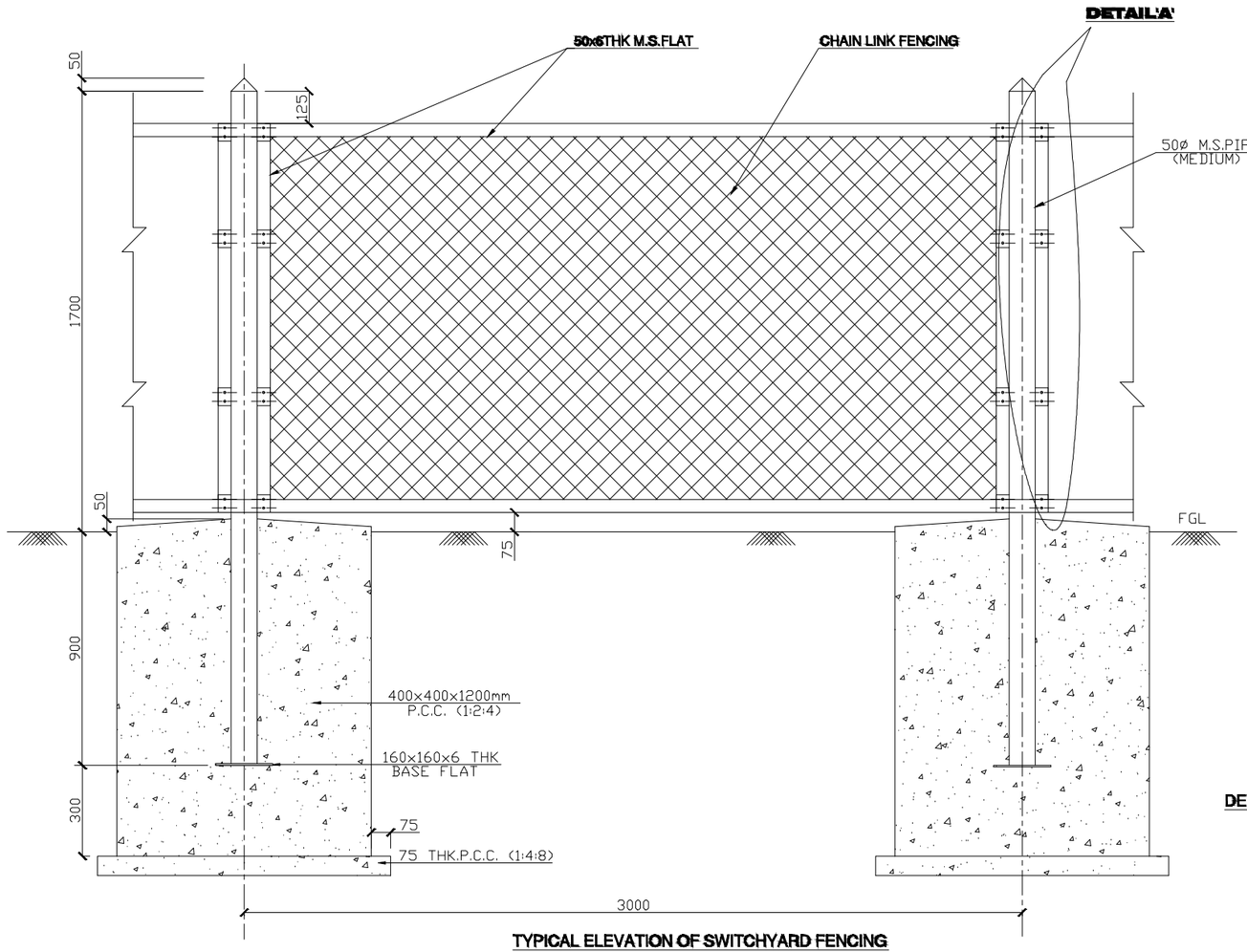
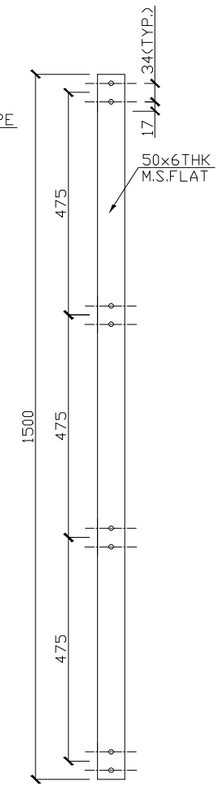
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
DETILS OF SUMP PIT

C:\SAMA\OM\SS-DWG-NEW

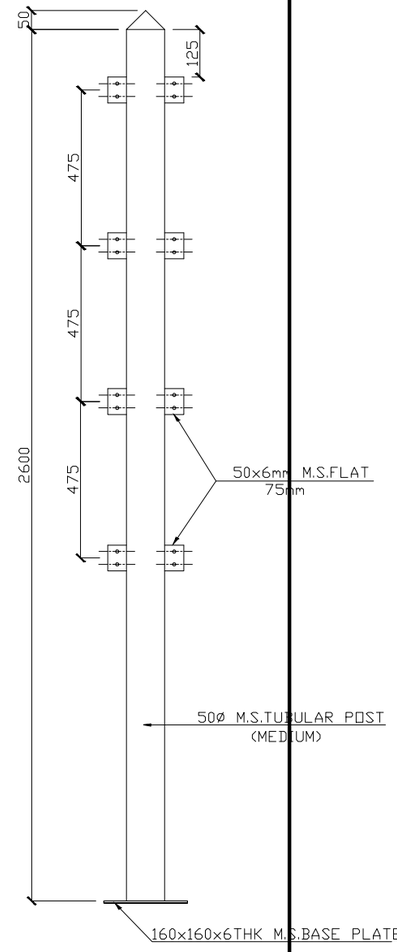
PLOT SCALE 1:1



TYPICAL ELEVATION OF SWITCHYARD FENCING



DETAIL VERTICAL M.S. FLAT 'A'



DETAIL OF TUBULAR POST

NOTES:

1. ±0.00 SHALL DENOTE SWITCHYARD FINISHED FORMATION LEVEL
2. CHAIN LINK FENCING SHALL HAVE 3.15 mm DIAMETER WIRE AS PER IS 2721 WITH 75x75 mm MESH SIZE AND PAINTED
3. TUBULAR POST SHALL BE PLACED @ 3.0m CENTRE TO CENTRE AND SHALL REST IN WELL COMPACTED EARTH
4. CORNER TUBULAR POST SHALL BE PROVIDED CLEATS IN FOUR SIDES SUITING TO REQUIREMENT
5. TUBES/PIPES OF POST SHALL BE GALVANIZED
6. CONCRETE GRADE FOR P.C.C. SHALL CONFORM IS 456: LATEST
7. EXPOSED SURFACE OF CONCRETE PAD (P.C.C.) SHALL BE PLASTERED WITH 12mm THICK CEMENT PLASTER (1:6)

RELEASED FOR TENDER & CONSTRUCTION.

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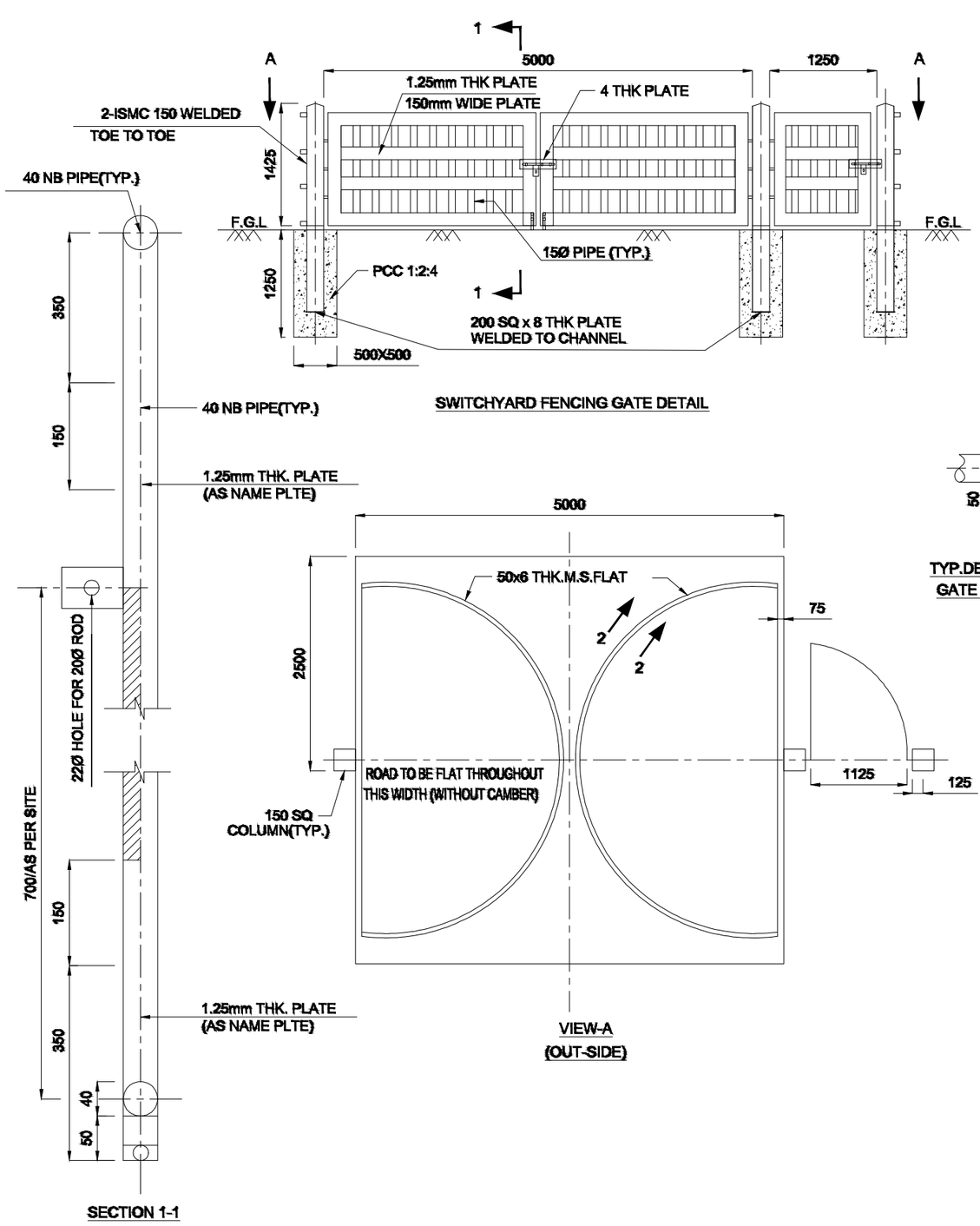
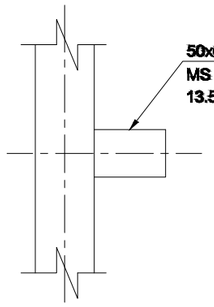
CPC 132KV Underground TL Project

New Patan Sub Station Construction Project

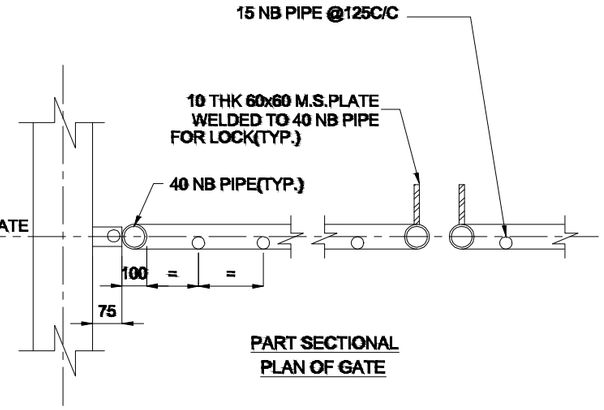
Title
DETAILS CHAINLINK FENCE



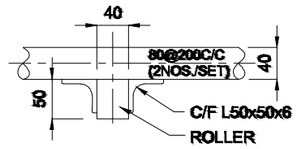
SWITCHYARD FENCING GATE DETAIL



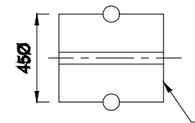
DETAIL -B



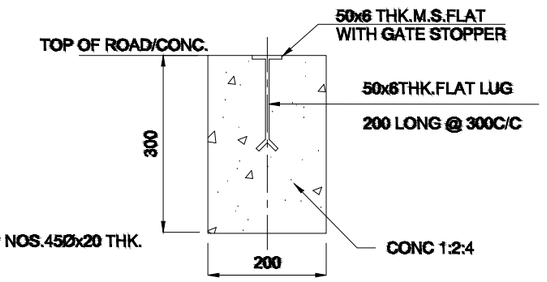
PART SECTIONAL
PLAN OF GATE



TYP.DETAIL OF
GATE ROLLER



DETAIL -A
(ROLLER BEARING)



SECTION 2:2

NOTES:

1. ALL DIMENSIONS ARE IN MM & ELEVATION ARE IN METER UNLESS NOTED OTHERWISE
2. ALL LEAN CONC. SHALL BE PCC (1:4:8)UNLESS NITED OTHERWISE.
3. UNLESS NOTED OTHERWISE LAP/ANCHOR LENGTH SHALL BE 50 TIMES THE DIA OF BARS
4. ALL STRUCTURAL STEEL CONFORM TO IS:2062 &SHALL PAINTED WITH A COAT OF APPROVED STEEL PRIMER &TWO COATS OF SYNTHETIC ENAMEL. PAINT UNLESS NOTED OTHERWISE.
5. DROP BOLTS SHOULD BO PROVIDED ON THE FAR SIDE ONLY.
6. ALL WELDS ARE 6MM THK. FILLET WELDS UNLESS NOTED OTHERWISE.
7. GATE & M.S.HOOKS TO BE PAINTED WITH ONE COAL APPROVED STEEL PRIMER BEFORE ERECTION &TWO COAT OF SYNTHETIC PAINTS AFTER ERECTION.
8. STRUCTURAL PIPES SHALL BE MEDIUM TYPE CONFORMING TO IS 1161/806

