SECTION VI

PARTICULAR TECHNICAL SPECIFICATIONS 33KV GAS INSULATED SWITCHGEAR

REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply and shall be complied with by the manufacturer/ supplier.

IEC 60694:	Standard specification for common clauses for high voltage switchgear & control gear;
IEC 62271-203:	High voltage switchgear and control-gear. Part 203: Gas insulated metal-enclosed switchgear for rated voltages above 52kV
IEC 60376:	Specification for acceptance of new sulphur hexafluoride, SF6 gas
IEC 60480:	Guide to checking of sulphur hexafluoride, SF6 taken from Electrical equipment
IEC 60099:	Surge Arresters, Part 4: Metal Oxide surge arrestors without gaps for a.c. systems
IEC 60137:	Insulated bushings for alternating voltages above 1000 V
IEC 60859:	Cable connections for gas insulated metal enclosed Switchgear for rated voltages of 72.5 KV and above;
IEC 60060:	High voltage test techniques;
IEC 60071:	Insulation coordination;
IEC 60255:	Electrical Relays;
IEC 60265:	High voltage switches, Part 2: Switches rate voltages of 52kV and above
IEC 60270:	High voltage techniques- Partial discharge measurement
IEC 60529:	Degree of protectionprovided by enclosures (IP Code);
IEC 60815:	Selection and dimensioning of high voltage insulators intended for use in polluted conditions;
IEC 61000:	Electro-magnetic compatibility;
IEC 61634:	Use and handling of SF6 gas in high voltage switchgear;
IEC 60364/ IEC 60479/ IEEE STD 80:	Standards for station grounding;
CENELEC/SVDB:	Pressure vessel code;
IEC 60114:	Recommendation for heat treated aluminum alloy bus-bar material of the aluminum-magnesium-silicon type;
IEEE STD C37.122.1-1993 IEEE:	Guide for Gas-Insulated Substations;
IEEE STD693:	Seismic design;
IEC 60044:	Instrument transformers;
IEC 60185:	Current transformers;
IEC 60186:	Voltage transformers;
IEC 62271-100:	High voltage alternating current circuit breakers;
IEC 60427:	Synthetic testing of high voltage alternating currentcircuit breakers;
IEC 60129:	Alternating current disconnectors (isolators);
IEC 62271-102:	Alternating current disconnectors and earthing switches;
IEC 61128:	Alternating current disconnectors, bus transfer current switching by disconnectors;
IEC 61129:	Alternating current earthing switches andinduced current switching;

IEC60507: Artificial pollution test on HV insulators to be used on ac system
IEC 60517: Gas insulated metal enclosed switchgear for rated voltages of 36 kV and above.

1. TERMS AND DEFINITIONS

For the purpose of this specification the definitions given in the reference standards shall apply.

2. REQUIREMENTS

4.1 Service Conditions

4.1.1 Climatic Conditions:

The equipment and the accessories to be supplied against this technical specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

a) Max ambient temperature: $+40^0$ C
b) Min. ambient temperature: -1^0 C
c) Max daily average ambient temperature: 30^0 C
d) Max relative Humidity (%): <95%
e) Max altitude above M.S.L (meters) : 2,200 m
f) Average Annual Rainfall (mm): 1000 mm
g) Max wind pressure (kg. /sq.mtr.) : 130
h) Isockeraunic level (days/yr.): 180 thunderstorm days per year
i) Average no. of rainy days / annum: 120
j) Induced electromagnetic disturbance: 1.6 kV
k) Pollution class / Creepage distance: "Very Heavy"; Level IV/ 31mm/kV, as per IEC
l) Seismic Zone: Zone V, as per IEEE 693
m) maximum ground acceleration, g: 0.5 g

4.1.2 System Particulars

4.1.2.1 Enclosure

a) Bus bar: Three Phase
b) Bay: Three Phase
c) Enclosure material: Aluminum Alloy

4.1.2.2 Electrical data:

Table 1: 33kV GIS Switchgear

Description	Units	Values
Rated System Voltage / Highest System/Equipment Voltage	kV	33 /36
One min. Power frequency withstand voltage	kV rms	70
Across open isolator	kV rms	80

Across the open gaps of CB		kV rms	70
Rated Lightning Impulse withstand voltage (1.2/50 micro second peak value)			
1	Phase to phase	kVp	170
2	Phase to earth	kVp	170
3	Across open isolator	kVp	200
4	Across the open gaps of CB	kVp	200
Rated Frequency		Hz	50
Rated Continuous current at 40^0C ambient temperature bus bar		Amps	2500
Feeder and Transformer Bay		Amps	1600
Rated short-circuit withstand current for 3 seconds.		kA	31.5
Rated dynamic withstand current		kAp	62.5
Radio frequency voltage at 1.1 Um/√3 and frequency range 0.5 to 2 MHz		µV	<500
Partial Discharge (at 1.1 Un)		pico-coulombs	≤ 10
System Neutral Earthing			Solidly earth
Maximum SF6 Gas leakage rate per year		% per year	0.5

4.1.2.3 Auxiliary Supply:

a) For Operation, control and signaling: 110 Volts DC (+10% & -20%).

b) For other loads: 440 / 230 Volts, AC 50 Hz. (+10% & -15%).

4.1.2.4 Seismic requirements:

The GIS shall comply with IEEE STD 693 – 1984 guideline to ensure functional adequacy under seismic disturbances. The maximum ground acceleration shall be 0.5 g.

4.2. Design and Construction

4.2.1 General design concept, construction & performance of SF_6 GIS

4.2.1.1 It is understood that each manufacturer has its own particular SF_6 GIS design concept and it is not the purpose of this specification to impose unreasonable restrictions. However, in the interest of safety, reliability and serviceability, the switchgear offered shall meet the following minimum requirements:

a) The station layout and equipment rating shall be based on the single line diagram and general layout enclosed. The supplier has to work out an optimum layout based on the specific features of his product within the constraints of overall dimensions of the building.

b) All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.

c) Furthermore, no part of the enclosure, or any loose parts may fly off the switchgear in such an event, and no holes may burn through the enclosure during maximum rated

short circuit currents for duration of three seconds. All grounding connections must remain intact during and after maximum rated short circuit currents.

d) Proper grounding for mitigating of over voltages during disconnector operation shall be included. Viewing windows shall be provided at the disconnectors and earthing switches to ensure that each contact position can be inspected easily from the floor level.

e) Each compartment shall have easily replaceable connection modules to allow for easy replacement of any component with minimum disturbance to the adjacent compartments.

f) The number of transport/shipping splits shall be minimized to keep installation time of GIS to a minimum. The arrangement shall afford maximum flexibility for routine maintenance. Equipment removal and SF_6 handling should be accomplished with ease.

g) All the tools and equipment including the crane required for maintenance of the GIS shall form part of scope of supply.

4.2.2 The ease of operation shall be ensured.

4.2.2.1 In general the contours of energized metal parts of the GIS and any other accessory shall be such as to eliminate areas or points of high electrostatic flux concentrations. Surfaces shall be smooth with no projection or irregularities, which may cause corona.

4.2.3 Modular Design & Future extensions

4.2.3.1 The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF_6 gas circuit breaker, disconnectors, maintenance grounding switches, fast earthing switches, voltage transformers, current transformers, bus & elbow sections, cable end enclosures, L.A., local control cubicle and all necessary components required for safe & reliable operation and maintenance.

4.2.3.2 All the three phases of the busbars and associated equipment like breakers, disconnectors, instrument transformers & earthing switches etc., as detailed in enclosed single line diagram are to be encapsulated in a single gas filled metallic enclosure.

4.2.3.3 The bus bars shall be sub-divided into compartments including the associated bus bar disconnector. Bus bars are partitioned at each bay with an objective to isolate busbar compartment for the purpose of extension and at the same time avoid damage to adjacent bays in the event of fault.

4.2.3.4 Materials used in the manufacture of the switchgear equipment shall be of the type, composition and physical properties best suited to their particular purposes and in accordance with the latest engineering practices.

4.2.3.5 The switchgear shall be of the freestanding, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic grounded enclosures, and suitably sub-divided into individual arc and gas-proof compartments.

4.2.3.6 Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. In case of any internal arc fault in a busbar, busbar disconnector or circuit breaker, of double bus system, repair works must be possible without shutting down complete substation and at least one busbar and the undisturbed bays must remain in operation.

4.2.3.7 Where bus coupler / sectionaliser is specified and in case of any internal arc fault in a busbar, busbar disconnector or sectionaliser, repair work must be possible without shutting down the complete substation and at least one half of the substation must remain in operation.

4.2.3.8 Documents indicating sequence of repair work steps and description of necessary restrictions during work shall be submitted with the technical bid. Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.

4.2.3.9 The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

4.2.3.10 There shall not be any kind of interference to the connected & nearby equipment and system, when the equipment is operated at maximum service voltage.

4.2.4 Maintenance and repair of a circuit breaker

4.2.4.1 The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance and repair without interfering with the operation of the adjacent feeders.

4.2.4.2 The GIS shall be so designed that any component of the GIS can be removed easily. With minimum flexibility in the layout arrangement it shall be possible to remove the circuit breaker with both busbars remaining in service and it shall be possible to remove the disconnector of the busbars, with one bus bar remaining in service.

4.2.5 Interchangeability

4.2.5.1 As much as possible, all the parts shall be of standard manufacture with similar parts and assemblies being interchangeable.

4.2.6 Future Extensions

4.2.6.1 The modular design of GIS switch gear shall be capable of extension in the future on either end by the addition of extra feeders, bus couplers, bus-bars, circuit breakers, disconnectors, and other switch gear components without drilling cutting, welding or dismantling any major part of the equipment. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect.

4.2.6.2 The arrangement shall be such that expansion of the original installation can be accomplished with minimum GIS down time. In case of extension, the interface shall incorporate facilities for installation and testing of extension to limit the part of the existing GIS to be re-tested and to allow for connection to the existing GIS without further dielectric testing.

4.2.6.3 The SF_6 GIS shall be of INDOOR type and suitable for the atmosphere of the location which is heavily polluted, windy, sandy desert & service condition indicated at clause 4.1. The required switchgear shall be capable of being supplied in a completely gas-insulated version in which case all switchgear components including the bus-bars shall be of gas-insulated type.

4.2.7 Seismic design criteria

4.2.7.1 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 non-concurrently.