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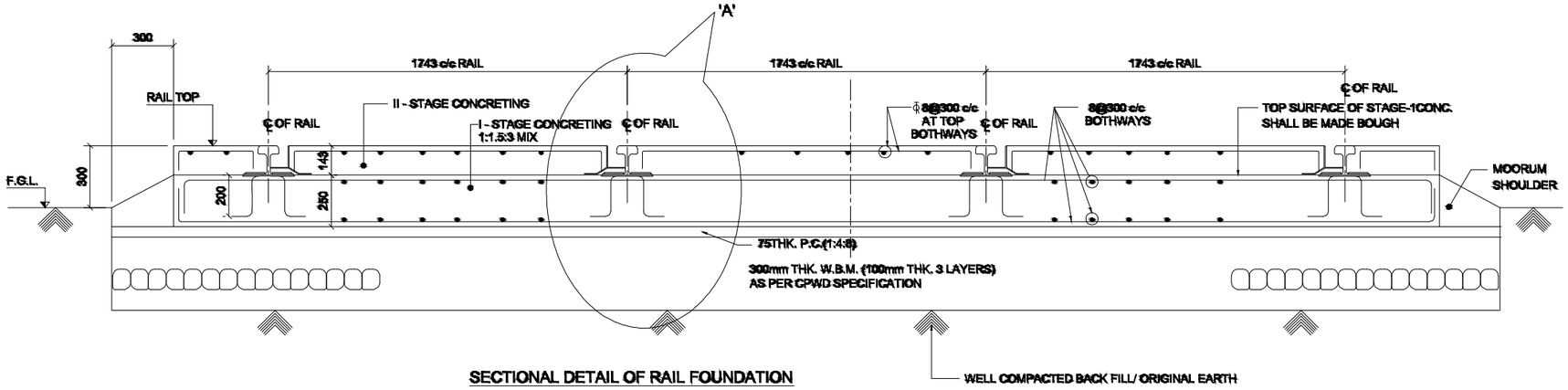
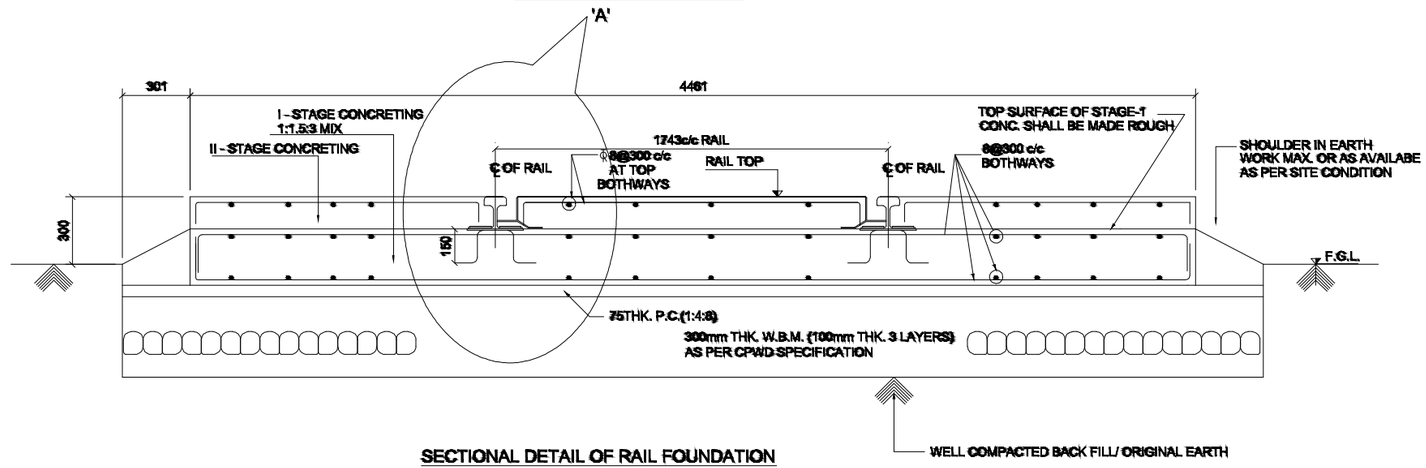
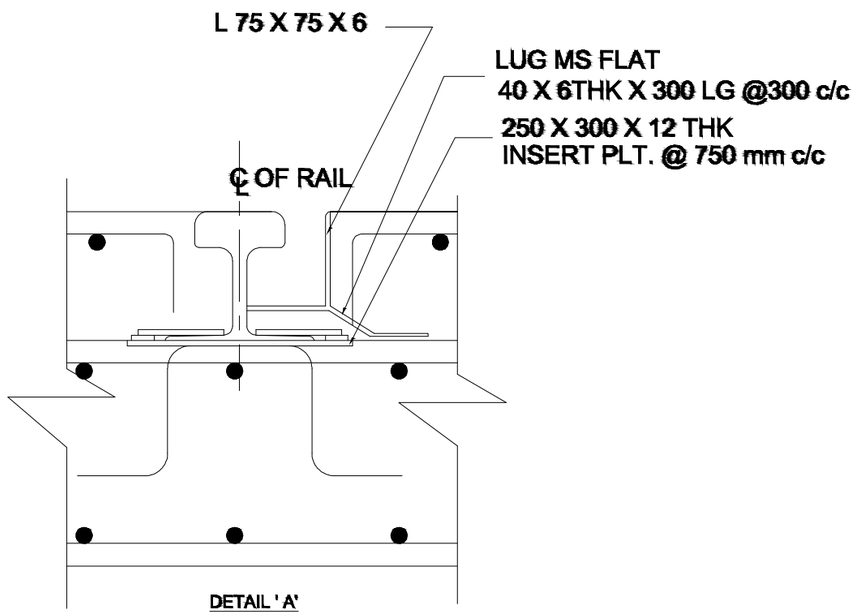
New Patan Sub Station
Construction Project
Title
SWITCHYARD GATE



SECTIONAL DETAIL OF RAIL FOUNDATION
FOR 315MVATRASFORMER



SECTIONAL DETAIL OF RAIL FOUNDATION



DETAIL 'A'

NOTES:-

1. ALL DIMENSIONS ARE IN MM. & ELEVATIONS ARE IN METRE UNLESS NOTED OTHERWISE.
2. ALL STRUCTURAL CONC. SHALL BE 1:1.5:3 (1 CEMENT:1.5COARSE SAND: 3 GRADED STONE AGGREGATE OF 20MM NOMINAL SIZE)
3. ALL LEAN CONC. SHALL BE 75MM. THK. AND OF GRADE 1:4:8 (1 CEMENT:4 COARSE SAND: 8 GRADED STONE AGGREGATE OF 40MM NOMINAL SIZE)
4. ALL REINFORCEMENT STEEL BARS (DENOTED AS Ø)SHALL CONFORM TO IS:1786–1985 OF GRADE Fe 415 OR TMT BARS OF EQUAL GRADE.
5. UNLESS NOTED OTHERWISE LAP/ANCHOR LENGTH SHALL BE 50 TIMES THE DIA. OF BARS.
6. THE DRAWING SHALL NOT BE USED FOR CONSTRUCTION IF EXPANSIVE SOIL IS MET
7. SECOND STAGE CONCRETE SHALL BE DONE AFTER RAILS ARE FIXED IN POSITION.

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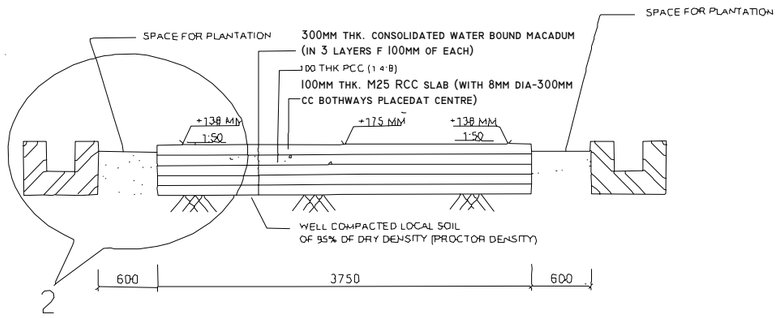
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
RAIL CUM ROAD

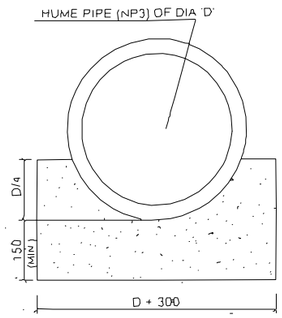
C:\SAMA\OM\SS-DWG-NEW
PLOT SCALE 1:1

C:\SAMA\OM\SS-DWG-NEW

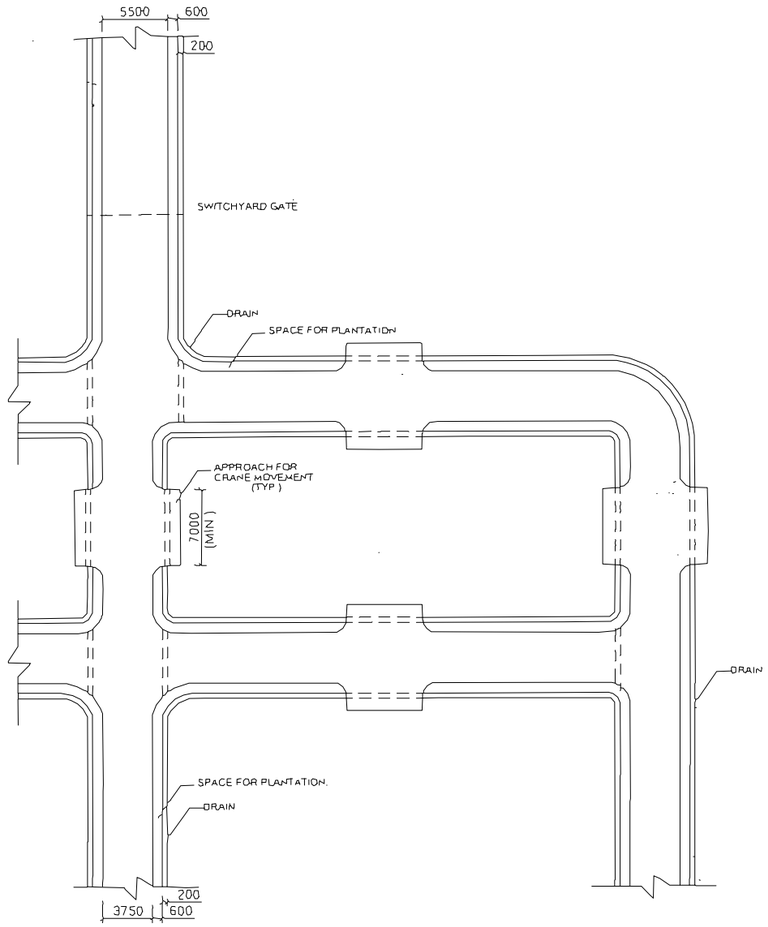
PLOT PROFILE SCALE 1:1



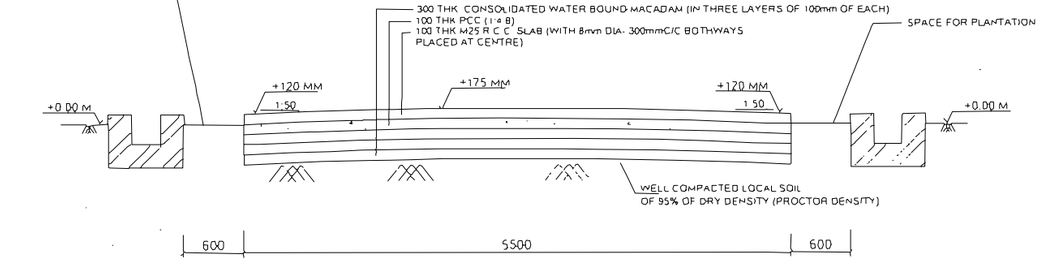
TYP. CROSS SECTION OF ROAD
(VALID FOR INTERNAL ROAD



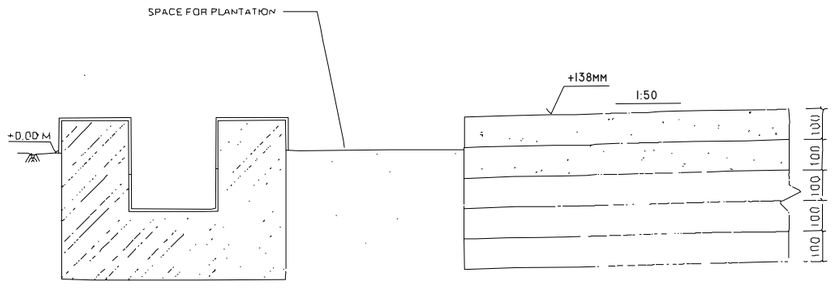
BEDDING FOR HUME PIPE



TYP. SWICHYARD ROAD AND DRAIN LAYOUTPLAN



TOP CROSS SECTION OF ROAD
(VALID FOR APPROACH TO SWITCHYARD)



DETIAL - 2

NOTES:

1. ALL DIMENSION IN MM.
2. CAMPER OF 1:50 SHALL BE PROVIDED.
3. EXPANSION JOINT 12MM THICK SHALL BE PROVIDEDEVERY 8.0M AND AT THE CENTRE.
4. POLYTHENE SHEET OF 125 MICRON SHALL BE PLACED BETWEEN PCC AND RCC SLAB (TOP SLAB).
5. 100MM DIA RCC HUME PIPE (NP3) SHALL BE PLACED ACROSS THE ROAD AT EVERY 100M INTERVAL ALONG THE ROAD,
6. FINISHED TOP OF ROAD CREST SHALL BE 175MM (MIN) ABOVE FGL.
7. IF EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDATION LVL. IT SHALL BE REPLACED BY WELL COMPACTED (3 LAYER) LOCALLY AVAILABLE CNS MATERIAL.

1:50

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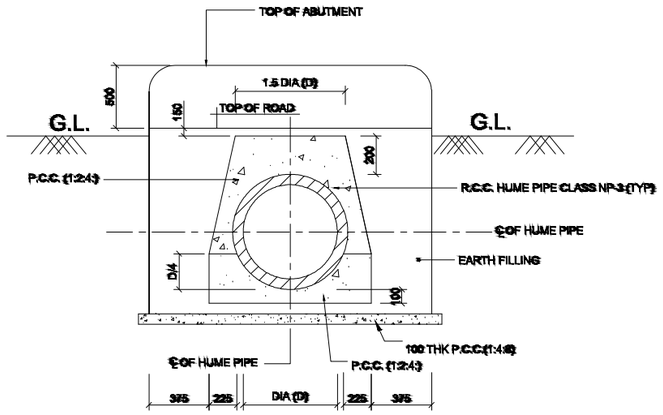
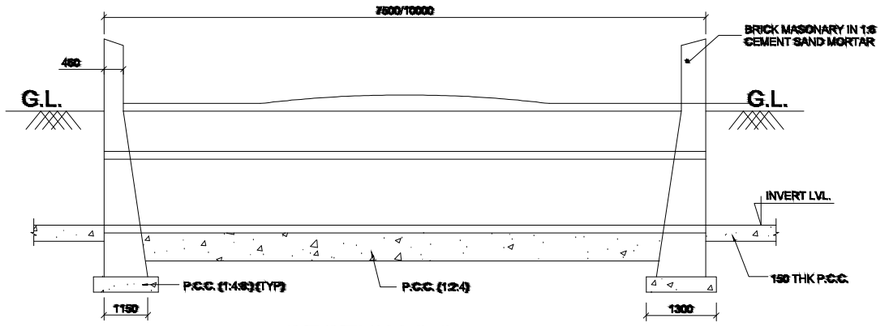
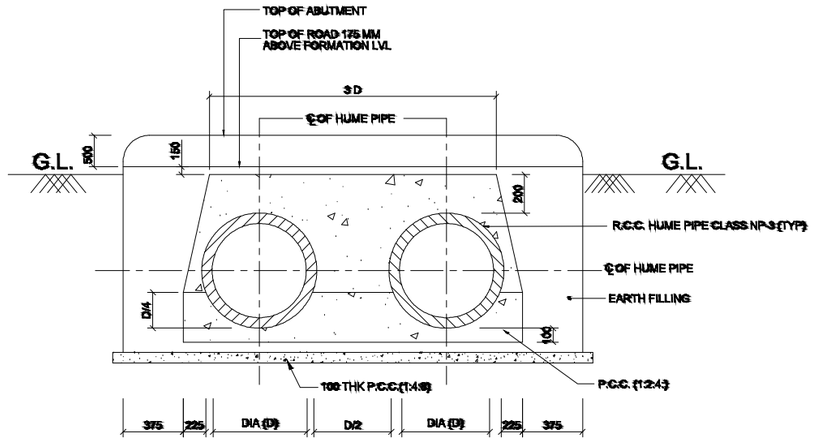
New Patan Sub Station Construction Project
Title
CONCRETE ROAD IN SWITCHYARD AREA



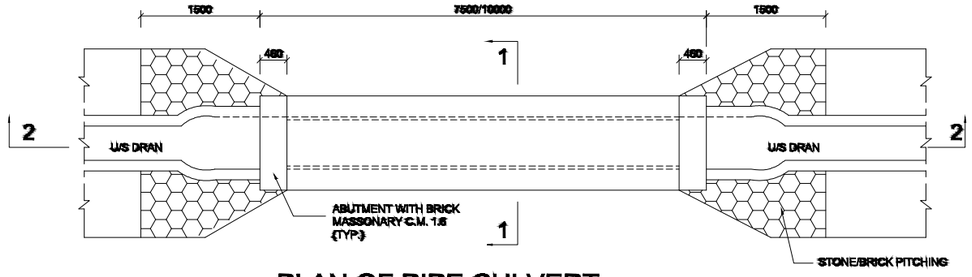
SECTION 1-1 FOR SINGLE PIPE



SECTION 2-2



SECTION 1-1 FOR DOUBLE PIPE CULVERT



PLAN OF PIPE CULVERT

NOTES:-

1. ALL DIMENSIONS ARE IN MM.
2. DO NOT SCALE THE DRG.
3. WORK SHALL BE DONE AS PER C.P.W.D. SPECIFICATION.

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NEPAL ELECTRICITY AUTHORITY
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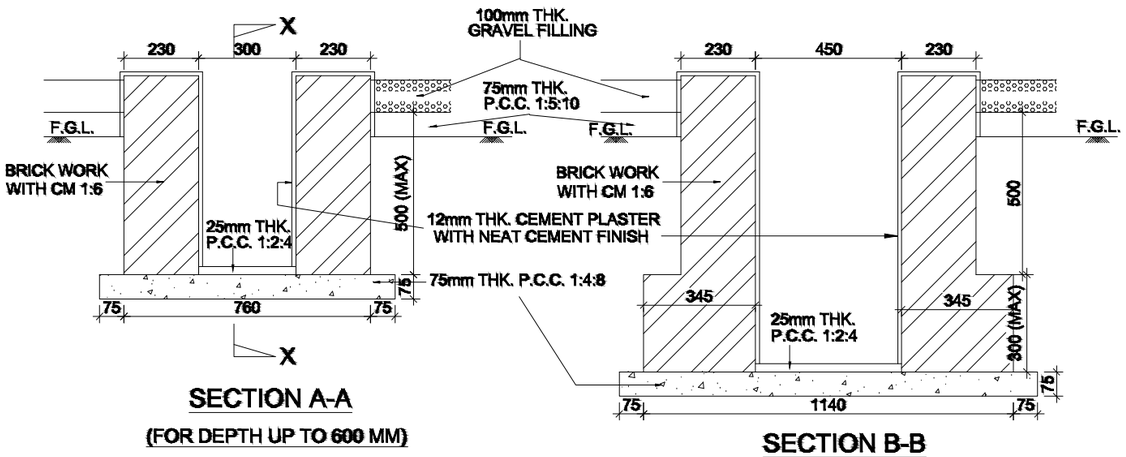
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
ROAD CULVERT

C:\SAMA\OM\SS-DWG-NEW

PLOT SCALE 1:1

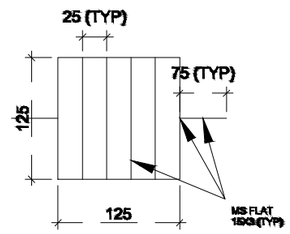


SECTION A-A

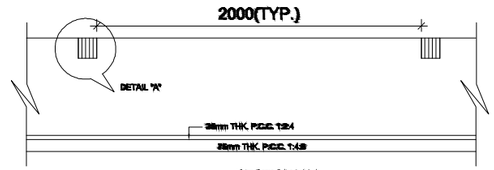
(FOR DEPTH UP TO 600 MM)

SECTION B-B

(FOR DEPTH FROM 600 TO 900 MM)

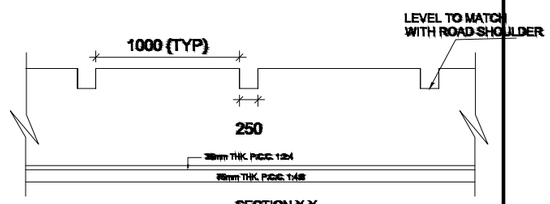


DETAIL "A"



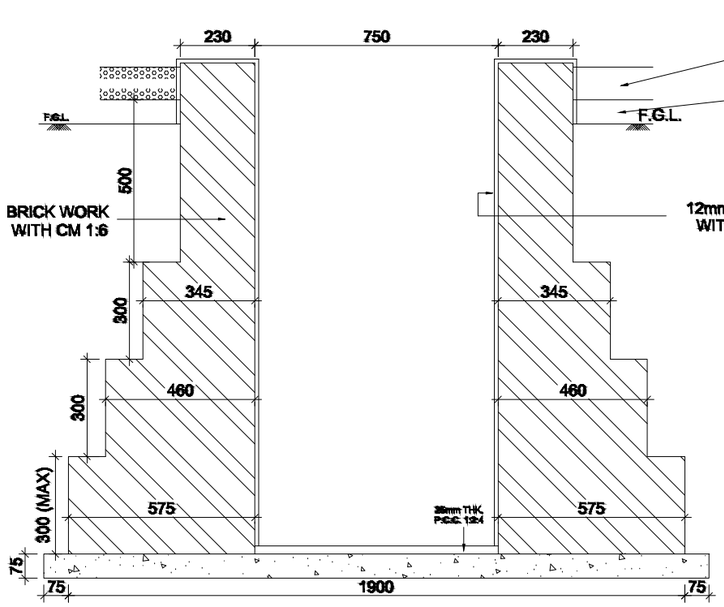
SECTION X-X

(APPLICABLE FOR GRAVEL SIDE)



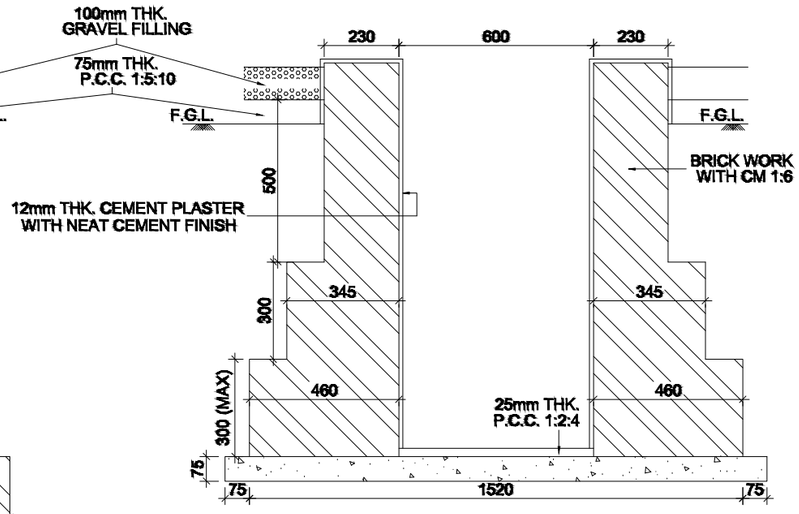
SECTION X-X

(APPLICABLE FOR ROAD SIDE)



SECTION D-D

(FOR DEPTH FROM 1200 TO 1500 MM)



SECTION C-C

(FOR DEPTH FROM 900 TO 1200 MM)

NOTES:-

1. ALL DIMENSIONS ARE IN MM. & ELEVATIONS ARE IN METRE UNLESS NOTED OTHERWISE.
2. ALL DRAINS SHALL BE GIVEN A MINIMUM SLOPE OF 1: 1000 IN THE LONGITUDINAL DIRECTION
3. MINIMUM DEPTH OF DRAIN SHALL BE 300MM BELOW FGL.
4. WHERE EVER TWO SECTIONS ARE MEETING A TRANSITION ZONE SHALL BE CONSTRUCTED HAVING LENGTH 1000mm.
5. 75X75mm WEEP HOLE SHALL BE PROVIDED AT SPACING OF 1500mm HORIZONTALY & 300mm VERTICALLY IN STAGGERED MANER.
6. DEPTH OFF DRAIN IS TAKEN AS HEIGHT FROM TOP OF DRAIN TO INVERT OF DRAIN
7. LAYOUT OF DRAIN WILL BE ISSUED DURING EXECUTION STAGE

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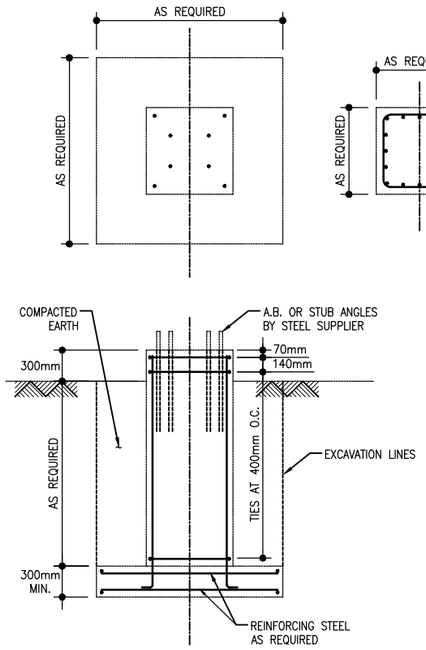
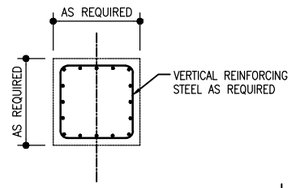
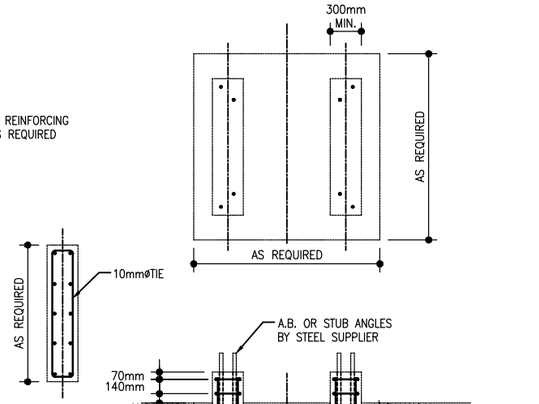
New Patan Sub Station Construction Project

Title: DRAIN DETAIL

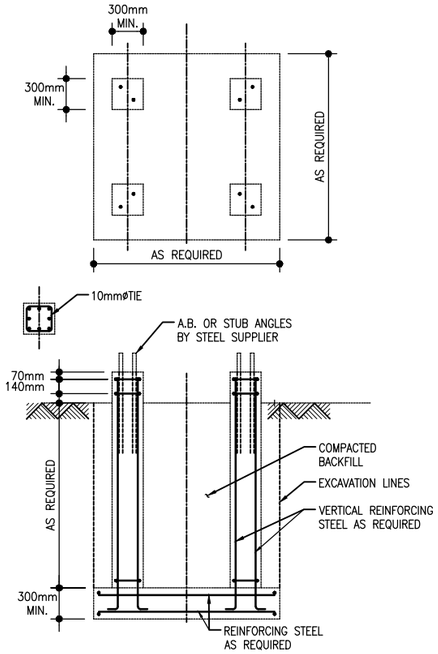


TYPICAL SINGLE PIER SPREAD FOOTING FOR 132kV EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES





TYPICAL SPREAD FOOTING FOUNDATION WITH TWO PIERS FOR EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES



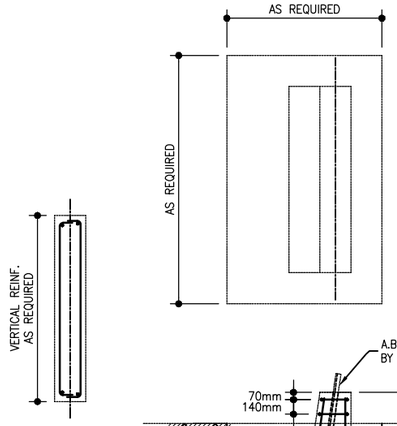
TYPICAL SPREAD FOOTING FOUNDATION WITH FOUR PIERS FOR EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES

GENERAL NOTES

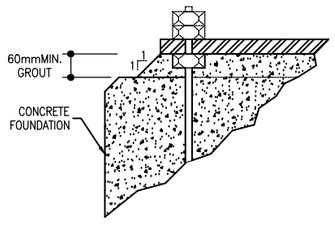
1. FOUNDATIONS OUTLINES AND DETAILS ILLUSTRATED ON THIS DRAWING ARE CONCEPTUAL ONLY AND ARE NOT RESTRICTED BEYONDTHE GENERAL OUTLINE CONFIGURATION AND MINIMUM DIMENSIONS.
2. FINAL FOUNDATION DESIGN SHALL BE BASED ON THE DESIGN PARAMETERS GIVEN IN THE SPECIFICATIONS.
3. FOR LOCATIONS AND LENGTH OF CABLE TRENCHES SEE GENERAL SUNSTATION LAYOUT DRAWINGS.

CONCRETE NOTES

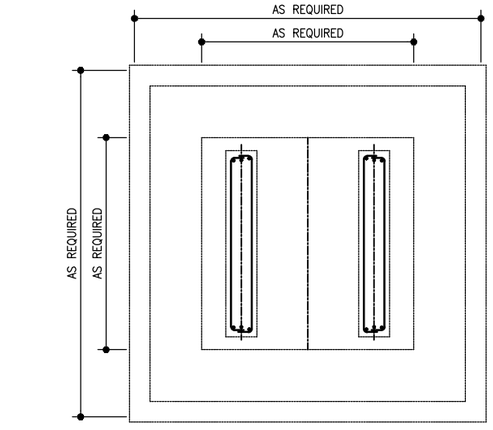
1. CONCRETE SHALL HAVE A 28 DAY MINIMUM COMPRESSIVE DESIGN STRENCTH OF 210kg/sq.cm.
2. ALL REINFORCING BARS SHALL BE DEFORMED NEW BILLET STEEL BAR CONFORMING TO ASTM A615 GRADE 60.
3. REINFORCING STEEL SHALL BE DETAILED AND FABRICATED IN ACCORDANCE WITH MANUAL OF STANDARD PRACTICE OF THE CONCETE REINFORCING STEEL INSTITUTE.
4. MINIMUM COVER FOR REINFORCING STEEL SHALL BE
   a. CONCRETE CAST AGAINST EARTH 75mm
   b. ALL OTHER CONCRETE 50mm
5. CONCRETE FOUNDATIONS SHALL HAVE THE FOLLOWING MINIMUM STEEL.
   a. FOUNDATION PIERS–0.003 GROSS AREA
   b. FOUNDATION FOOTINGS–0.003 AVERAGE GROSS AREA
6. ALL EXPOSED CONCRETE SHALL HAVE 20x20mm CHAMFER EDGES.