4.2.7.2 Seismic level Zone- IV, as per new IEEE STD 693-1984 has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration.

4.2.7.3 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.

4.2.7.4 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.

4.2.7.5 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 purchase's approval.

4.3 Specification requirements for 33kV GIS

4.3.1 General

4.3.1.1 The 33 kV GIS switch-gear shall be of a double bus design having three-phase common enclosure concept, and it shall consist of line & transformer bays as indicated in attached Single Line Diagram and General lay out plan. This configuration shall meet within the given area indicated in layout plan.

4.3.2 Current Rating

4.3.2.1 The current rating of the switchgear should be assessed on the following requirements:

4.3.2.1.1 Capable of handling power to an extent of as to an ambient day-time mean temperature between -1^0C and $+40^0$C ,

4.3.2.1.2 The switchgear described in this specification is intended for:

a) Continuous duty at the specified ratings and under all system operating conditions including sudden change of load and voltage within its ratings and at specified ambient conditions 24 hours a day, 365 days a year unless indicated otherwise.

b) The installed capacity of the power transformers is given in SLD attached.

4.3.2.2 Every current carrying part of the switchgear including current transformers, disconnecting switches, connectors and joints shall be capable of carrying its specified rated normal current continuously under IEC rating and in no part shall the temperature rise exceed the values IEC specified in relevant standards.

4.3.3 Electrical, Mechanical and Thermal Capability

4.3.3.1 The assembled equipment shall be capable of withstanding the electrical, mechanical and thermal ratings of the specified system.

4.3.3.2 All joints and connections shall be required to withstand the forces of expansion, vibration, contraction, and specified seismic requirements without deformation or malfunction and leakage. The apparatus shall be capable of withstanding the specified environment.

4.3.4 Insulation level

4.3.4.1 The switchgear and other equipment shall be designed for a maximum operating voltage and rated impulse withstands voltage according as specified in clause 4.1.2.2.

4.3.4.2 The switchgear may require to be installed in an unmanned distribution network with predominantly overhead interconnection or EHV cable as the case may be. Circuit breakers shall be capable of interrupting line, transformer & cable charging currents of the magnitude indicated in the data schedules.

4.3.5 Physical arrangement

4.3.5.1 The layout shall be properly designed by the bidder to completely accommodate the present & future requirements of the substation as per the furnished single line diagram and the enclosed site plan. They may be adjusted as necessary to suit the manufacturer's standard design and KPLC need.

4.3.5.2 The arrangement of the switchgear offered must provide adequate access for checking and maintenance. Optimized arrangements are required so as to reduce installation time, minimize maintenance & repair cost, provide ease of operation and facilitate future expansions

4.3.4 Gas Sectionalisation

4.3.4.1 The switch-gear gas enclosures must be sectionlised with gas tight barriers between sections or compartments.

4.3.4.2 The sections shall be so designed as to minimize the extent of plant rendered inoperative when gas pressure is reduced, either by excessive leakage or for maintenance purposes, and to minimize the quantity of gas that has to be evacuated and then recharged before and after maintaining any item of equipment.

4.3.4.3 The arrangement of gas sections or compartments shall be such that it is possible to extend existing bus-bars without having to take out of service another section of the bus-bar at a time.

4.3.4.4 For limitation of any internal arc to the concerned bay and to reduce the extent of necessary gas works of each section of the bus-bar must be sectionalized bay by bay. Sectionalisation shall ensure that circuit breaker enclosure will not include any other equipment in its gas compartment.

4.3.6 Expansion Joints and Flexible Connections

4.3.6.1 The layout shall sufficiently take care of the thermal expansion / contraction of the assembly by the provision of expansion joints. Expansion joints shall be placed in between any bay section of the bus-bar. All joint surfaces shall be machined, and all castings shall be spot faced for all bolt heads or nuts and washers.

4.3.6.2 If necessary, the number and position of expansion joints or flexible connections are to be determined by the manufacturer to ensure that the complete installation will not be subject to any expansion stresses which could lead to distortion or premature failure of any piece of the SF_6 equipment, support structures or foundations.

4.3.6.3 Bracing shall be provided for all mechanical components against the effects of short circuit currents specified under system parameter. The design of the equipment shall be such that the agreed permitted movement of foundations or thermal effects does not impair the assigned performance of the equipment. The design calculations for all the supports shall be submitted to ensure care taken.

4.3.6.4 The continuity of service during thermal expansion / contraction and vibrations shall be ensured. Expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. Required sliding plug-in contacts for conductors shall be provided.

4.3.6.5 This is to ensure that unreasonably excessive accuracy is not required when installing such equipment and constructing the associated foundations or support structures, e.g. transformers or the interconnection of isolated sections of switch-gear by means of long GIS bus-bar or duct installations. Flexible joints may also be provided to allow more efficient maintenance andfuture extensions of the GIS.

4.3.7 Barrier and Non-Barrier Insulators

4.3.7.1 Support insulators shall be used to maintain the conductors and enclosure in proper relation. These support insulators may be of two types. Barrier insulators which are employed to isolate gas compartments and non-barrier insulators which allow the gas pressure to equalize.

4.3.7.2 The gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum pressure difference that could occur across the barrier, i.e. maximum operating pressure at one side while a vacuum is drawn at the other side & in case of internal arc fault with a safety factor of 2.

4.3.7.3 The support insulators and section barriers / insulators shall be manufactured from the highest quality material. Epoxy resins of bisphenol A cycloaliphatic or hydration are preferred. Fillers (typically 70% by weight) of quartz fused alumina or aluminium trihydrate can also by singly used.

4.3.7.4 They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall also be of sufficient strength to ensure that the conductor spacing and clearances are maintained when short circuit faults occurs.

4.3.7.5 The insulators shall:

4.3.7.5.1 Withstand the high internal and surface electric fields, typically up to 4.0kV/mm (rms) for continuous operation and 17.0kV/mm (peak) under lightning impulse conditions.

4.3.7.5.2 Withstand short circuit forces.

4.3.7.5.3 Be made of non-tracking material so that no conducting tracks occur during testing.

4.3.7.5.4 Be relatively insensitive to surface contamination.

4.3.7.6 Tests shall be carried out during the manufacture of the switchgear to ensure that all parts of the equipment are free of partial discharge with a partial discharge extinction voltage which is at least 10% higher than the rated voltage.

4.3.8 Gas seals, Gas Density & Pressure and other requirements.

4.3.8.1 Single sealing of O-ring type shall be used for sealing the connections between the switch-gear modules. The leakage rates shall be kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.5% p.a. for the service life of equipment.

4.3.8.2 Piping and fittings for gas monitoring and gas supply shall be made of copper or brass. The gas monitor device should be installed at each individual compartment of the

module. Each gas compartment must be independent, external gas pipe connections should be avoided to minimize leakage.

4.3.8.3 All gas compartments shall be fitted with filter material which absorbs the residual moisture and moisture entering inside the high-voltage enclosure. Filters in gas compartments with switching devices must also be capable to absorb the gas decomposition products resulting from the switching arc.

4.3.8.4 The rated pressure of the SF_6 insulating gas in the metal-clad equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks.

4.3.8.5 The SF_6 switch-gear shall be designed for use with SF_6 gas complying with the recommendations of IEC – 60376 at the time of the first charging with gas. Connections including bolts and nuts shall be adequately protected from corrosion and easily accessible with the proper tools.

4.3.8.6 All components shall be fire retardant and shall be tested in accordance with relevant standards. Gas emissivity when the material is heated shall be minimal.

4.3.9 Gas Treatment Requirements

4.3.9.1 Under normal operating conditions it shall not be necessary to treat the insulating SF_6 gas between major overhauls. In all gas compartments permanent efficient filters and desiccants shall be effective for the duration of time between major overhauls.

4.3.9.2 Notwithstanding this, the insulators in the circuit breaker shall be made of epoxy resin composition that will resist decomposition products in contract with moisture.

4.3.10 Gas Monitoring Devices

4.3.10.1 Gas density or pressure monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and automatic monitoring of the state of the gas. The SF_6 gas monitoring device shall have two supervision and alarm settings.

4.3.10.2 These shall be set so that, an advanced warning can be given that the gas density/pressure is reducing to an unacceptable level. After an urgent alarm, operative measures can be taken to immediately isolate the particular compartment electrically by tripping circuit breakers and opening disconnectors. It shall be ensured that there is no chance of the gas liquefying at the lowest ambient temperature.

4.3.10.3 The gas monitoring device shall monitor at least the following, locally and on remote:

a) "**Gas Refill" Level**- This will be used to annunciate the need for gas refilling.
b) "**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 device contact shall trip the breaker and block the closing circuits.
c) **Over pressure alarm level**- This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.

4.3.10.4 It shall be possible to test all gas monitoring relays without de-energizing the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion of the plug. Two potential free electrical contacts shall be provided with each and every alarm condition

4.3.11 Conductors

4.3.11.1 The conductors shall be made of copper suitable for specified voltage and current ratings. The electrical connections between the various gas sections shall be made by means of multiple contact connectors (plug-in type) so that electrical connection is automatically achieved when bolting one section to another. Field welding of conductor is not acceptable. The surface of the connector fingers and conductor on such connections shall be silver plated.

4.3.11.2 Both, the conductors as well as the contacts for the conductor connections must be designed for the continuous rated current of the switch gear under the ambient conditions furnished, and shall not exceed the permissible temperature rise.

4.3.12 Enclosures

4.3.12.1 The metal enclosures for the SF_6 gas insulated equipment modules shall be made from Copper. Suitable anti corrosive paints shade 632 of BS 381 C: 1988 must be applied on the exterior of the enclosures.

4.3.12.2 The enclosure shall be suitable for three phases, i.e. Single Enclosure. The external fixtures should be made of corrosion-resistant material and should be capped where required.

4.3.12.3 Bellow compensators shall be made of stainless steel to preserve the mechanical strength of the equipment at the connection portions to deal with the following problems:

a) Expansion and contraction of outer enclosure and conductor due to temperature variations.
b) Mismatch in various components of GIS
c) Vibration of the transformer and switching equipment
d) Dimensional variations due to uneven settling of foundation
e) Seismic forces as mentioned in climatic condition.

4.3.12.4 Standard paint shade 632 of BS 381 C: 1988 shall be used with satin mat finish having high scratch resistance.

4.3.12.5 The gas-filled enclosures shall conform to the pressure vessel code applied in the country of manufacturer. Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum pressure differential that could occur across the barrier, i.e., with a vacuum drawn on the one side of the barrier and on the other side, at least the maximum gas pressure that can exist under normal operating or maintenance conditions and in case of internal arc fault.