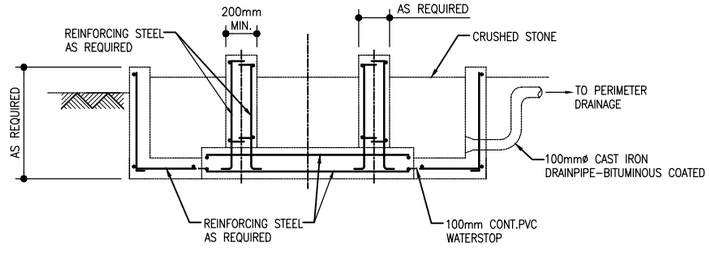


TYPICAL SPREAD FOOTING FOR 132kV GANTRY TOWER

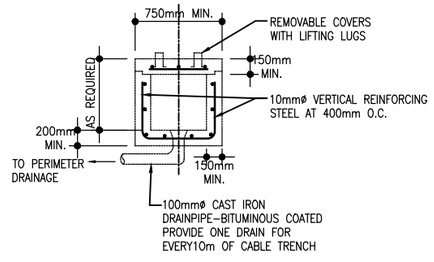


TYPICAL BASEPLATE AND GROUT DETAIL





132kV TRANSFORMER FOUNDATION WITH OIL CONTAINMENT

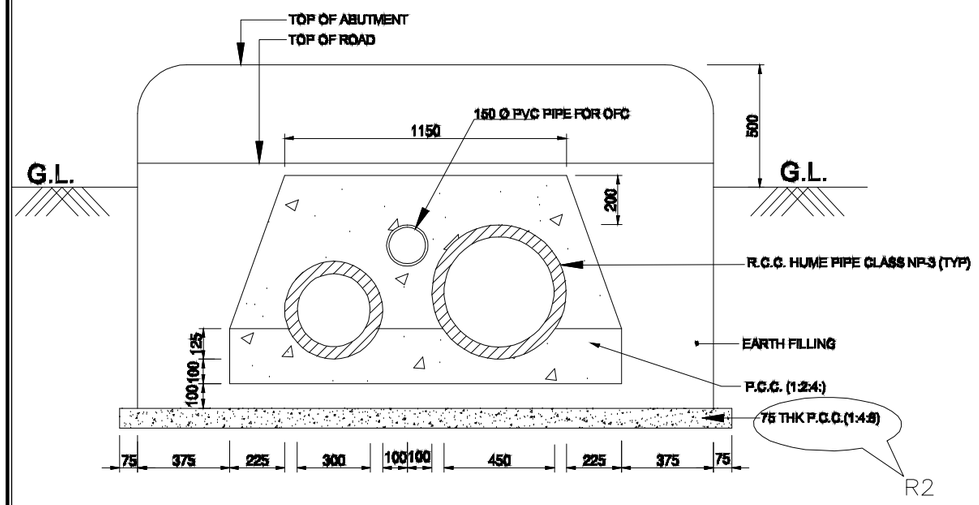


TYPICAL CABLE TRENCH DETAIL
SLOPE TO DRAINAWAY FROM CONTROL BUILDING

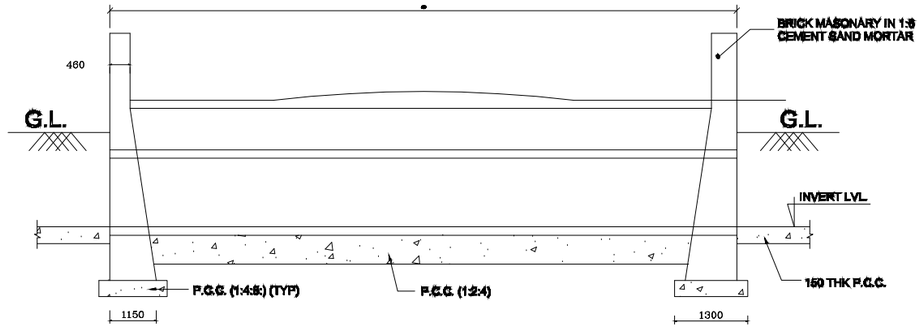
REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

Rev.	Date	Description			Approved

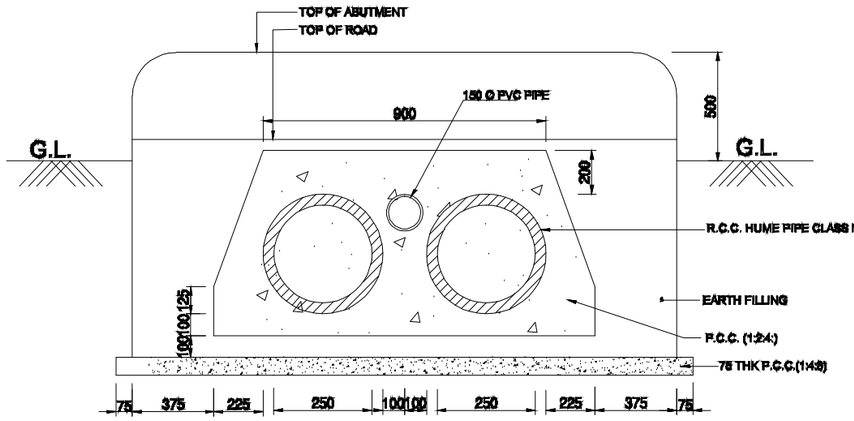
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
TYPICAL EQUIPMENT FOUNDATION



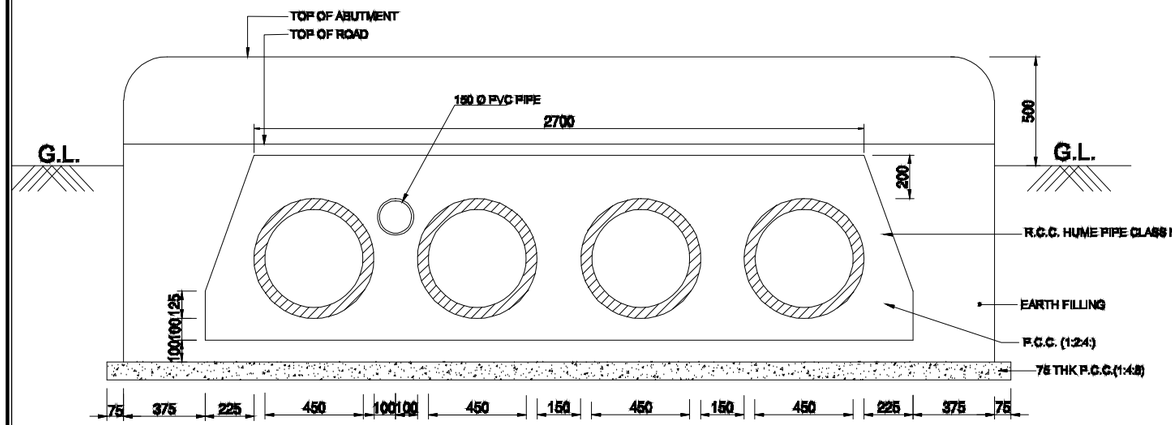
CABLE TRENCH SECTION 2-2 CROSSING ROAD



LONGITUDUNAL SECTION THROUGH CABLE TRENCH CROSSING ROAD



CABLE TRENCH SECTION 3-3 CROSSING ROAD



APPROVED BY E.D.ENGG-S/Stn & T/L VIDE NOTE SHEET
Ref:- C/ENGG/CIVIL/STD/CT-CROSSING Dated 11/06/2012

General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. F.G.L. DENOTES FINISHED GROUND LEVEL.
4. CLASS 75 BRICKS SHALL BE USED
5. CONCRETE MIX FOR COVERING RCC PIPE SHALL BE 1:2:4 (1 CEMENT; 2 COARSE SAND: 4 COARSE AGGREGATE)
6. RCC HUME PIPE SHALL BE OF GRADE NP3
7. ALL LEAN CONCRETE SHALL BE OF GRADE 1:4:8 (1 CEMENT; 4 COARSE SAND: 8 COARSE AGGREGATE)
8. BRICK MASONRY SHALL BE DONE USING CEMENT MORTAR 1:6 (1 CEMENT; 6 FINE SAND)

REFERENCE DRAWING. ONLY
FOR
TENDER PROPOSE

Rev.	Date	Description			Approved

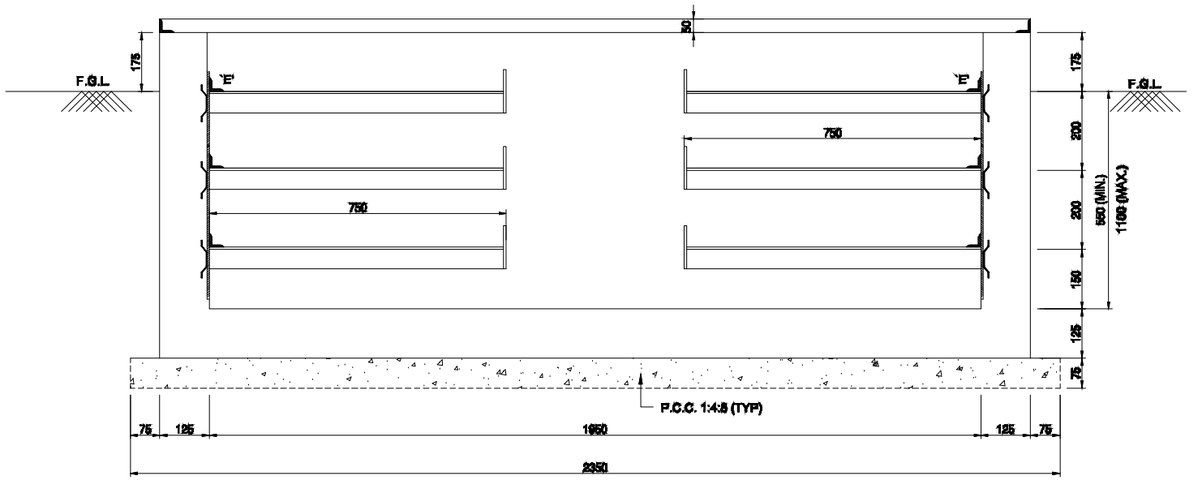
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
Project Management Directorate
CPC 132KV Underground TL Project

New Patan Sub Station
Construction Project

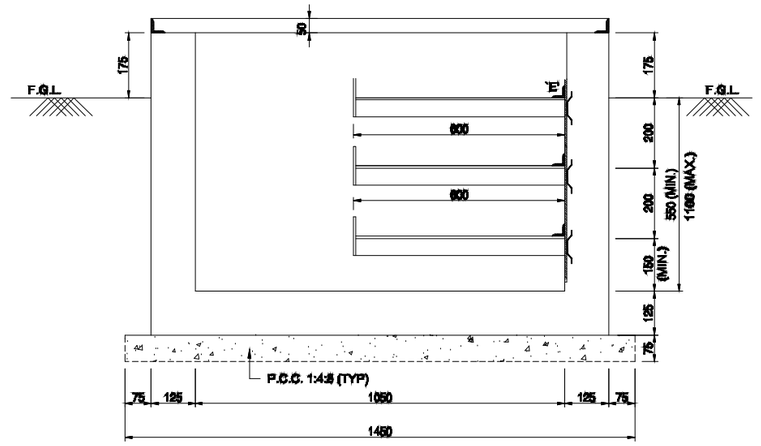
Title
CABLE TRENCH CROSSING

C:\SAMA\OM\SS-DWG-NEW

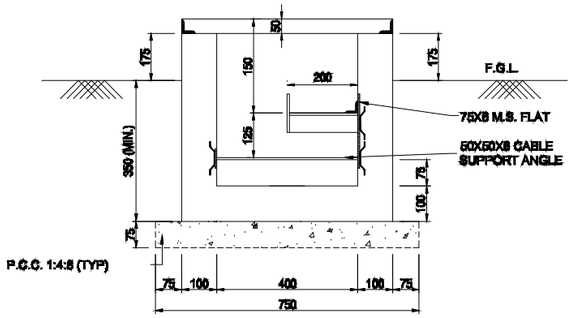
PLOT PROFILE SCALE 1:1



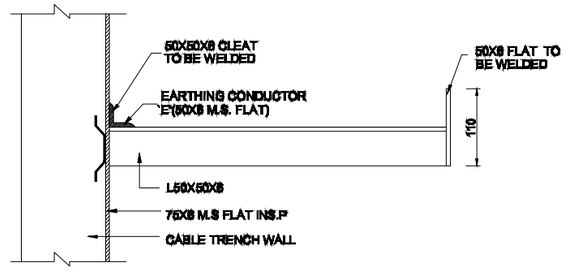
SECTION 1-1



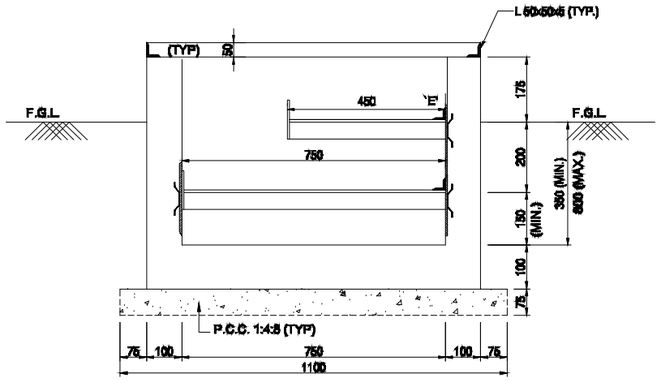
SECTION 2-2



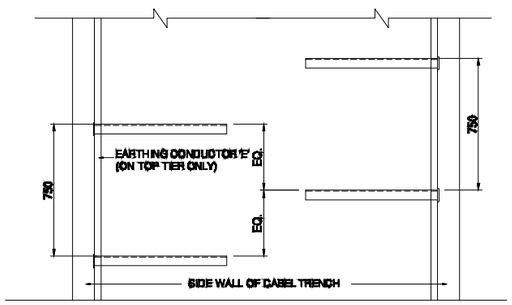
SECTION 4-4



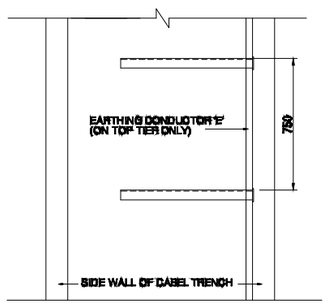
TYPICAL CABLE SUPPORT



SECTION 3-3



PLAN
CABLE TRAY SUPPORT FOR SECTION 1-1



PLAN
CABLE TRAY SUPPORT FOR SECTION 2-2 & 3-3

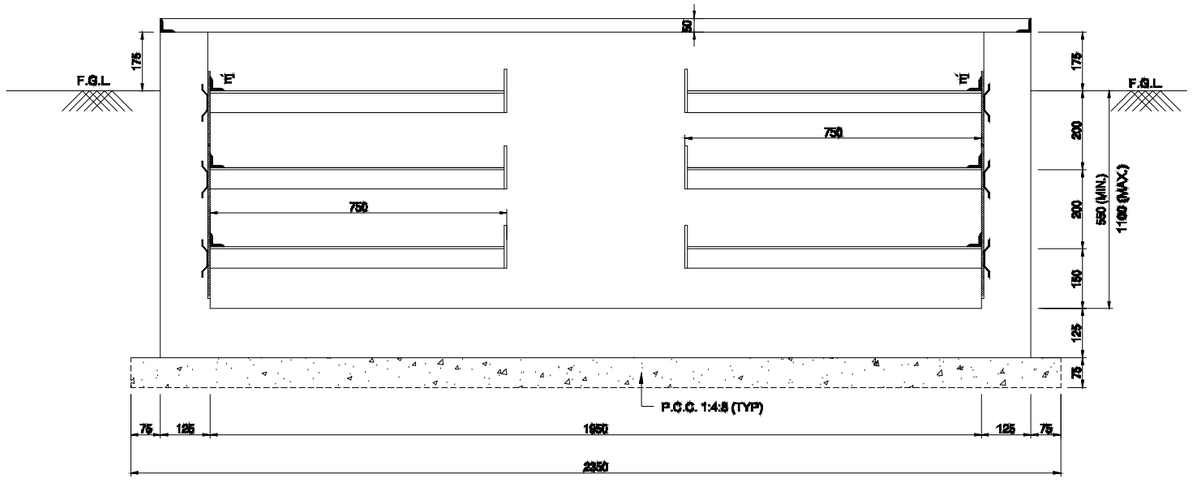
General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
3. LAP LENGTH SHALL BE 47 TIMES DIA OF BAR.
4. PROVIDE CLEAR COVER TO REINF.AS UNDER.
   * 25mm FOR TOP SIDE OF BOTTOM SLAB.
   * 50mm FOR OUTER SIDE OF WALL
5. ALL R.C.C SHALL BE OF GRADE M25 UNLESS NOTED OTHERWISE.
6. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
7. NECESSARY OPENINGS SHALL BE PROVIDED AT APPROPRIATE LOCATIONS TO TAKE OUT CABLES.
8. FOR ACTUAL DEPTH OF TRENCHES REFER APPROVED CABLE TRENCH LAYOUT
9. F.G.L. DENOTES FINISHED GROUND LEVEL.
10. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
11. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE
12. ALL STEEL STRUCTURES PLATES SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT OVER A COAT OF SUITABLE PRIMER BEFORE INSTALLATION OF CABLES, EARTHING CONDUCTOR SHALL BE PAINTED RED.
13. CONSTRUCTION JOINT SHALL BE PROVIDED AT 30M OR AS PER SITE REQUIREMENT BUT NOT EXCEEDING 30M.
14. ALL SUPPORT ANGLES SHALL BE 50x50x6
15. ANCHORING FLAT (75x6) SHALL BE PROVIDED AT EACH SUPPORT ANGLE POINT.
16. EARTHING CONDUCTOR 'E' SHALL BE PROVIDED ON THE TOP TIER OF EACH CABLE TRENCH SECTION.
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL. NECESSARY TREATMENT OF SOIL SHALL BE DONE AS PER RECOMMENDATION OF SOIL CONSULTANT/REPORT BEFOR PLACING THE FOUNDATIONS.
18. ALL REINFORCEMENT STEEL BARS (Φ) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

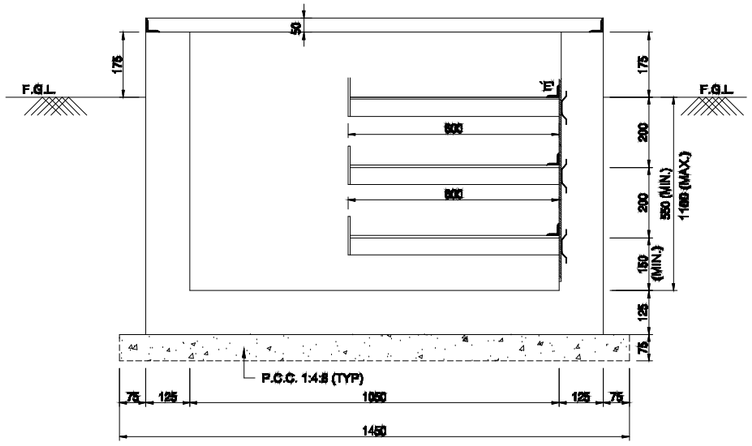
REFERENCE DRAWING. ONLY
FOR
TENDER PROPOSE

Rev.	Date	Description			Approved

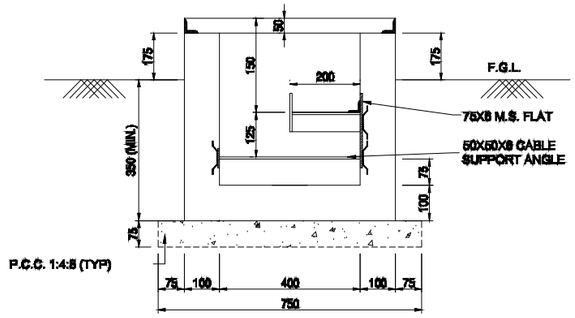
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
CABLE TRENCH DETAIL



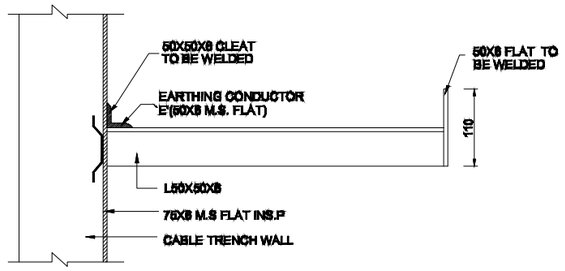
SECTION 1-1



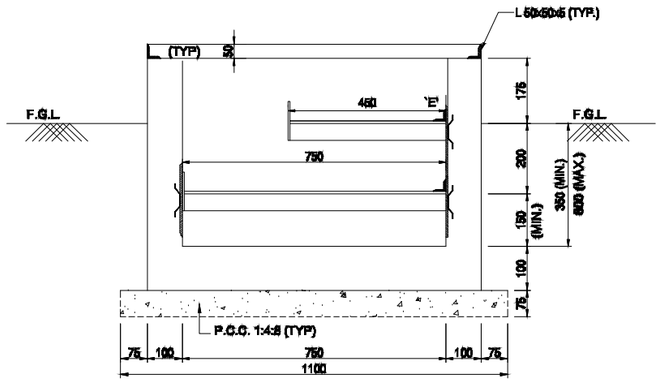
SECTION 2-2



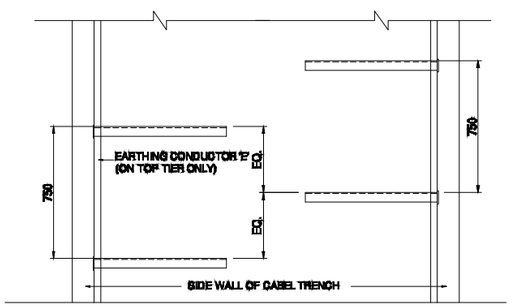
SECTION 4-4



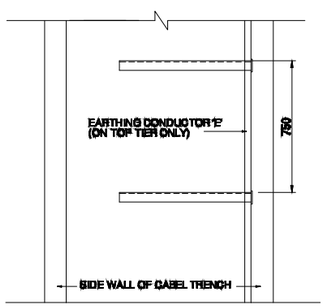
TYPICAL CABLE SUPPORT



SECTION 3-3



PLAN
CABLE TRAY SUPPORT FOR SECTION 1-1



PLAN
CABLE TRAY SUPPORT FOR SECTION 2-2 & 3-3

General Notes

1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE
2. DO NOT SCALE THE DRAWING, ONLY WRITTEN DIMENSIONS TO BE FOLLOWED
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4. PROVIDE CLEAR COVER TO REINF.AS UNDER.
   * 25mm FOR TOP SIDE OF BOTTOM SLAB.
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5. ALL R.C.C SHALL BE OF GRADE M25 UNLESS NOTED OTHERWISE.
6. LIFTING HOOK SHALL BE PROVIDED IN EVERY TENTH COVER SLAB.
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8. FOR ACTUAL DEPTH OF TRENCHES REFER APPROVED CABLE TRENCH LAYOUT
9. F.G.L. DENOTES FINISHED GROUND LEVEL.
10. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
11. EARTHING CONDUCTOR 'E' 50x6 M.S. FLAT SHALL BE WELDED TO THE CABLE SUPPORTING STRUCTURE BEFORE INSTALLATION OF CABLE
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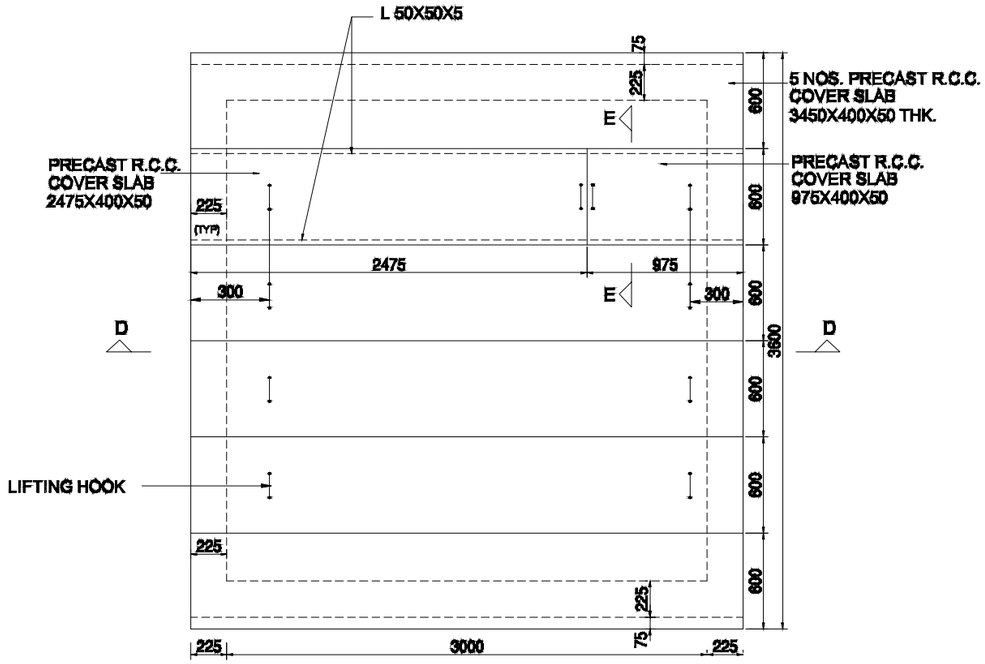
17. INCASE EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDING LEVEL. NECESSARY TREATMENT OF SOIL SHALL BE DONE AS PER RECOMMENDATION OF SOIL CONSULTANT/REPORT BEFOR PLACING THE FOUNDATIONS.
18. ALL REINFORCEMENT STEEL BARS (TOR) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

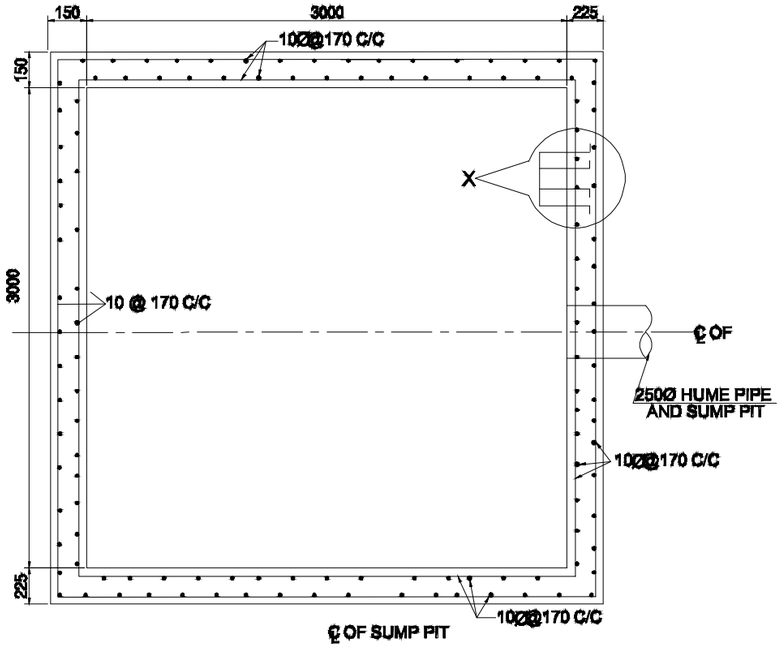
Rev.	Date	Description		Approved

NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
RCC DETAILS CABLE TRENCH

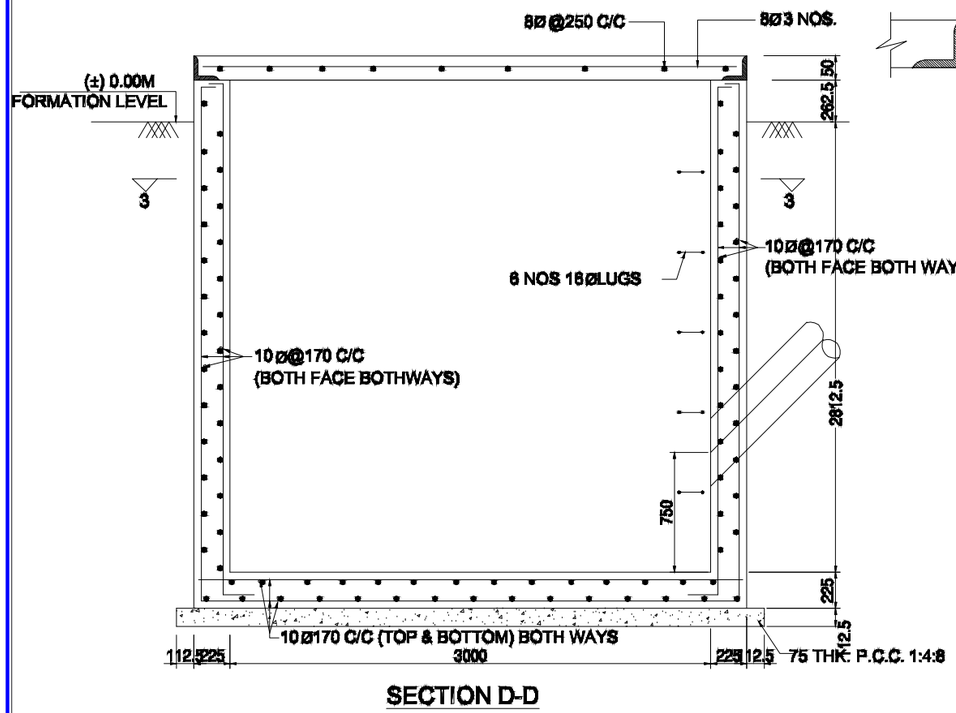
C:\SAMA\OM\SS-DWG-NEW
PLOT SCALE 1:1



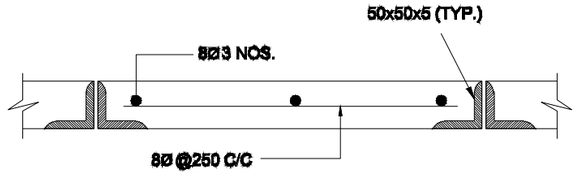
TOP PLAN OF SUMP PIT



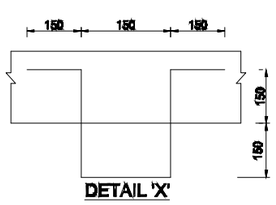
SECTION 3-3



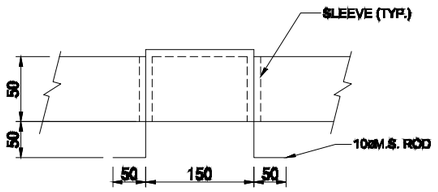
SECTION D-D



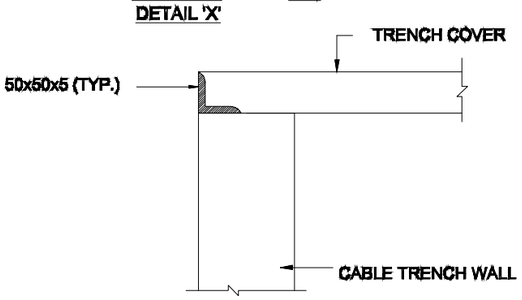
SECTION E-E



DETAIL 'X'



DETAIL OF LIFTING HOOK



TYPICAL DETAIL OF SLAB SUPPORT

General Notes

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10. ALL CABLE TRENCHES SHALL HAVE A SLOPE OF 1:1000 IN THE DIRECTION OF MAIN RUN AWAY FROM THE BUILDING.
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18. ALL REINFORCEMENT STEEL BARS (T) SHALL CONFORM TO IS:1786-1985 OF GRADE Fe500