4.3.12.6 The finish of interior surfaces of the metal-clad enclosures shall facilitate cleaning and inspection. High quality primer followed by two coats of anti-corrosive paint of glossy white shade shall be used such that they will not deteriorate when exposed to the SF_6 gas and other vapors, Arc products, etc., which may present in the enclosures. They shall also not contain any substances which could contaminate the enclosed gas or affect its insulating properties over a period of time.

4.3.13 General Finish and Cleaning

4.3.13.1 The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness. Very dusty / sandy conditions may exist at the site hence, whenever possible, the complete feeders or major assembly of components should be shipped as transport units. Before the metal clad enclosed sections are joined together and charged with the SF_6 gas they must be thoroughly cleaned.

4.3.13.2 Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkles or gets removed by abrasion due to normal handling. Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished with GIS.

4.3.14 Gas filling and Evacuating Plant/Gas reclaimer for 33 kV GIS unit.

4.3.14.1 All apparatus necessary for filling, evacuating, and recycling the SF_6 gas into and from the switch-gear equipment shall be supplied by the bidder to enable any maintenance work to be carried out.

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

4.3.14.3 The apparatus for filling, evacuating and recycling all gases to be used shall be provided with all necessary pipes, couplings flexible hoses, tubes and valves for coupling to the switch-gear equipment.

4.3.14.4 The gas compartments shall preferably be fitted with permanent vacuum couplings through which the gas is pumped into or evacuated from the compartments. Details of the filling and evacuating apparatus that will be supplied, and also a description of the filling, evacuating and recycling procedures, shall be provided with the bid.

4.3.14.5 The initial gas filling of the entire switch-gear including the usual losses during commissioning shall be supplied over and above the required quantity of spare gas. An additional quantity of SF_6 gas for compensation of possible losses during installation and service of 20 years shall be supplied.

4.3.14.6 The quantity of the same shall be indicated in GTP, considering leakage rate of 1% per year for complete GIS system, even if, the designed leakage rate is lower than 0.5% per annum. Such spare gas shall be supplied in sealed cylinders of uniform size, which shall be decided during detailed engineering.

4.3.14.7 Gas reclaimer shall have gas storage facility of sufficient capacity.

4.3.15 SF_6 Gas Processing Unit

4.3.15.1 An SF_6 gas-processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF_6 gas during the initial installation, subsequent maintenance and future extension of GIS shall be provided. The cart shall be equipped with rubber wheels and shall be easily maneuverable within the GIS building.

4.3.15.2 A wheeled maintenance unit shall be supplied which shall be self-contained (except for additional gas storage bottles and external power supply at 415 V AC, 3-phase, 50 Hz) and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet temperature, tank pressure and temperature, valving and piping to perform the following operations as a minimum requirement:

a) Evacuation from a gas filled compartment using the vacuum pump,
b) Transfer of SF_6 gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter,
c) Recirculation of SF_6 gas in the storage tank through the drier,
d) Recirculation of SF_6 gas in any switchgear or bus duct compartment through the drier and filter;
e) Evaporating and filling SF_6 gas,
f) Drawing off and liquefying SF_6 gas,
g) A combination operation of filling SF_6 gas into a gas system and evacuating a second gas system using the vacuum pump.

4.3.15.3 Adequate length of hoses with necessary adaptors shall be provided for filling of SF6 gas in any of the gas compartment with the help of gas cart.

4.3.15.4 G A drawing and Schematic drawing for gas processing unit shall be submitted for approval.

4.3.16 Support Structures

4.3.16.1 All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied. Sufficient attachment points to the apparatus and concrete foundations shall be furnished to ensure successful installation, with required clearances, while taking into account thermal expansion and contraction. Earthquake requirements are also to be considered.

4.3.16.2 Any scaffolding or a movable platform, required for maintenance, shall also be supplied.

4.3.16.3 All steel structure members shall be hot-dip galvanized after fabrication as per ISO 1461 requirements. Minimum thickness of galvanizing shall be 610 grams per square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable.

4.3.16.4 Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

4.3.16.5 Foundation channels and anchor bolts shall be installed in the civil works in accordance with instructions provided by the manufacturer.

4.3.17 Auxiliary Equipment

4.3.17.1 The following items shall be included for a complete installation:

a) Control system including local control cabinets
b) Cable and wiring between individual items of supplier supplied equipment.
c) Nameplates
d) All ladders, platforms, stairs, walkways, and supports necessary to operate and maintain all equipment safely and efficiently.
e) Special tools and tackles for installation
f) Special tools and tackles for maintenance

4.3.18 Safety Precautions.

4.3.18.1 The switch-gear must provide a maximum degree of safety for the operators and others in the vicinity of the switch gear under all normal and fault conditions. The safety clearances of all live parts of the equipment shall be as per relevant standards.

4.3.18.2 It must be made impossible to touch any live part of the switch-gear unwillingly, i.e. without use of tools or brute force.

4.3.18.3 An operator standing in the normal operating position should not be endangered by any moving external part of the switch-gear.

4.3.19 Interlocks.

4.3.19.1 Mechanical & electrical interlocks must be provided to ensure absolute and reliable protection against potentially harmful mal-operation of the switchgear.

4.3.19.2 All interlocks that prevent potentially dangerous mal-operations shall be so constructed such that they cannot be defeated easily, i.e. the operator must use tools and/or technique to over-ride them only in case of emergency.

4.3.19.3 The following functions shall be provided:

a) The operator must be forced in to the only safe and logical sequence to actuate the circuit breakers, disconnectors & earthing switches.
b) The actual, completely closed or completely opened position of all switching devices must be checked before and after each move.
c) Implementation of logic checks and issuing the resultant signals Enabled or Blocked for the switching device.

4.3.19.4 If in spite of all possible safety measures if any arc occurs, the following is required.

a) The effects of an internal arcing fault must be limited to the related gas compartment.

b) Each gas compartment must have its own automated external pressure relief device to provide instant and safe discharge of accidental overpressure during internal arc. Rupture diaphragms shall be preferably used as pressure relief mechanisms. The bursting pressure of relief device should be effectively coordinated with the rated gas pressure and the pressure rise due to arcing. PRD shall be positioned such that it will not be below any circuit breaker or disconnector drive or LCC.

c) All earthing connections must remain operational.

d) The enclosure of the switch gear must withstand the thermal effects of an arc at the full rated short circuit current until the nearest protective relay has acted and tripped the breaker.

e) To limit the effects of an internal arc the switch gear shall be suitably subdivided into individual arc and gas-proof compartments, at least for:

- Bus-bar together with bus-bar isolator and earthing switch
- Circuit breaker
- Line isolators and earthing switch (Line, transformer)
- Instrument transformers.

4.3.19.5 The following requirements are to be followed.

a) The bracing/welding of all components subject to mechanical forces caused by short circuit currents shall be capable so as to withstand the effects of at least 2.5 times the rated symmetrical short time withstand current.

b) The thermal rating for all current carrying parts and insulating materials shall be a minimum of three seconds for the rated short time withstand current.

c) All components of the switch gear which are on ground potential shall be electrically interconnected and effectively earthed.

4.3.20 Special tools, tackles and equipment

4.3.20.1 Special tools, tackles and equipment that are required to perform installation, commissioning, operation & maintenance of the gas insulated switch gear shall be included in scope of supply.

4.3.20.2 Minimum following tools shall be supplied:

a) Dew point measurement meter,
b) SF_6 gas leakage detector ,
c) Precision pressure gauge ,
d) Gas-service carts ,
e) Any other special tool/tackle required.
f) Gas density monitor in the switchgear room

4.3.20.3 The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

4.3.20.4 The requirement of HV testing during commissioning or repairing or replacement shall be fulfilled by successful bidder by arranging the required HV testing equipment at no extra cost to KPLC. No delay shall be permitted on account of the non-availability of the HV test equipment.

4.3.21 Grounding of GIS.

4.3.21.1 GIS will be housed on GIS floor. The bidder will provide under-ground mat below the substation. The bidder shall also provide adequate number of galvanized steel risers to be connected to grounding mat, as per relevant standards and in consultation with KPLC during detailed engineering, in the event of an order.

4.3.21.2 The bidder shall supply entire material for ground bus of GIS such as conductor, clamps, joints, operating and safety platforms etc. to be laid / embedded in GIS floors. The bidder is also required to supply all grounding connectors and associated hardware material for:

a) Connecting all GIS equipment, bus duct, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS
b) Connecting ground bus of GIS to the ground mat risers.

4.3.21.3 The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values as per IEEE std. 80-2000. The enclosures of the GIS shall be grounded at several points such that there shall be a grounded cage around all live parts.

4.3.21.4 The ground continuity between each enclosure shall be affected over flanges, with or without links or straps to bridge the flanges. Copper/Aluminum straps shall however bridge the metallic expansion bellows. The grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed. The inductive voltage against ground in each part of the enclosure shall not be more than 65 Volts.

4.3.21.5 Where operating mechanism cabinets are mounted on the switchgear, the grounding shall be made by separate conductor. Bay control cabinets shall be grounded through a separate conductor. All conduits and control cable sheaths shall be connected to the control cabinet grounding bus. All steel structures shall be grounded. Each removable section of catwalk shall be bolted to the support structure for ground continuity.

4.3.21.6 The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE STD 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS.

4.3.21.7 The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the

anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus.

4.3.21.8 Provisions of IEC 60517 &60694 regarding safeguards in grounding of connected cables, testing during maintenance and other safety measures shall be ensured.

4.3.21.9 Earthing conductors shall be designed to allow flow of short circuit current. Conductors with copper bars are preferred over copper wires.

4.4 Detailed technical requirements for GIS Components

4.4.1 Circuit Breaker

4.4.1.1 General

4.4.1.1.1 The GIS circuit breakers shall comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC-62271-100 specifications.

4.4.1.1.2 Circuit – breakers shall be of single pressure, single break, self-compression self-blast / auto puffer type with SF6 as arc quenching & insulation medium and with a minimum- maintenance contact system.

4.4.1.1.3 They shall be of three phase encapsulated type. Ratings of the circuit breaker shall be as per enclosed technical parameters .They should be shipped as a completed three-phase unit within a complete bay module.