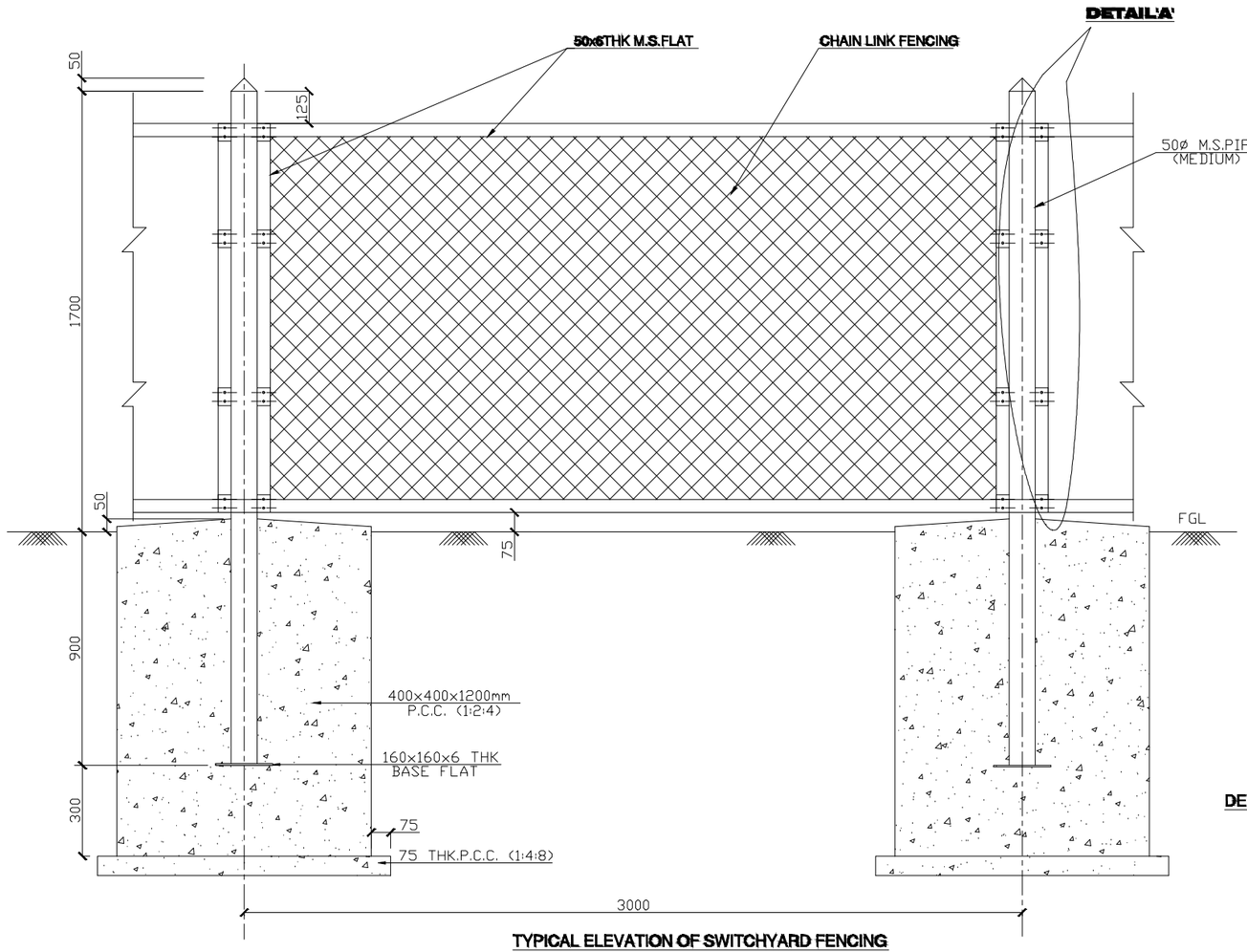
REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

Rev.	Date	Description			Approved

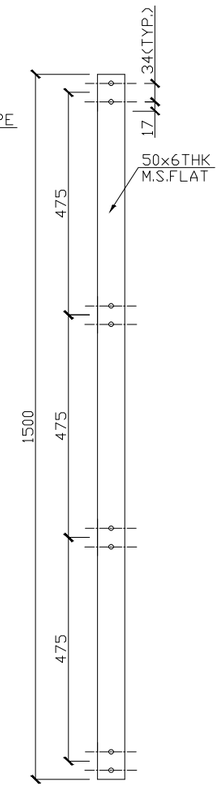
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
DETILS OF SUMP PIT

C:\SAMA\OM\SS-DWG-NEW

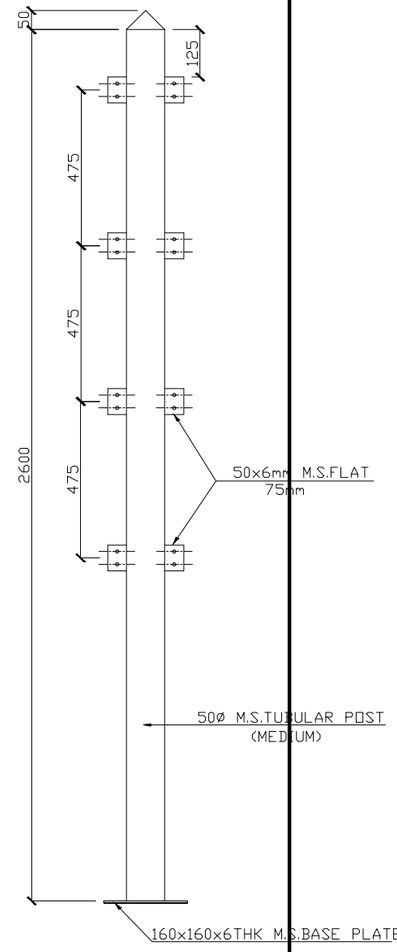
PLOT SCALE 1:1



TYPICAL ELEVATION OF SWITCHYARD FENCING



DETAIL VERTICAL M.S. FLAT 'A'



DETAIL OF TUBULAR POST

NOTES:

1. ±0.00 SHALL DENOTE SWITCHYARD FINISHED FORMATION LEVEL
2. CHAIN LINK FENCING SHALL HAVE 3.15 mm DIAMETER WIRE AS PER IS 2721 WITH 75x75 mm MESH SIZE AND PAINTED
3. TUBULAR POST SHALL BE PLACED @ 3.0m CENTRE TO CENTRE AND SHALL REST IN WELL COMPACTED EARTH
4. CORNER TUBULAR POST SHALL BE PROVIDED CLEATS IN FOUR SIDES SUITING TO REQUIREMENT
5. TUBES/PIPES OF POST SHALL BE GALVANIZED
6. CONCRETE GRADE FOR P.C.C. SHALL CONFORM IS 456: LATEST
7. EXPOSED SURFACE OF CONCRETE PAD (P.C.C.) SHALL BE PLASTERED WITH 12mm THICK CEMENT PLASTER (1:6)

RELEASED FOR TENDER & CONSTRUCTION.

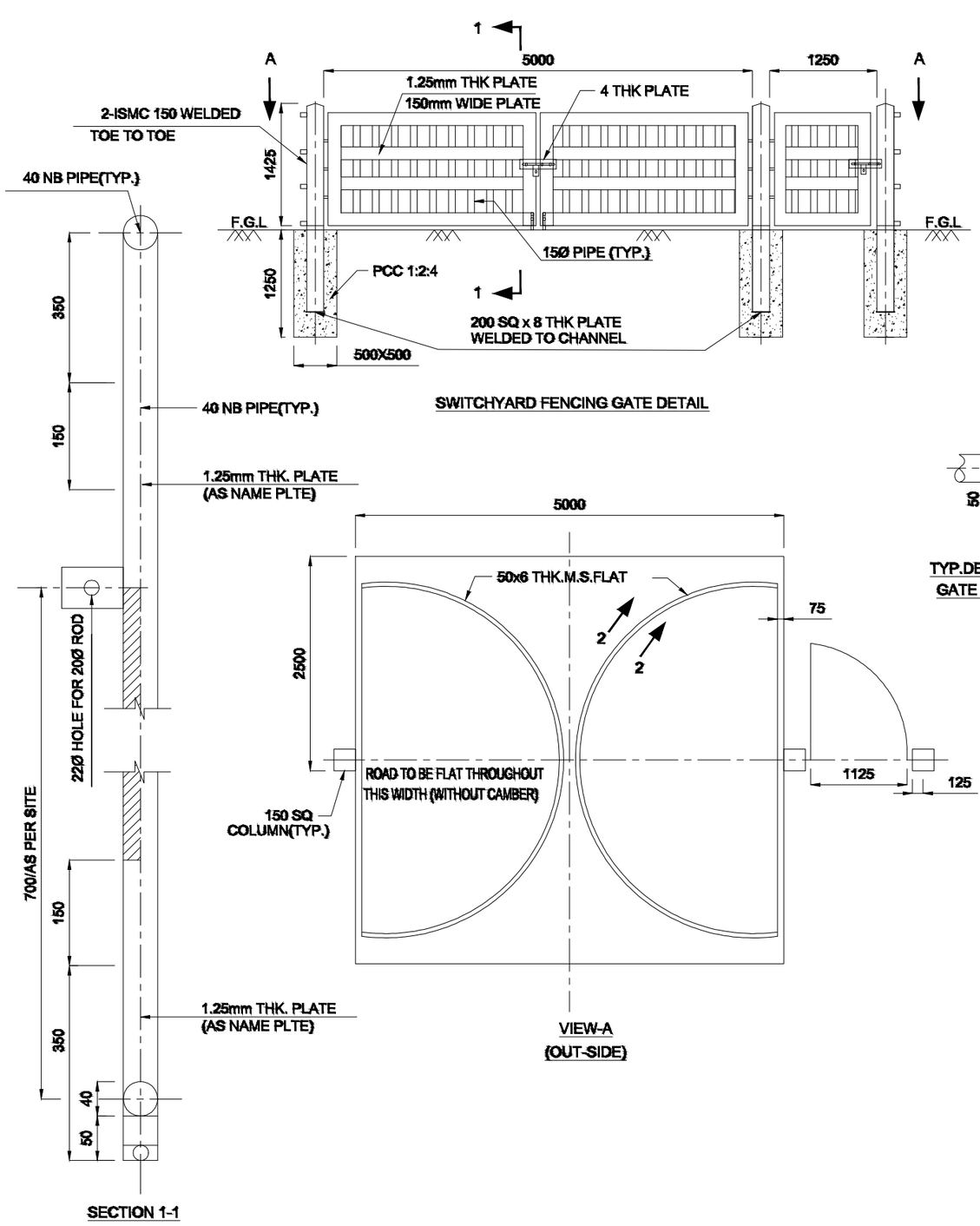
REFERENCE DRAWING. ONLY FOR TENDER PROPOSE

Rev.	Date	Description			Approved

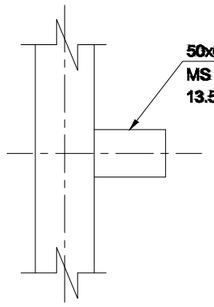
NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
PROJECT MANAGEMENT DIRETORATE
CPC 132KV Underground TL Project

New Patan Sub Station Construction Project

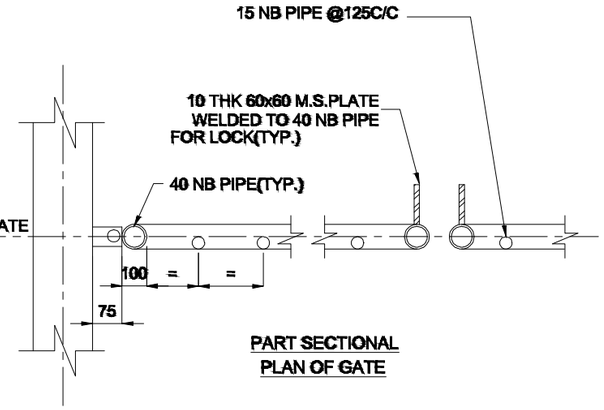
Title
DETAILS CHAINLINK FENCE



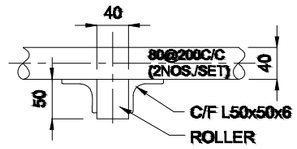
SWITCHYARD FENCING GATE DETAIL



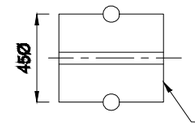
DETAIL -B



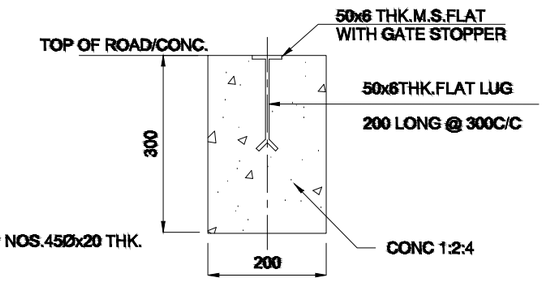
PART SECTIONAL
PLAN OF GATE



TYP.DETAIL OF
GATE ROLLER



DETAIL -A
(ROLLER BEARING)



SECTION 2:2

NOTES:

1. ALL DIMENSIONS ARE IN MM & ELEVATION ARE IN METER UNLESS NOTED OTHERWISE
2. ALL LEAN CONC. SHALL BE PCC (1:4:8)UNLESS NITED OTHERWISE.
3. UNLESS NOTED OTHERWISE LAP/ANCHOR LENGTH SHALL BE 50 TIMES THE DIA OF BARS
4. ALL STRUCTURAL STEEL CONFORM TO IS:2062 &SHALL PAINTED WITH A COAT OF APPROVED STEEL PRIMER &TWO COATS OF SYNTHETIC ENAMEL. PAINT UNLESS NOTED OTHERWISE.
5. DROP BOLTS SHOULD BO PROVIDED ON THE FAR SIDE ONLY.
6. ALL WELDS ARE 6MM THK. FILLET WELDS UNLESS NOTED OTHERWISE.
7. GATE & M.S.HOOKS TO BE PAINTED WITH ONE COAL APPROVED STEEL PRIMER BEFORE ERECTION &TWO COAT OF SYNTHETIC PAINTS AFTER ERECTION.
8. STRUCTURAL PIPES SHALL BE MEDIUM TYPE CONFORMING TO IS 1161/806