4.4.1.1.4 Each circuit-breaker shall have spring/hydraulic/combined drive mechanism ensuring proper closing and opening, and shall permit checking of adjustments and opening/closing characteristic.

4.4.1.1.5 The ON/OFF latches shall be mechanically interlocked with each other. The circuit breaker shall be completely factory assembled, adjusted and tested.

4.4.1.1.6 The total break time from energizing the trip coil at rated control voltage to final arc extinction shall be as short as possible, but in any event not greater than 3 cycles i.e. 60 ms.

4.4.1.1.7 The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC recommendations.

4.4.1.1.8 The breakers are to be restrike-free. The circuit-breakers shall be capable of tripping and re-closing (Auto reclose) according to the specified duty cycle without derating: O – 0.3 s – CO – 3 min. – CO.

4.4.1.1.9 Breaker shall be suitable for following switching duties:

- Terminal faults
- Short line faults

- Out of phase switching
- Interruption of small inductive current including transformer magnetizing inrush currents.
- Interruption of line and cable charging currents

4.4.1.1.10 The circuit breaker shall meet all the double circuit overhead transmission line and cable characteristics for any type of fault or fault location, and also for line charging and dropping when used on an effectively grounded system. Effect of second circuit in parallel shall also be considered.

4.4.1.1.11 The circuit breakers shall be capable of being operated locally or from remote. Local operation shall be by means of an open/close control switch located in the bay control cabinet. The minimum guaranteed nos. of maintenance free operations of complete GIS shall be 10,000 nos. at rated capacity i.e. M2 class of circuit breakers.

4.4.1.1.12 The drive shall have sufficient stored energy for completing 2 CO with auxiliary power switched off. Circuit breakers, being an arcing device, shall not house any passive device like current transformer in its housing.

4.4.1.1.13 The breaker layout arrangement shall be vertical or horizontal but shall provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favorable and considered in the elevation.

4.4.1.2 Closing Devices

4.4.1.2.1 The closing coils shall be suitable for operation at any voltage between 110% and 80% of the nominal control voltage measured at the device terminals.

4.4.1.2.2 The breaker shall close correctly when an electrical closing pulse of 50 msec. duration is applied to the closing coil

4.4.1.3 Tripping Devices.

4.4.1.3.1 All electrical tripping coils shall be suitable for operation at any voltage between 110% and 70%of the nominal control voltage measured at the device terminals.

4.4.1.3.2 Each circuit-breaker shall be equipped with two shunt trip system. The one shunt trip system shall be electrically separated from the other system. An emergency hand tripping (mechanical) device shall be provided in the operating mechanism.

4.4.1.4 Anti-Pumping.

4.4.1.4.1 The circuit-breaker mechanism shall be provided with means to prevent pumping while the closing circuit remains energized, should the circuit breaker either fail to latch, or be tripped during closing due to the operation of the protective relays.

4.4.1.5 Operating Mechanism

4.4.1.5.1 The breaker shall include suitable spring/hydraulic/combined operating mechanism to assure proper opening & closing operations. The provision shall be made for checking adjustments and opening characteristics.

4.4.1.5.2 The mechanism shall be capable of re-closing within the range specified in the applicable standards. The mechanism shall include dual trip coils. Charging of opening mechanism shall be possible in the event of failure of the motor drive

4.4.1.5.3 **Spring Operated Mechanism**

4.4.1.5.3.1 Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

4.4.1.5.3.2 As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

4.4.1.5.3.3 After failure of power supply to the motor, at least two close-open (C-O) operations of the circuit breaker shall be possible.

4.4.1.5.3.4 Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.

4.4.1.5.3.5 Motor rating shall be such that it requires only about 30 seconds for fully charging the closing spring.

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

4.4.1.5.3.7 When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.

4.4.1.5.4 **Hydraulic Operated Mechanism.**

4.4.1.5.4.1 Hydraulic operated mechanism shall comprise self-contained operating unit with power cylinder, control valves, high and low pressure reservoir, motor, etc. A hand pump set shall also be provided for emergency operation.

4.4.1.5.4.2 The oil pressure controlling the oil pump and pressure in the high pressure reservoir shall be continuously monitored. Necessary hardware to achieve this, including the loose pressure gauge, instruments and interconnecting piping etc. shall form integral part of this mechanism.

4.4.1.5.4.3 The mechanism shall be suitable for at least two close-open operations after failure of AC supply to the motor.

4.4.1.5.5 **The mechanism shall be in a dust proof (IP55) box for this installation of Gas Insulated Switchgear.**

4.4.1.5.5.1 One vermin-proof, sheet steel cabinet of adequate size shall be provided for housing the operating mechanism, auxiliary relays, control and auxiliary equipment and for terminating all control, alarm and auxiliary circuits in suitable terminal boxes.

4.4.1.5.5.2 The control cabinet shall be provided with hinged doors with provision for locking and removable cable gland plates for bottom cable entry.

4.4.1.5.5.3 Viewing windows shall be provided for observation of the instruments without opening the cabinet. Suitably engraved nameplates shall be provided to identify all equipment in the control cabinet.

4.4.1.6 Auxiliary Switches.

4.4.1.6.1 Each breaker shall have auxiliary switches with adequate number of NO and NC contacts all wired to terminals located in the local control cabinet of the circuit breaker bay. 20 % spare contacts should be provided.

4.4.1.7 Indicating Devices.

4.4.1.7.1 Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed. Each circuit-breaker shall be provided with an operation counter to record the number of tripping operations performed.

4.4.1.7.2 The counter may be located at the local control cabinet. All position indicators and counters shall be readable at a convenient elevation i.e. from the place of operation.

4.4.1.8 Gas Connections.

4.4.1.8.1 Necessary valves and connections shall be provided to assure ease in handling the SF_6 gas.

4.4.1.9 Timing Test

4.4.1.9.1 Timing tests are to be carried out after the switchgear has been completely charged with SF6 gas.

4.4.1.10 Testing instruments

- Air / gas humidity tester,
- Gas purity detector for SO_2, H_2O, CF_4, AIR etc.,
- Gas leakage tester,
- Breaker timing measurement kit,
- Set of equipment for pressure measurement and gas density meter.

4.4.1.11 Testing facilities

4.4.1.11.1 Timing test facility shall be provided with switchgear such that it is not necessary to open up any gas section to make test connections to the circuit breaker terminals.

4.4.1.11.2 All details of test facilities to be provided shall be submitted with technical bid.

4.4.1.12 Principle Parameters

4.4.1.12.1 The Circuit Breakers of GIS equipment shall confirm to the specific technical requirements given as below.

Table 2: Circuit Breaker Technical Particulars

Sr No.	Particulars	33 kV
1)	Enclosure	Three Phase
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage, Um	36 kV
4)	Rated current	2500A for bus coupler/ incomers and 1600A for bay module
5)	Rated frequency	50 Hz
6)	Rated short-circuit breaking current	40kA rms 3 sec for bus coupler/incomer and 31.5kA for bay module
7)	Rated break-time	3 cycle

8)	Rated short-circuit making current		62.5 kA peak
9)	Difference for simultaneity of 3 poles		4 ms (Max.)
10)	Rated insulation level under minimum SF6 gas pressure		
	a) Power frequency withstand voltage		140 kV rms
	b) Lighting impulse withstand voltage		350 kV peak
11)	Rated operating sequence		O-0.3s-CO-3min-CO
12)	Type of operating mechanism for circuit Breaker		Spring – Spring/hydraulic
13)	Rated control voltage	- Tripping coil	110/220 VDC
		- Closing coil	110/220 VDC
14)	Mechanical Endurance class		M1
15)	Electrical Endurance class		E1
16)	Re-striking probability class		C1
17)	Rated line charging breaking current		10 A
18)	Rated cable charging breaking current		125 A
19)	Rated capacitor bank switching current		410 A
20)	Rated out of phase making and breaking current in % of rated short circuit breaking current		25
21)	Characteristic for short line fault related to rated short circuit breaking current		As per IEC 62271 – 100
22)	TRV characteristics		As per IEC 62271 – 100
23)	Inductive current breaking capability		Switching No Load current of transformer
24)	First pole to clear factor		As per IEC 62271 - 100
25)	Opening time in ms.		Not more than 40
26)	Closing time in ms.		Not more than 100
27)	Noise level at the base of CB		As per NEMA standard
28)	No of tripping coils per breaker		2
29)	No of closing coils per breaker		1

4.4.2 Disconnector Switches and Maintenance Grounding Switches

4.4.2.1 General

4.4.2.1.1 The GIS disconnector switches and grounding switches shall comply with the following general requirements of disconnector switches and the latest version of the relevant specifications IEC 60129, 61128, 61129, 61259.

4.4.2.1.2 Disconnector switches shall be three phase encapsulated, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.

4.4.2.1.3 Maintenance earthing switches shall be three phase encapsulated, group operated, no break, with one common motor operated mechanism for all the three poles. They shall also have facilities for emergency manual operation and necessary handles shall be provided.

4.4.2.1.4 Disconnector switches and grounding switches shall have electrical and mechanical interlocks to prevent grounding switch from closing on an energized

section. Interlocks with other bays for bus transfer switching shall be done through bay control cabinets.

4.4.2.1.5 Actuation of the emergency manual operating device shall also disable the electrical control. Disconnectors in open condition shall be secured against reclosure.

4.4.2.1.6 Disconnecting switches and adjacent safety grounding switches shall have electrical interlocks to prevent closure of the grounding switches when the disconnecting switches are in the closed position and to prevent closure of the disconnecting switch when the grounding switch is in the closed position.

4.4.2.1.7 The disconnector shall be pad lockable in the close & open position. Interlocks interlocking devices must provide absolute and positive protection against potentially harmful mal-operations of the switchgear.

4.4.2.1.8 The following functions shall be assured:

a) Forcing the operator into the only safe and logic sequence to actuate breakers, switches, isolators and grounding switches.
b) Checking the actual fully closed or fully open-position of all switching elements before and after each move.
c) Providing the logical checks and issuing the resulting PERMISSIVE or BLOCKED signals for the switchgear.
d) Indicating positively the absolute condition/position of the supervised equipment.
e) Local manual and remote electrical operation of all essential functions.
f) Local emergency unlocking facilities via safety-key switches under the full responsibility of the operator. Intra-bay and inter-bay interlocking shall be provided. Electrical interlocking arrangement shall be fail-safe type. Mechanical interlocks for isolator & Earthing Switch shall be fail-safe type.