REFERENCE DRAWING. ONLY FOR
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NEPAL ELECTRICITY AUTHORITY
(GoN Undertaking)
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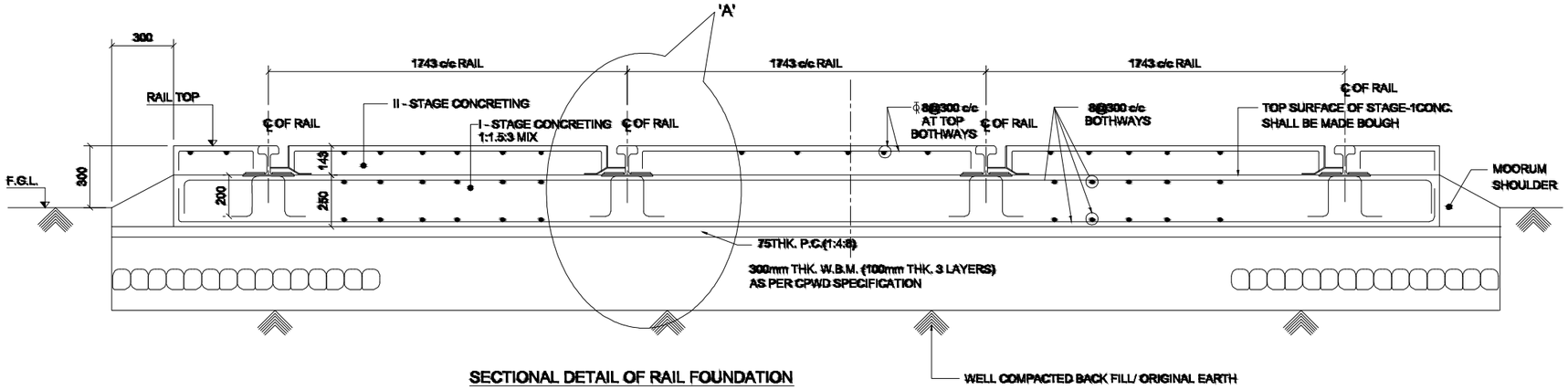
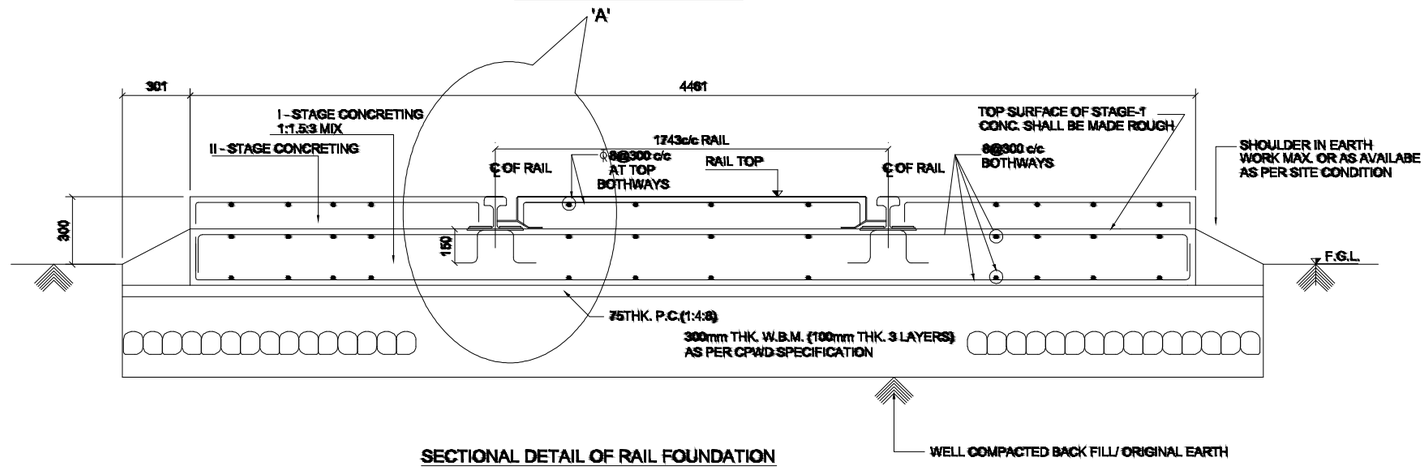
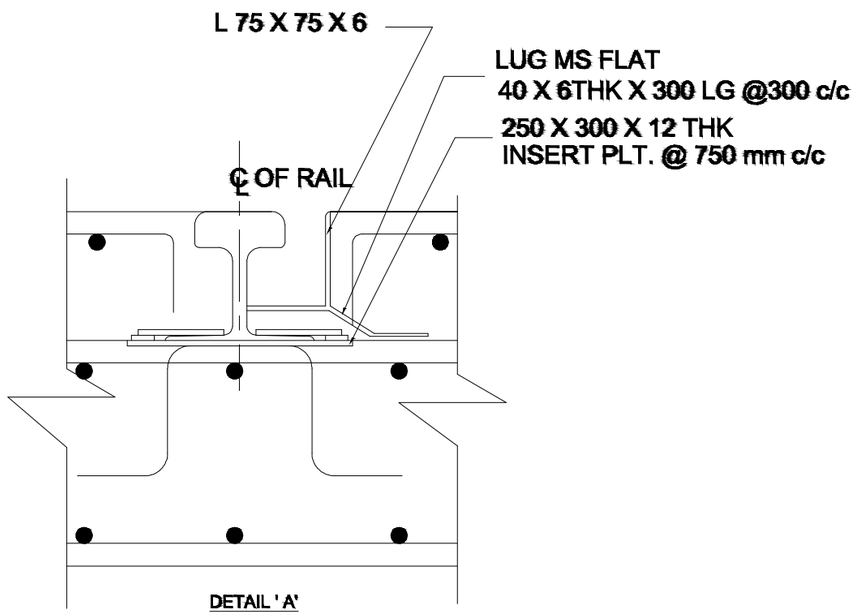
CPC 132KV Underground TL Project
New Patan Sub Station
Construction Project
Title
SWITCHYARD GATE



SECTIONAL DETAIL OF RAIL FOUNDATION
FOR 315MVATRASFORMER



SECTIONAL DETAIL OF RAIL FOUNDATION



DETAIL 'A'

NOTES:-

1. ALL DIMENSIONS ARE IN MM. & ELEVATIONS ARE IN METRE UNLESS NOTED OTHERWISE.
2. ALL STRUCTURAL CONC. SHALL BE 1:1.5:3 (1 CEMENT:1.5COARSE SAND: 3 GRADED STONE AGGREGATE OF 20MM NOMINAL SIZE)
3. ALL LEAN CONC. SHALL BE 75MM. THK. AND OF GRADE 1:4:8 (1 CEMENT:4 COARSE SAND: 8 GRADED STONE AGGREGATE OF 40MM NOMINAL SIZE)
4. ALL REINFORCEMENT STEEL BARS (DENOTED AS Ø)SHALL CONFORM TO IS:1786–1985 OF GRADE Fe 415 OR TMT BARS OF EQUAL GRADE.
5. UNLESS NOTED OTHERWISE LAP/ANCHOR LENGTH SHALL BE 50 TIMES THE DIA. OF BARS.
6. THE DRAWING SHALL NOT BE USED FOR CONSTRUCTION IF EXPANSIVE SOIL IS MET
7. SECOND STAGE CONCRETE SHALL BE DONE AFTER RAILS ARE FIXED IN POSITION.

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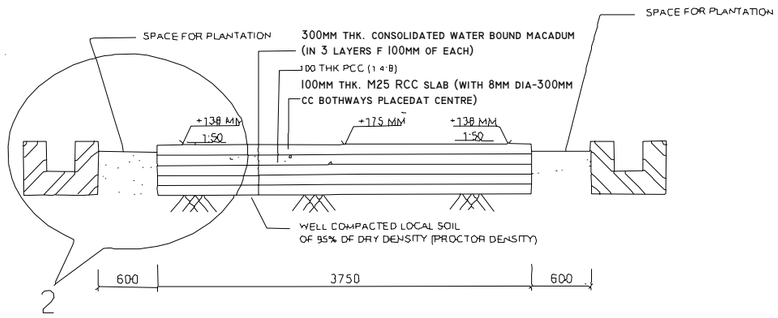
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project
Title
RAIL CUM ROAD

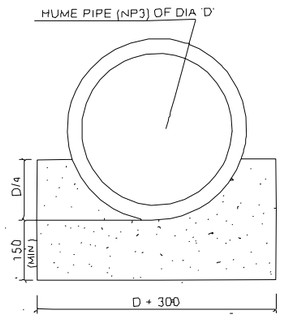
C:\SAMA\OM\SS-DWG-NEW
PLOT SCALE 1:1

C:\SAMA\OM\SS-DWG-NEW

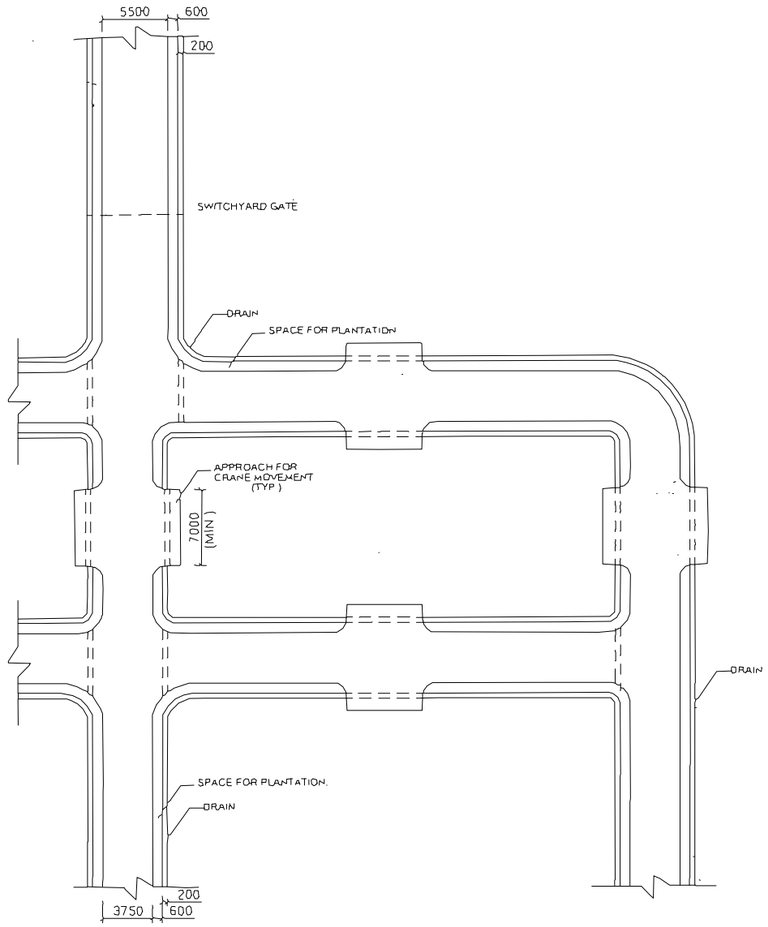
PLOT PROFILE SCALE 1:1



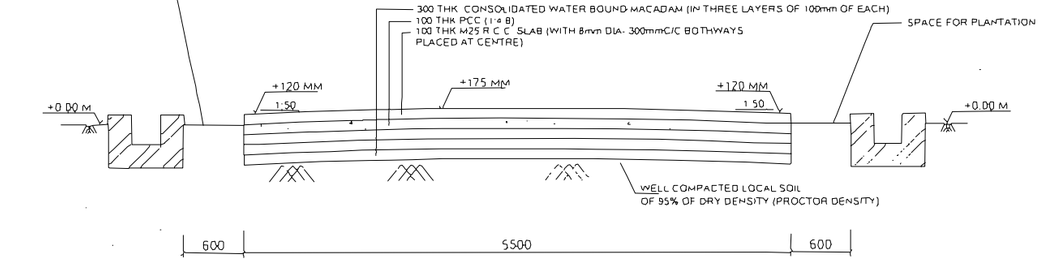
TYP. CROSS SECTION OF ROAD
(VALID FOR INTERNAL ROAD



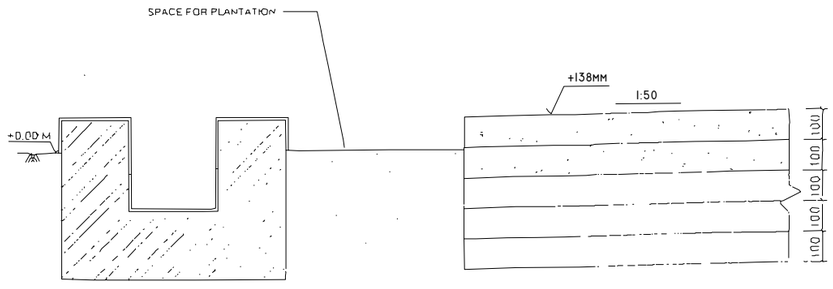
BEDDING FOR HUME PIPE



TYP. SWICHYARD ROAD AND DRAIN LAYOUTPLAN



TOP CROSS SECTION OF ROAD
(VALID FOR APPROACH TO SWITCHYARD)



DETIAL - 2

NOTES:

1. ALL DIMENSION IN MM.
2. CAMPER OF 1:50 SHALL BE PROVIDED.
3. EXPANSION JOINT 12MM THICK SHALL BE PROVIDEDEVERY 8.0M AND AT THE CENTRE.
4. POLYTHENE SHEET OF 125 MICRON SHALL BE PLACED BETWEEN PCC AND RCC SLAB (TOP SLAB).
5. 100MM DIA RCC HUME PIPE (NP3) SHALL BE PLACED ACROSS THE ROAD AT EVERY 100M INTERVAL ALONG THE ROAD,
6. FINISHED TOP OF ROAD CREST SHALL BE 175MM (MIN) ABOVE FGL.
7. IF EXPANSIVE SOIL IS ENCOUNTERED AT FOUNDATION LVL. IT SHALL BE REPLACED BY WELL COMPACTED (3 LAYER) LOCALLY AVAILABLE CNS MATERIAL.

1:50

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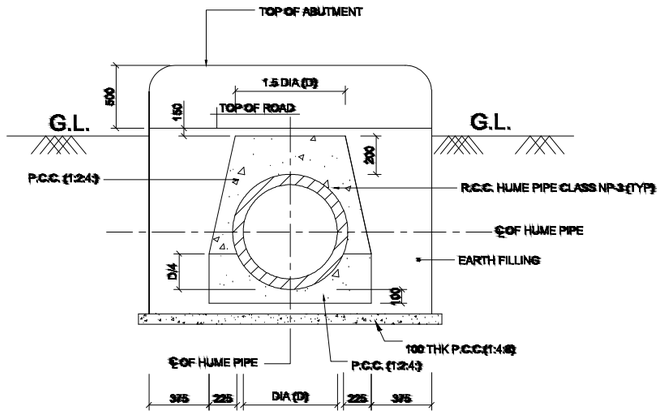
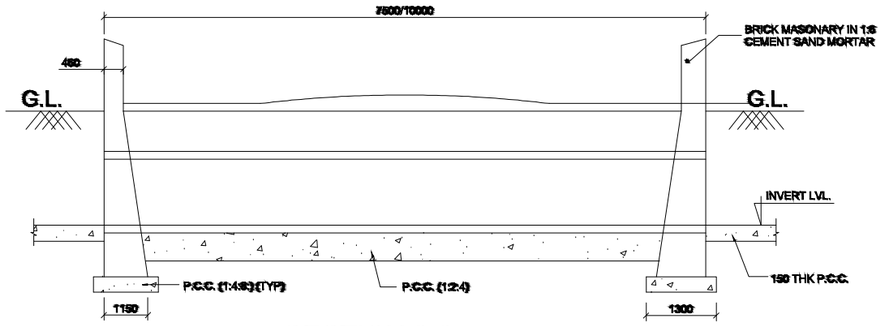
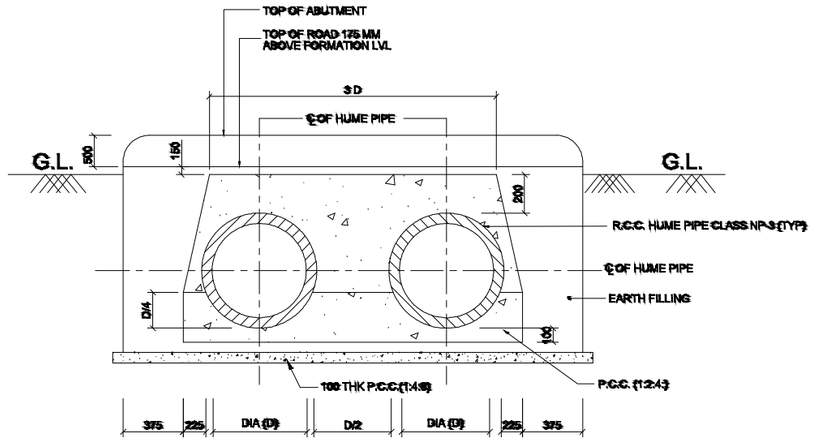
New Patan Sub Station Construction Project
Title
CONCRETE ROAD IN SWITCHYARD AREA