4.4.2.1.9 All main contacts, male and female, shall be silver-plated.

4.4.2.1.10 Each disconnect switch and grounding switch shall open or close only due to motor driven or manual operation independently. The switch contact shall not move due to gravity or other means, even if a part fails.

4.4.2.1.11 Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact be held closed. Operation of respective end position limit switches shall only disconnect the motor mechanism.

4.4.2.1.12 There should also be a pre-set timer in motor circuit for protection against time over –run in case of inadvertent failure of drive mechanism in any intermediate position of the disconnector travel path.

4.4.2.1.13 The disconnect switches and grounding switches shall be located as shown in the Single Line Diagram.

4.4.2.1.14 The disconnect switches shall be capable of interrupting the charging current of the connected GIS bus & associated components.

4.4.2.1.15 **Duty requirements:**

4.4.2.1.15.1 The disconnecting switches shall have breaking capabilities as per IEC requirements. Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when currents are interrupted.

4.4.2.1.15.2 The bus disconnecting switches shall reliably handle capacitive currents due to the making and breaking of switchgear components as well as commutation currents due to bus bar reconfiguration. The fast acting ground switches, used for overhead double circuit lines and underground cable feeders shall be capable of switching induced current as per IEC requirement.

4.4.2.1.16 **Short Circuit Requirements**

4.4.2.1.16.1 The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:

a) Mechanical damage to any part of the isolator or earthing switch.
b) Separation of the contacts or contact welding.
c) A temperature rise likely to damage insulation.

4.4.2.1.17 **Access for maintenance and repair:**

Suitable means of access should be provided in each disconnect-switch and grounding-switch housing and mechanism for repair and/or maintenance of contacts.

4.4.2.1.18 **Operation Mechanism.**

4.4.2.1.18.1 Mechanism shall be arranged mechanically, electrically, so that all three phases of any particular disconnect switch or grounding switch operate simultaneously.

4.4.2.1.18.2 All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all

necessary operation rods and rod guides. Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.

4.3.1.1.1.1 The auxiliary supply shall be electrically decoupled from the motor when the switch is operated manually.

4.3.1.1.1.2 The mechanisms shall be arranged for locking in the open and in the closed position. Facility shall be available to allow the switch to be padlocked in any position.

4.3.1.1.1.3 Disconnecting operating mechanism of all disconnector/ isolator & earth switches shall be at easy operable height.

4.3.1.1.1.4 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing.

4.3.1.1.1.5 They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator. It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficiently to allow improper functioning of the isolator when the isolator is opened or closed at any speed.

4.3.1.1.1.6 The operating mechanism design shall be such that during the operation of the isolator (especially manual operation), once the moving blades reach the sparking distance, springs shall take over to give a quick, snap action closing so that the isolator closing is independent of manual efforts.

4.3.1.1.1.7 Similarly, the springs must assist during the opening operation to give quick breaking feature. Disconnector and high speed motor operated earthingswitch mechanisms shall be provided with a mechanism with stored energy to always assure completed operations.

4.3.1.1.2 **Auxiliary Switches:**

4.3.1.1.2.1 All disconnecting switches shall be provided with electrically independent auxiliary switch, directly driven by the common operating shaft.

4.3.1.1.2.2 Each disconnect switch and grounding switch shall be furnished with sufficient Nos. of NO – NC as per entire scheme requirement plus five (5) NO-NC electrically independent contacts terminated up to terminal board, at user's disposal.

4.3.1.1.2.3 The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

4.3.1.1.3 **Position Indicators**

4.3.1.1.3.1 Mechanically connected position indicators shall be provided externally to permit observation of close/open position of the disconnect switch and grounding switch.

4.3.1.1.3.2 The place of Position Indicators should be easily visible from the place of operation of respective equipment.

4.3.1.1.3.3 Visual verification shall be provided for each pole of each disconnector switch and grounding switch to permit visual inspection of each switchblade position.

4.3.1.1.4 **Technical Data Requirement**

Table 3: Disconnectors:

Sr No.	Particulars		Parameters
1)	Enclosure		Three Phase
2)	Enclosure material		Aluminum Alloy
3)	Rated voltage		36 kV
4)	Rated current at 50^0C ambient temperature		2500 A for bus coupler/ incomer and 1600A for bay module
5)	Rated short-time current		40 kA rms 3 sec for bus coupler/incomer and 31.5 kA rms for bay module
6)	Rated dynamic short circuit withstand current		80 kA
7)	Rated control and operating voltage		110 V DC
8)	Type of operating mechanism		Motor operated
9)	Type		Mechanically ganged operated
10)	Rated insulation levels : As per IEC		
	a)	Power frequency withstand voltage	
		- phase to phase between phases	70 kV (rms)
		- Across the isolating distance	90 kV (rms)
11)	Rated insulation levels: 1.2/50 µs		
	b)	Lightning impulse withstand voltage	
		- phase to phase between phases	±170 kVp
		- Across the isolating distance	±170 kVp
11)	Mechanical Endurance Class		M1
12)	Bus transfer switching capability (% of rated current)		80
13)	Rated bus charging current		0.1 A
14)	Number of spare auxiliary contacts on each isolator		5NO and 5NC

15)	Maximum radio frequency voltage for frequencies between 0.5 to 2 MHz	≤ 500 μV (at 92 kV (rms)

4.3.1.1.5 **Low-voltage test provision:**

A low-voltage test provision may be supplied with a grounding switch to permit test voltages of up to 10kV (optional 2.5kV) and upto 200 A to be applied to the conductor without removing SF6 gas or other components, except for ground shunt leads.

4.3.2 Fast Acting Grounding Switches

4.3.2.1.1 **General.**

4.3.2.1.1.1 Fast acting grounding switches can be located at the terminal of HV/EHV overhead line/ cable. They shall be able to switch safely load currents of overhead lines. They must have fault making capability and be able to switch on a live line. Applicable standards are IEC60129, 60517, 61129. The fast acting grounding switches shall comply with the following general requirements of fast acting grounding switches and the latest revision of the relevant IEC specifications.

4.3.2.1.1.2 Fast acting grounding switches shall be of three phase, encapsulated, three phase linkage group operated by a maintenance-free self-contained electrical motor. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

4.3.2.1.1.3 Fast acting grounding switches shall be electrically or mechanically interlocked with related disconnector, to prevent the fast acting grounding switch from closing on an energized bus section.

4.3.2.1.1.4 All main contacts, male and female, shall either be silver plated or shall have silver inserts.

4.3.2.1.1.5 Each fast acting grounding switch shall open or close only due to motor-drive or manual operation but shall be operable from local only. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

4.3.2.1.1.6 Each fast acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV.

4.3.2.1.2 **Operation Mechanism.**

4.3.2.1.2.1 Mechanisms shall be coupled either mechanically or electrically or by both, so that all three phases of any particular fast acting grounding switch operate simultaneously without any discrimination.

4.3.2.1.2.2 All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs so arranged that energizing of the motor will cause the springs to be charged and then released. The springs in turn shall close the fast acting grounding switch.

4.3.2.1.2.3 Motors shall be suitable for operation at any voltage between 80% and 110% of the rated auxiliary voltage, measure at the motor terminals.

4.3.2.1.2.4 For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides.

4.3.2.1.2.5 The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

4.3.2.1.2.6 The mechanisms shall be arranged for locking in the open and in the closed position.

4.3.2.1.3 **Auxiliary Switches**

4.3.2.1.3.1 Each fast acting grounding switch shall be furnished with sufficient Nos. of NO – NC as per entire scheme requirement plus five (5) NO-NC electrically independent contacts, suitably terminated at terminal blocks, at user's disposal.

4.3.2.1.3.2 The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

4.3.2.1.4 **Position Indicators**

4.3.2.1.4.1 Mechanically connected position indicators shall be provided externally to ascertain the open/close position of the grounding switch. It should be easily visible from the place of operation of equipment.

4.3.2.1.4.2 Visual verification shall be provided for each pole of each disconnector switch and grounding switch to permit visual inspection of each switchblade position.

4.3.2.1.5 **Test Facility**

4.3.2.1.5.1 Each fast acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes.

4.3.2.1.5.2 The insulation shall be capable of withstanding an applied power frequency voltage of 5 kV. High speed earthing switches shall be capable of interrupting line coupling currents upon opening and in worst conditions closing.

4.3.2.1.6 **Technical Data Requirement**

Table 4: High Speed Earthing Switch

Sr. No.		Particulars	Parameters
1)		Enclosure	Three phase
2)		Enclosure material	Aluminum Alloy
3)		Rated voltage	36 kV
4)		Rated short-time current	40 kA rms 3 sec for bus coupler/ incomer and 31.5 kA rms for bay module
5)		Rated peak withstand current	40 kA peak
6)		Type of operating mechanism	Motor operated
7)		Rated control and operating voltage	110 V DC
8)		Rated insulation levels:	
	i)	Power frequency withstand voltage to earth	70 kV rms
	ii)	Across the open gap	90 kV rms
9)		Rated insulation levels: 1.2/50 µs lightning impulse withstand voltage:	
	i)	To earth	±170 kVp
	ii)	Across the open gap	±190 kVp
10)		Electrical Endurance class	E1
11)		Rated induced current switching capability	As per IEC 62271 – 102 class B
12)		Number of auxiliary contacts on each earthing switch	5NO and 5 NC

Table 5: Maintenance Earthing Switch

S. No.		Particulars	Parameters
1)		Enclosure	Three phase
2)		Enclosure material	Aluminum Alloy
3)		Rated voltage	36 kV
4)		Rated short-time current	40 kA rms 3 sec for bus coupler/ incomer and 31.5kA for bay module
5)		Type of operating mechanism	Motor operated
6)		Electrical Endurance class	E0
7)		Rated insulation levels as per IEC	
	i)	Power frequency withstand voltage to earth	70kV rms

	ii)	across the open gap	90 kV rms
8)		Rated insulation levels: 1.2/ 50 µs	
	i)	Lightning impulse withstand voltage to earth	±170kVp
	ii)	across the open gap	±170kVp

4.3.3 Current Transformers:

4.3.3.1 General

4.3.3.1.1 The current transformers provided for each phase shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC 60044 specifications.

4.3.3.1.2 The current transformers must be suitable for continuous operation when installed on the conditions.

4.3.3.1.3 The current transformer shall be ring / toroidal type, multi ratio with fully distributed secondary windings with relay accuracy as per IEC 60185 (1987), incl. IEC 60044-4 (1992), multi core as per requirement and shall be mounted inside the high voltage enclosure.

4.3.3.1.4 The secondary terminals of current transformers shall be placed outside the high voltage enclosures, mounted in suitable, accessible terminal boxes and the secondary leads of all the current transformers shall be wired to shorting type terminals.

4.3.3.1.5 It shall be possible to test each current transformer without the removal of gas through the insulated grounding switches.

4.3.3.1.6 The number and position of the current transformers shall be relative to the circuit-breakers, disconnecting switches and ground switches as detailed in the attached single line diagram.

4.3.3.1.7 The rating, No of cores, ratios, accuracy class, characteristics etc. for the individual current transformer secondary cores shall be as specified below. The various ratios of current transformers shall be obtained by changing the effective number of turns on the secondary winding.

4.3.3.1.8 Each current transformer shall be provided such that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured. Provision shall be made to prevent arcing across the enclosure insulation.

4.3.3.2 Rating and Diagram Plates

4.3.3.2.1 Rating and diagram plates shall be provided.

4.3.3.2.2 The information to be supplied on each plate shall be as specified in the relevant IEC 60044-1 specification, which shall be given for the tap for which the rated performance is specified and for each transformer core.

4.3.3.2.3 **Technical Data Requirements**

Table 5: Technical data for Current Transformer

Sr. No.		Particulars	Parameters
1)		Voltage rating, Um	36 kV (rms)
2)		Frequency	50Hz
3)		System neutral earthing	Solidly earthed
4)		Rated short time thermal current	40kA for 3 sec
5)		Rated dynamic current	80kAp
6)		Rated insulation levels	
	a)	1.2/50 µs impulse voltage	± 170kVp
	b)	1 (one) min, power frequency withstand voltage	70kV (rms)
7)		1 (one) min, power frequency withstand voltage between secondary terminal and earth	5 kV (rms)
8)		Primary current	
9)		Secondary current	1A
10)		Output	**VA
11)		Radio frequency voltage at 1.1 Um/√3 and frequency range 0.5 to 2 MHz	< 500µV
12)		Partial discharge level as per IEC 60185	≤ 10 pC
13)		Rated continuous thermal current	125% on all taps
14)		Transmitted Overvoltage Limits	Type B As per IEC 60044-1
15)		Class of insulation (Thermal Class)	Class A As per IEC 60085

**** -** Based on approved CT/VT calculations.

Table 6: 33KV class CT - Bay wise core requirement considering 60 MVA Transformer

Core No		Purpose	Ratio	Output burden	Accuracy class	Instrument security factor	Min. Knee point voltage at highest rated current	Max. excitation current at KPV	Max. CT Rct Sec.at highest ratio
A	**Feeder bay**								
	1	Metering	1600-1200-800/1	30	0.5	<5	--	--	--

	2	Dir. O/C-E/F Protection	1600-1200-800/1	**30VA**	5P	20	--	--	--
	3	Dir. O/C-E/F Protection	1600-1200-800/1	**30VA**	5P	20	--	--	--
B	**Transformer bay (HV)**								
	1	Metering	600-300 / 1	30	0.5	<5	--	--	--
	2	Non - Dir. O/C-E/F Protection	600-300 / 1	**30VA**	5P	20	--	--	--
	3	Differential Protection	600-300 / 1	--	PX	--	**600V**	25mA	< 5 Ohm
	4	Differential Protection	600-300 / 1	--	PX	--	**600V**	25mA	< 5 Ohm
C	**Bus coupler bay**								
	1	Metering	1600-1200-800/1	30	0.5	<5	--	---	--
	2	Non - Dir. O/C-E/F Protection	1600-1200-800/1	**30VA**	5P	20	--	--	--
	3	Non - Dir. O/C-E/F Protection	1600-1200-800/1	**30VA**	5P	20	--	--	--
B	**Incomer bay (33kV LV)**								
	1	Metering	1600-1200-800/1	30	0.5	<5	--	--	--
	2	Non - Dir. O/C-E/F Protection	1600-1200-800/1	**30VA**	5P	20	--	--	--
	3	Differential Protection	1600-1200-800/1	--	PX	--	**600V**	25mA	< 5 Ohm
	4	Differential Protection	1600-1200-800/1	--	PX	--	**600V**	25mA	< 5 Ohm

4.3.4 Voltage Transformer

4.3.4.1 SF6 insulated

4.3.4.1.1 Each voltage transformer shall be metal enclosed, SF6 insulated in accordance with relevant IEC 60044.

4.3.4.1.2 The location, polarity, ratios, and accuracy shall be as specified in accordance with IEC 60186.

4.3.4.2 Construction

4.3.4.2.1 VTs should be in segregated compartment and not forming a part of bus bar.

4.3.4.2.2 Transformers should be of either plug-in construction or the disconnect-link type, and be attached to the gas-insulated system in such a manner that they can be easily disconnected while the system is being dielectrically tested.

4.3.4.2.3 Alternately, a voltage transformer designed so that it does not have to be disconnected during dielectric testing may be specified. The metal housing of the transformer should be connected to the metal enclosure of the GIS with a flanged, bolted, and gasketed joint so that the transformer housing is grounded to the GIS enclosure.

4.3.4.2.4 Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits, which might result from fast transients (VFT) or Ferro-resonance.

4.3.4.3 Covers and shields.

4.3.4.3.1 Special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the transformer.

4.3.4.4 Primary and secondary terminals.

4.3.4.4.1 Primary and secondary terminals should have permanent markings for identification of polarity, in accordance with IEC.

4.3.4.4.2 Provision shall be made for grounding of the secondary windings inside the local control cabinet.

4.3.4.4.3 Test condition for tests at site: Power frequency tests for the completed GIS at site shall be possible without removing the VT.

4.3.4.4.4 The primary and secondary neutral terminal points, intended to be earthed, should be insulated and shall withstand power frequency voltage of 3 kV rms for 1 minute. The VT shall be capable to withstand discharge current arising from capacitance of underground cable circuits.

4.3.4.5 Technical Data Requirement:

Table 7: Technical particulars of Voltage Transformer

Sr. No.		Particulars	Parameters
1		Rated voltage	33kV
2		Highest system voltage	36 kV
3		Rated frequency	50 Hz
4		P F (dry) withstand voltages	70 kV (rms)
5		Voltage factor	1.2 continuous
6		Rated insulation level	
	a	1.2/50 micro sec. lightning impulse withstand voltage	±170 kVp
	b	One minute power frequency withstand voltage	70 kV (rms)
		One minute power frequency withstand voltage between terminal and earth	3 kV (rms)
7		Rated frequency voltage at 1.1 $U_m/\sqrt{3}$ and frequency range 0.5 to 2 MHz	<500 µV
8		Rated voltage factor	1.2 continuous & 1.5 for 30s
9		Partial discharge level as per IEC 60186	≤ 10 pC
7		System neutral earthing	Effective
8		Class of insulation (Thermal Class)	Class A as per IEC 60085

Table 8: 33 KV class PT Core Details

Core	Purpose	Ratio	Burden	Class of accuracy
1	Metering	33kV/110	100VA	0.5
2	Protection	33kV/110	100VA	3P
3	Protection	33kV/110	100VA	3P

4.3.5 Bushings.

4.3.5.1 General

4.3.5.1.1 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 GTP.

4.3.5.1.2 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.

4.3.5.1.3 Bushings shall generally be in accordance with the requirements of IEC publication 60137 as applicable.

4.3.5.1.4 Outdoor bushings shall be provided for connection of conventional external conductors to SF6 GIS if asked in general layout plan.

4.3.5.1.5 Suitable clamp & connectors shall be supplied with bushing. The dimensional and clearance requirements for the metal clad enclosure shall be maintained as per requirement of relevant standards.

4.3.5.1.6 All the bushings shall have an impulse & power frequency withstand level that is higher or equal to the level specified in clause 4.1.2.2, Table 1. Only SF6 insulated composite silicon bushings will be accepted. The terminals on the outdoor bushings shall be a solid stem with dimensions specified.

4.3.5.2 Insulation levels and creepage distances

4.3.5.2.1 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 31 mm/kV.

4.3.5.3 Bushing types and fitting

4.3.5.3.1 Condenser type bushings will be preferred but alternative types can also be considered.

4.3.5.3.2 Liquid filled bushings shall be provided with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will only be accepted if specifically approved.

4.3.5.4 Mechanical forces on bushing terminals

4.3.5.4.1 Outdoor bushings must be capable of withstanding cantilever forces due to weight of conductor, wind force and short circuit forces etc. Design calculations in support of the cantilever strength chosen shall be submitted for KPLC review and approval.

4.3.5.4.2 Transition buses shall be provided for connections on all outdoor bushings to prevent straining the actual bushing. This includes all feeders, 33kv incomers and 33/11kv transformer bushings.

4.3.5.5 The major parameters of the bushings shall be as follows:-

S. No	Particulars	
a)	Rated voltage (kV), U	33kV
b)	Rated voltage (kV) , Um	36kV
c)	Rated current	2000A
d)	Lightning impulse withstand voltage (kVp)	±170 kVp
e)	One minute power frequency withstand voltage kV (rms)	70 kV (rms)
f)	Minimum total creepage distances (mm)	2250 mm

4.3.6 Metal-Enclosed Surge Arresters.

4.3.6.1 The 28 kV, hermetically sealed, gapless, ZnO, outdoor surge arrestor, for each phase, at the 33 kV line underground cable terminals on the transition bus structure to the entry of GIS bushings shall be provided.

4.3.6.2 Each surge arrester shall be provided with self-leakage current monitoring device at convenient elevation.

4.3.6.3 They shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes.

4.3.6.4 The surge arresters when provided with pressure relief devices shall be capable of withstanding the internal pressures developed during the above discharges without operation of the pressure relief devices.

4.3.6.5 Access to the arrester ground connection, when it is provided with means for leakage current monitoring should not be obstructed.