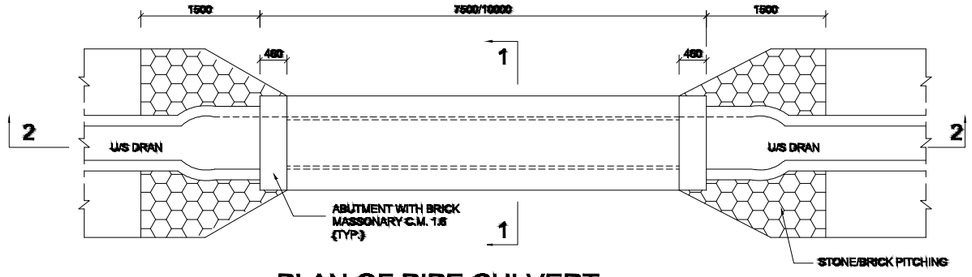
SECTION 1-1 FOR SINGLE PIPE



SECTION 2-2



SECTION 1-1 FOR DOUBLE PIPE CULVERT



PLAN OF PIPE CULVERT

NOTES:-

1. ALL DIMENSIONS ARE IN MM.
2. DO NOT SCALE THE DRG.
3. WORK SHALL BE DONE AS PER C.P.W.D. SPECIFICATION.

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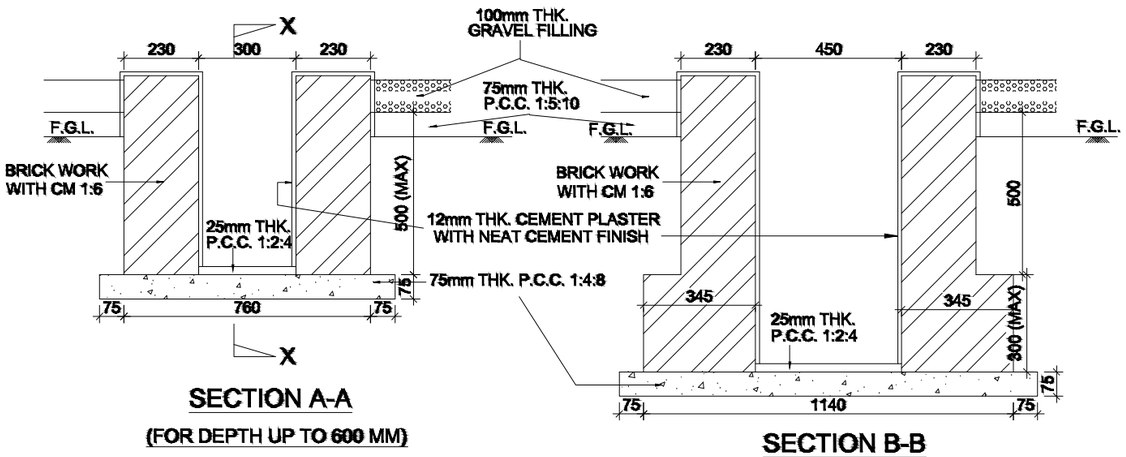
Title
ROAD CULVERT

C:\SAMA\OM\SS-DWG-NEW

PLOT SCALE 1:1

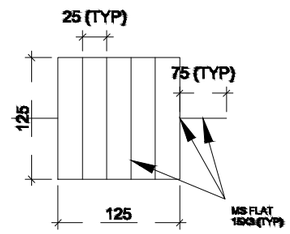


SECTION A-A

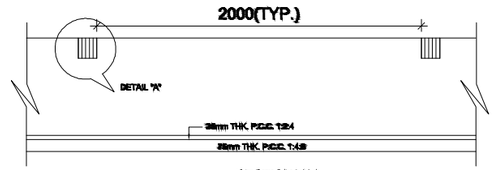
(FOR DEPTH UP TO 600 MM)

SECTION B-B

(FOR DEPTH FROM 600 TO 900 MM)

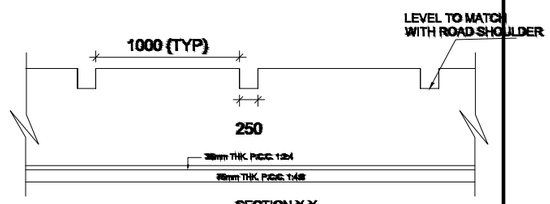


DETAIL "A"



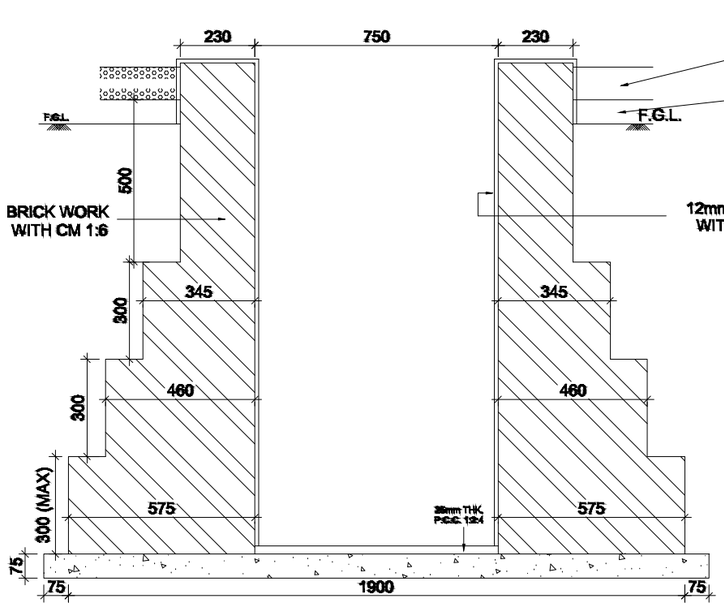
SECTION X-X

(APPLICABLE FOR GRAVEL SIDE)



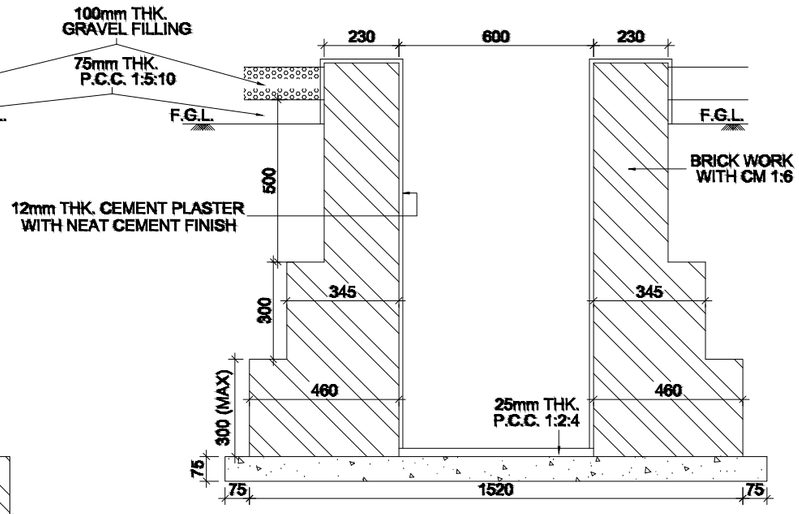
SECTION X-X

(APPLICABLE FOR ROAD SIDE)



SECTION D-D

(FOR DEPTH FROM 1200 TO 1500 MM)



SECTION C-C

(FOR DEPTH FROM 900 TO 1200 MM)

NOTES:-

1. ALL DIMENSIONS ARE IN MM. & ELEVATIONS ARE IN METRE UNLESS NOTED OTHERWISE.
2. ALL DRAINS SHALL BE GIVEN A MINIMUM SLOPE OF 1: 1000 IN THE LONGITUDINAL DIRECTION
3. MINIMUM DEPTH OF DRAIN SHALL BE 300MM BELOW FGL.
4. WHERE EVER TWO SECTIONS ARE MEETING A TRANSITION ZONE SHALL BE CONSTRUCTED HAVING LENGTH 1000mm.
5. 75X75mm WEEP HOLE SHALL BE PROVIDED AT SPACING OF 1500mm HORIZONTALY & 300mm VERTICALLY IN STAGGERED MANER.
6. DEPTH OFF DRAIN IS TAKEN AS HEIGHT FROM TOP OF DRAIN TO INVERT OF DRAIN
7. LAYOUT OF DRAIN WILL BE ISSUED DURING EXECUTION STAGE

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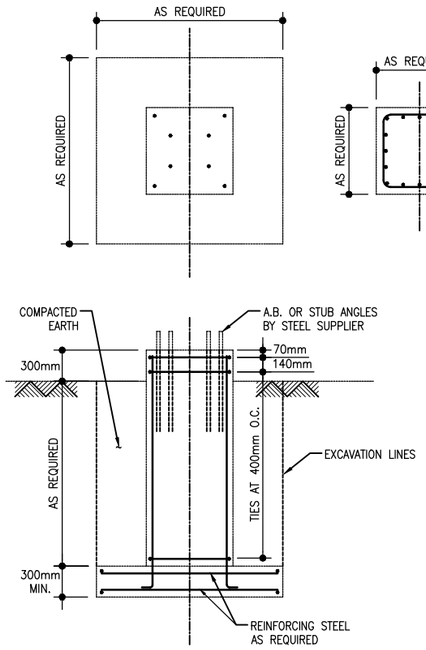
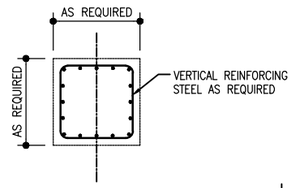
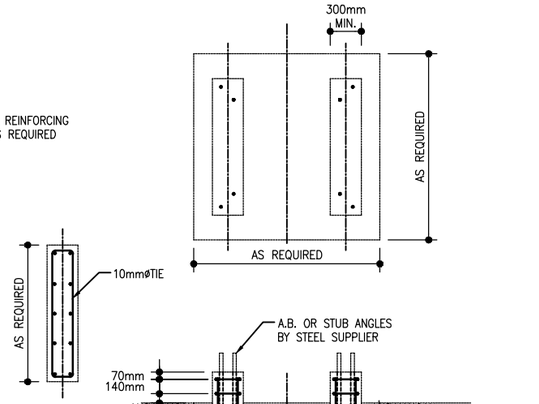
CPC 132KV Underground TL Project
New Patan Sub Station Construction Project

Title: DRAIN DETAIL

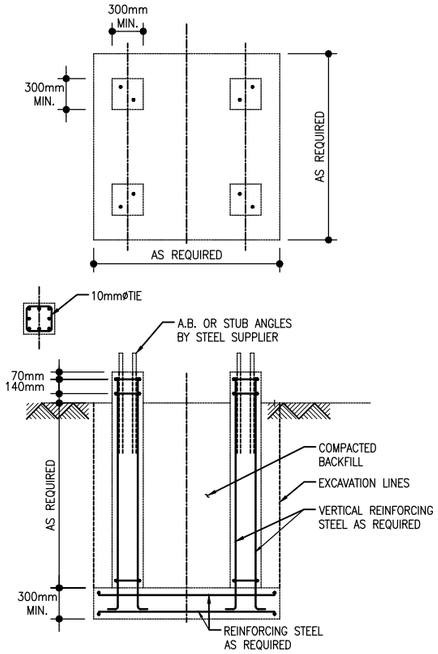


TYPICAL SINGLE PIER SPREAD FOOTING FOR 132kV EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES





TYPICAL SPREAD FOOTING FOUNDATION WITH TWO PIERS FOR EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES



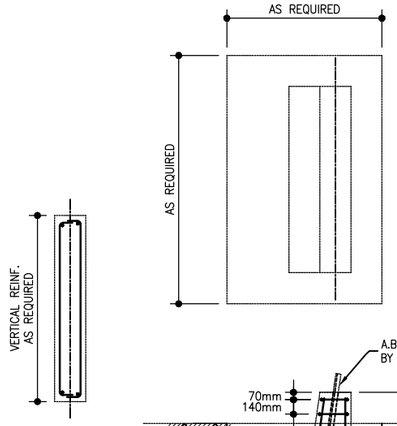
TYPICAL SPREAD FOOTING FOUNDATION WITH FOUR PIERS FOR EQUIPMENT AND EQUIPMENT SUPPORT STRUCTURES

GENERAL NOTES

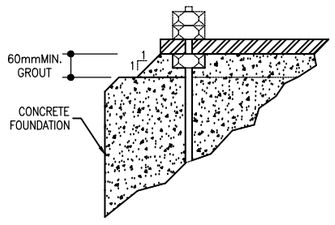
1. FOUNDATIONS OUTLINES AND DETAILS ILLUSTRATED ON THIS DRAWING ARE CONCEPTUAL ONLY AND ARE NOT RESTRICTED BEYONDTHE GENERAL OUTLINE CONFIGURATION AND MINIMUM DIMENSIONS.
2. FINAL FOUNDATION DESIGN SHALL BE BASED ON THE DESIGN PARAMETERS GIVEN IN THE SPECIFICATIONS.
3. FOR LOCATIONS AND LENGTH OF CABLE TRENCHES SEE GENERAL SUNSTATION LAYOUT DRAWINGS.

CONCRETE NOTES

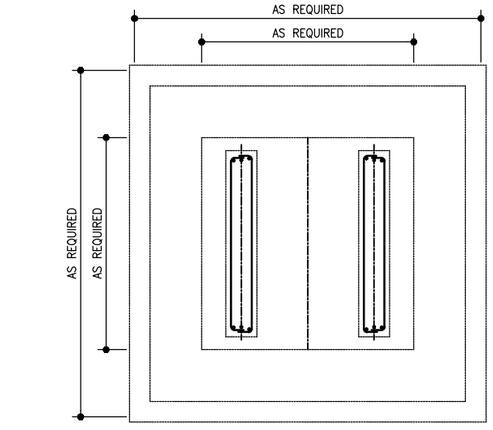
1. CONCRETE SHALL HAVE A 28 DAY MINIMUM COMPRESSIVE DESIGN STRENCTH OF 210kg/sq.cm.
2. ALL REINFORCING BARS SHALL BE DEFORMED NEW BILLET STEEL BAR CONFORMING TO ASTM A615 GRADE 60.
3. REINFORCING STEEL SHALL BE DETAILED AND FABRICATED IN ACCORDANCE WITH MANUAL OF STANDARD PRACTICE OF THE CONCETE REINFORCING STEEL INSTITUTE.
4. MINIMUM COVER FOR REINFORCING STEEL SHALL BE
   a. CONCRETE CAST AGAINST EARTH 75mm
   b. ALL OTHER CONCRETE 50mm
5. CONCRETE FOUNDATIONS SHALL HAVE THE FOLLOWING MINIMUM STEEL.
   a. FOUNDATION PIERS–0.003 GROSS AREA
   b. FOUNDATION FOOTINGS–0.003 AVERAGE GROSS AREA
6. ALL EXPOSED CONCRETE SHALL HAVE 20x20mm CHAMFER EDGES.

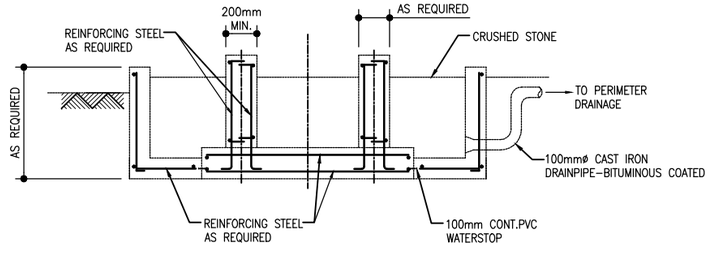


TYPICAL SPREAD FOOTING FOR 132kV GANTRY TOWER

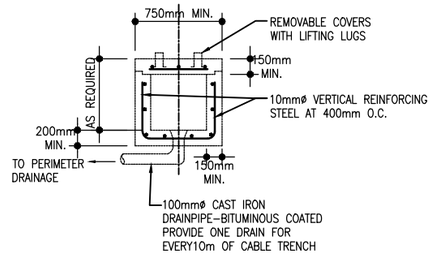


TYPICAL BASEPLATE AND GROUT DETAIL





132kV TRANSFORMER FOUNDATION WITH OIL CONTAINMENT



TYPICAL CABLE TRENCH DETAIL
SLOPE TO DRAINAWAY FROM CONTROL BUILDING

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Title
TYPICAL EQUIPMENT FOUNDATION