Table 8: Technical particulars of Surge Arrestors

S. No.	Description	Requirement
1)	Rated voltage	33 kV (rms)
2)	System highest voltage Um	36 kV (rms)
3)	Rated frequency	50Hz
4)	Nominal discharge current	10 kA
5)	Long duration discharge class	2
6)	Earth fault factor, k	1.4
7)	Continuous operating voltage	28 kV
8)	Maximum short circuit current	40 kA for 3 seconds
9)	Creepage distance, minimum	2250 mm
10)	Internal partial discharges	≤ 10pC
11)	Lightning impulse withstand voltage (kVp)	±170kVp
12)	One minute power frequency withstand voltage kV (rms)	70 kV (rms)

4.4 Insulating gas and gas leakage rate.

4.4.1 General

4.4.1.1 The GIS shall be furnished with sufficient sulfur hexafluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density.

4.4.1.2 The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.5% p.a. for the service life of equipment.

4.4.1.3 The quality of new filled-in SF_6 gas shall meet the following requirements in line with IEC 60376.

- SF6 purity> 99.90 % by weight
- Air < 500 ppm by weight (0.25 vol.-%)
- CF4 < 500 ppm by weight (0.1 vol.-%)
- H2O < 15 ppm by weight (0.012 vol.-%)
- Mineral oil < 10 ppm by weight
- Acidity, in terms of HF < 0.3 ppm by weight
- Hydrolysable fluorides,
- In terms of HF < 1 ppm by weight

4.4.2 Reuse or recycling of removed gas

4.4.2.1 The supplier should provide guidelines or recommended practices for the reuse or recycling of SF6 gas removed from the equipment.

4.4.2.2 These guidelines should be consistent with current industry practices, as they pertain to the effect of SF6 on global warming; i.e. SF6 gas should be reused and recycled whenever possible and never be unnecessarily released into the atmosphere.

4.4.2.3 Clear instructions shall be provided by bidder about handling, recycling & treatment of new and used SF6 gas.

4.4.2.4 During commissioning dew point of SF6 gas shall be measured and documented. This measurement of the moisture content after erection on site shall not exceed the maximum limit permitted by the manufacturer.

4.4.2.5 Components may be filled with N_2 for transportation and refilled with SF6 at site.

4.4.3 Gas sections

4.4.3.1 The GIS enclosures (one enclosure for all the three phases) shall be divided into several gas sections separated by gas-tight barriers.

4.4.3.2 Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section.

4.4.3.3 Location of gas barrier insulators is to be clearly discriminated outside the enclosure by a band of distinct colour normally used for safety purposes.

4.4.3.4 The gas system proposed shall be shown on a “gas single line diagram” and submitted with the technical bid and in the event of an order for approval.

4.4.3.5 It should include the necessary valves, connections, density monitors, gas monitor system and controls, indication, orifices, and isolation to prevent current circulation.

Means of calibrating density monitors without de-energizing the equipment should be specified by the supplier.

4.4.3.6 For the purpose of gas monitoring and maintenance, the GIS shall be divided into various individual zones in each bay.

4.4.3.7 The CB gas zone shall be independent from all other gas compartments and shall meet the requirement of relevant IEC.

4.4.3.8 Each gas zone shall be furnished with a gas monitoring system consisting of a gas density continuous monitoring device provided with two electrically independent contacts which operate in two stages as follows:

a) **First alarm**: At a gas density normally 5 to 10% below the nominal fill density.
b) **Second alarm**: Minimum gas density to achieve equipment ratings.

4.4.3.9 In special cases determined by the supplier, a third stage with a set of contacts may be necessary in certain areas. Provisions shall be made for connecting pressure gauges, service cart, and moisture test instrumentation to any one of the gas sections.

4.4.3.10 Permanent Gas Treatment Devices: Means shall be provided inside each enclosure for treating the SF6 gas by the use of Desiccants, driers, filter, etc. to remove impurities in the gas.

4.4.3.11 All gas compartments shall be fitted with static filter material containers that will absorb residual and entering moisture inside the high voltage enclosures.

4.4.3.12 Filters inside the breaker compartment shall also be capable of absorbing gas decomposition products resulting from the switching arc.

4.5 GIS Connection.

4.5.1 GIS to Transformer

4.5.1.1 Transformers shall be connected to the GIS termination bushing via a transition bus

4.5.1.2 The connection between GIS and high voltage cable at GIS end shall be done through cable termination / cable sealing end. For transformer end connection the cable termination on structure shall be provided outdoor, if specified in schedule of requirements.

4.5.1.3 The plug in cable sealing ends for XLPE cables shall consist of gas tight plug in sockets and prefabricated plugs with grading elements of silicone rubber.

4.5.2 GIS to Line.

4.5.2.1 The 33 kV lines and cables shall be connected to the GIS termination bushings via a transition bus.

4.5.3 33 kV Power Cable connection.

4.5.3.1 The connection between GIS and high voltage cable at GIS end is done through cable termination / cable sealing end. Plug in cable sealing ends for XLPE cables shall consist of gas tight plug in sockets, and prefabricated plugs with grading elements of silicone rubber.

4.5.3.2 A separate cable basement is provided for cable entry, its distribution and installation.

4.5.3.3 The design of the cable end box shall fully comply with the IEC standard. The type and size of cable is specified.

4.5.3.4 All end cable modules shall be suitable for connecting single core, XLPE specified cable.

4.5.3.5 Necessary provision for termination of specified nos. of such power cables shall be made in GIS. GIS supplier shall either carry out the work of termination or coordinate with cable terminator for such connection as specified in schedule of requirement.

4.5.3.6 Provision shall be suitable for terminating **KPLC**approved cable.

4.6 Local & Remote Control and Operation.

4.6.1 General.

4.6.1.1 One local control cabinet (LCC) of OEM of GIS shall be supplied for the local control and operation of each bay. Each LCC shall contain the local control, interlocking, operation and indication devices for the associated GIS bay.

4.6.1.2 The LCC shall be mounted on each GIS bay. The LCC's shall be located with sufficient space for access and the possibility to work at the equipment even when the LCC doors are open, or directly at the switch-gear in front of the related circuit breaker.

4.6.1.3 The LCC's shall be installed indoor and care must be taken with the design to ensure that all LCC's are drip and splash proof. The LCC's shall also be dust and vermin proof. The control and operation circuits shall be well shielded and with safety

measures to protect operator from touching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute.

4.6.1.4 The LCC should have required arrangement for control and operations of GIS from Remote i.e. from the control room through SCADA compatible control and protection panel.

4.6.1.5 The LCC shall include all required functions for control and supervision of a complete GIS as well as the marshaling of all connections to and from the GIS bays.

4.6.1.6 Safe station operation is ensured through following base functions.

a) Feeder & station interlocking, depending on the position of all high voltage components with their blocking functionality.
b) Blocking of commands when crank handle of disconnector or earthing switches is introduced.
c) Extensive circuit breaker supervision through "Anti-Pumping", pole discrepancy, Gas density and position supervision of circuit breaker.

4.6.2 Required features for conventional local control cabinets.

4.6.2.1 The LCC's shall be provided with the following features:

4.6.2.1.1 A mimic diagram showing the single line diagram. Position indictors, on/off switches for the HV devices and local / off / remote switches shall be installed on or adjacent to the various symbols of the mimic diagram.

The following devices shall be supplied as a minimum:

- Circuit breaker control switches with ON – OFF indicating lamps. – Circuit breaker "local-remote" selector switch.
- Disconnect switch, control switch with ON – OFF indicating lamps.
- Grounding switch, control switch with ON – OFF indicating lamps.
- Mimic bus including symbols according to the single line diagram.
- Monitoring control of all high voltage switching devices in a bay.
- Digital display of current, voltage, active and reactive power, power factor etc.

4.6.2.1.2 Any interposing relays and control switches associated with the circuit breakers disconnect switches, grounding switches etc.

4.6.2.1.3 The alarm and indication for devices specified e.g. gas, DC & AC supervision.

4.6.2.1.4 Fuses and links. These shall be installed in the interior of the LCC's

4.6.2.1.5 Terminal blocks for the terminating and marshaling of auxiliary supply circuits, control, interlocking, and indication & alarm circuits from the GIS and for cable connections to the remote control room or the owner's control system.

4.6.2.1.6 Each LCC shall be furnished with a guarded resistance heater to prevent the internal equipment from humidity deposit. The heater shall be rated 230 V AC and fed through a two pole fused disconnect switch.

4.6.2.1.7 A fluorescent lamp and a duplex convenience outlet rated 230 V AC, 15 amps with ground fault interrupter shall be installed in each LCC.

4.6.2.1.8 The Local control cubicle shall be fitted with pre wired interface terminal blocks for connection to user's control & protection panels.

4.6.2.1.9 The interface includes CT & PT inputs for protection & Measuring system, Protection trip 1 & 2 signals, Aux switch contacts etc.

4.6.3 Wiring Requirements

4.6.3.1 Each circuit breaker shall have control suitable for operation on 110V DC with two electrically independent trip circuits. The miniature circuit-breakers (MCB) shall be provided for the closing circuit and an independent separate switch fuse unit of suitable rating shall be provided for the primary and back up trip circuits.

4.6.3.2 Wiring shall be complete in all respects to ensure proper functioning of the control, protection, and monitoring and interlocking schemes.

4.6.3.3 DC circuit for trip coil 1 & 2 shall be wired separately.

4.6.3.4 Wiring shall be done with flexible 1100V grade, FRLS, PVC insulated, switchboard wires with 2.5 mm^2 stranded copper conductor. The control wire in a grouped environment shall not convey flame, continue to burn. Wiring between equipment and control cubicle shall be routed through G.I. rigid conduits and shall be done by PVC & screened cable only, with safety measures to protect operator from touching energized parts.

4.6.3.5 Each wire shall identify at both ends with permanent markers bearing wire numbers as per Contractor's wiring diagram.

4.6.3.6 Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

4.6.3.7 All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired up to terminal blocks in the control cubicle.

4.6.3.8 Terminal blocks shall be 1100V grade, stud type with engraved numbers suitable for termination of at least two numbers of 2.5 mm^2 stranded copper conductor. Terminal blocks for CT, PT, and auxiliary AC & DC supply shall be disconnecting link type.

4.6.3.9 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

4.6.3.10 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.6.3.11 Terminal connectors that carry power supply should be shrouded from adjoining connectors.

4.6.3.12 Manufacturer shall provide all control wiring and terminations internal to the switchgear, and connecting the switchgear to the bay control cabinets.

4.6.3.13 All control cables shall be shielded. Cable shields shall be grounded. Grounding connections shall be as short and direct as possible and shall terminate at the point of entry to cabinets or terminal boxes.

4.6.3.14 Co-axial type cable glands suitable for use with shielded cables shall be used at each termination.

4.6.3.15 All control cables shall be installed and terminated in such a manner as to limit the effects of transient electromagnetic voltages on the control conductors to an acceptable level.

4.6.3.16 Any cabling within GIS shall be supported on cable tray. No cable shall be in hanging position.

4.6.3.17 Insulator cones shall be embedded in full return current carrying metal fixing rings in order to avoid mechanical stresses to the cast resin part and to impart full conductivity across the flange connection. Earthing of different gas compartments/enclosures is not allowed with cross bonding with any metal strips.

4.6.4 Connections within the GIS and their LCC's.

4.6.4.1 All cable connections between the various GIS modules and the LCC's shall be made by prefabricated multi-core cables with multipoint plug in connections on both the ends. PTs & CTs circuit shall be wired with crimped type copper lugs.

4.6.4.2 All cables shall be shielded and adequate for their application (indoor / outdoor).

4.6.4.3 The cables shall be fire retardant low smoke.

4.6.4.4 The length and the number of terminal points of control wiring & SF6 gas connections shall be minimized.

4.6.4.5 The electrical connections between the various gas sections shall preferably be made by means of multiple contact connectors so that electrical connection is automatically achieved when bolting on section to another. The surface of the connector fingers and conductor tubes on such connections shall be silver-plated.

4.7 Maintenance

4.7.1 The operational integrity of the GIS switchgear shall not be subjected to external influences, such as pollution, moisture, dust etc. As a consequence of this GIS switchgear should be practically maintenance free; however, the details of inspection required at regular interval shall be indicated in the offer.

4.7.2 Visual inspection shall be required not below 2 (two) years interval. Inspection shall not be required often than every 10 years. During inspection it must not be necessary to open the switchgear enclosures for interrupt operation of substation.

4.7.3 Provision of functional testing of the close and trip coils, auxiliary switches, pressure and control switches etc. shall be provided.

4.7.4 Following minimum maintenance period shall be accepted.

a) Circuit breaker: 10000 closing and opening or 100interruption at max rated current.
b) Disconnector: 5000 closing and opening operations.
c) Fast acting earth switch: 2000 closing and opening operations or 2 making operations on to max rated fault current.

4.7.5 The bidder shall provide the services of experienced persons, supervisors, engineers, experts, etc., for complete specified work for satisfactory operation.
The bidder shall have dedicated localized after sales & service team which should be capable any activity to operate complete GIS satisfactorily.

4.8 33kV Gas Insulated Switchgear room

4.8.1 The GIS building shall be modified to fit the equipment to be installed. This shall include all the necessary renovations and reinforcements. The proposed arrangement of building and positions in which the switchgears shall be installed relative to lines, transformers, cable circuit and any other switchgear of any other voltages will be indicated in general arrangement layout. The overall height of building shall allow for overhead traveling crane.

4.8.2 The room shall be supplied to house the 33kV GIS. A gantry crane shall be supplied in the same room as the GIS for the purpose of transporting the GIS from any installation position to an appropriate location within the building for easy removal.

4.8.3 The gantry crane shall be suitable for lifting the heaviest module that is expected to be installed within the room

4.8.4 The clearance around the panels shall be a minimum of 1500mm to the front of the panel, and a minimum of 1400mm to the back, with rear door closed, and 600mm to the back with rear door open.

4.8.5 A minimum clearance of 1500mm shall be allowed on the sides of the panel. Additional clearances shall be provided if required by the manufacturer's specifications.

4.8.6 The bidder shall provide complete floor plan detailing the fixing positions, levels and size of fixing bolt pockets and foundation required for all equipment. Drawings giving similar details shall be provided.

4.8.7 All static and dynamic loads plus dimensional tolerances shall be given on these drawings.

4.9 Spares

4.9.1 Bidder shall submit a list and supply of following spares.

a) Recommended spare parts for three (3) years after guarantee period of satisfactory and trouble-free operation.
b) Commissioning spares
c) Maintenance spares
d) Special tools, tackles & spanner required during commissioning, operation and maintenance.
e) Viewing mechanism
f) Spare GIS modules of CT, Breaker, and Isolator & LA.
g) Any other necessary spareparts.

4.9.2 All spares indicated in list for above shall be considered in the scope of supply. Each list shall be complete with specification, ratings, type, make, identification number, unit rate, quantity etc.

4.10 Quality Assurance

4.10.1 Superior quality control system shall be adopted to assure high product quality.

4.10.2 Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of GIS. High reliability of materials shall be ensured so as to keep maintenance work to a minimum.

4.10.3 A quality assurance plan for major components such as breakers, disconnecting switches, lightning arrestors, earth switches, etc. with in-process inspection methods, tests, records, etc. shall be submitted with the technical bid. Customer hold points will also be included in the plan, which shall be mutually agreed by the PURCHASER and MANUFACTURER, and approved.

4.10.4 The following type test reports as specified in IEC standard 62271 – 203 & 62271-100 shall be submitted for the offered type, rating of GIS invariably with the technical bid.

4.10.4.1 Complete Bay - IEC 622271-203.

- Dielectric Tests
- Radio interference (RIV) level tests
- Short time and peak withstand current tests
- Electromagnetic compatibility tests (EMC)
- Additional tests at auxiliary & control circuits(Electrical & Mechanical Endurance, Heat run, IR & HV test)
- Verification of making and breaking capacity
- Mechanical and environmental tests
- Pressure test on partitions
- Test under conditions of arcing due to an internal fault
- Insulator tests.
- Seismic tests.
- Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
- Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
- Tests to verify the making and breaking capacity of the included switching devices.
- Tests to prove the satisfactory operation of the included switching devices.
- Tests to prove the strength of enclosures.
- Verification of the degree of protection of the enclosure.
- Tests to prove the satisfactory operation at limit temperatures.
- Tests to prove performance under thermal cycling and gas tightness tests on insulators.
- Corrosion test on earthing connections (if applicable).
- Tests to assess the effects of arcing due to an internal fault.
- Tests on solid dielectric components (operating rods, spacers, etc.)
- Seismic test
- Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)

4.10.4.2 Circuit Breaker – IEC 62271-100

- Dielectric Tests
- Radio interference (RIV) level tests
- Measurement of the resistance of the main circuits
- Temperature-rise tests
- Short time and peak withstand current tests
- Verification of the protection
- Tightness tests
- Electromagnetic compatibility tests (EMC)
- Miscellaneous provisions for making and breaking tests
- Test circuits for short circuit making and breaking tests
- Mechanical and environmental tests
- Short circuit test quantities
- Basic short-circuit test-duties
- Critical current tests
- Single-phase and double-earth fault tests
- Short line fault tests
- Out of phase making and breaking tests
- Capacitive current switching tests
- Additionally, the circuit breaker shall comply with IEC 61233 in regard to inductive load switching.

4.10.4.3 Disconnector & Earth Switch – IEC 62271-102

- Dielectric Tests
- Radio interference (RIV) level tests
- Measurement of the resistance of the main circuits
- Temperature-rise tests
- Short time and peak withstand current tests
- Verification of the protection
- Tightness tests
- Electromagnetic compatibility tests (EMC)
- Tests to prove the short-circuit making performance of earthing switches
- Operating and mechanical endurance tests
- Test to verify functioning of position indication
- Bus transfer current switching tests of earth switches
- Induced current switching tests of earth switches
- Bus charging test disconnectors.

4.10.4.4 Current Transformer – IEC 60044-1, IEC 60044-6, IEC 60185

- Lightning, Impulse voltage withstand test
- Temperature rise test
- Short time current test
- Determination of errors test
- Radio interference voltage measurement (RIV)

4.10.4.5 Voltage Transformer – IEC 60186, IEC 60044-2

- Temperature rise test
- Lightning Impulse Test
- Determination of errors
- Short-circuit withstand test capability
- Measurement of the radio interference voltage (RIV)
- Chopped impulse test on primary winding
- Mechanical Tests
- Transmitted overvoltage measurements

4.10.4.6 Surge Arrestors

- Insulation withstand tests;
- Residual voltage tests;
- Long duration current impulse withstand test;
- Operating duty tests;
- Partial discharge tests;
- Short circuit test;
- Bending moment test (cantilever);
- Environmental test;
- Arrester disconnector/fault indicator tests;
- Radio interference voltage tests.
- UV test
- Thermal endurance test
- Flammability test
- Long term water immersion test
- Dielectric Testing
- Tracking and Erosion test

4.10.5 Important note for type tests

4.10.5.1 The type test report shall be submitted for the offered class and rating of GIS. However, the type test report for higher class/rating can be accepted for scrutiny of technical bid but the same test/s shall have to be carried out on the offered class/rating GIS.

4.11 Routine tests

4.11.1 Routine tests on the GIS, LCCs and accessories shall be carried out as per the latest edition of relevant IEC standards. The complete routine test report including GIS, LCCs, CTs, VTs, cables from GIS to LCCs etc. arranged section wise for each bay shall be submitted to KPLC for approval 3 months before inspection.

4.11.2 Also two (2) sets of inspection packages (which shall include approved set of drawings, test procedures, copies of relevant standards, day wise test programme etc.) shall be submitted at least one (1) month before each inspection.

4.11.3 The routine tests to be witnessed by KPLC engineers at the factory before shipment shall be in accordance with IEC 62271-203, IEC 62271-100, IEC 62271-102, IEC 60044-1, IEC 60044-2, IEC 60186 and this specification and shall include the following:

4.11.3.1 Complete Bay – IEC 62271-203

- Dielectric tests on main circuit
- Tests on auxiliary and control circuits
- Measurement of the resistance of the main circuit
- Tightness test
- Design and visual check
- Pressure tests on enclosures
- Mechanical operation tests
- Tests on auxiliary circuits, equipment and interlocks in the control mechanism
- Pressure test in partitions
- Visual inspection and design check, schemes and interlocks check, LCC tests, gas pressure switch test, etc. as required by KPLC.
- Nameplates check, measurement of insulation resistance, earth continuity checks.

4.11.3.2 Circuit Breaker – IEC 62271-100

- Dielectric tests on the main earth
- Dielectric withstand tests on control and auxiliary circuits
- Measurement of the resistance of the main circuit
- Tightness tests
- Design and visual checks
- Mechanical operating tests (including resistance and current measurement of closing and trip coils and checking ant-pumping function, timing etc.)
- Measurement of operating time/timing diagram.

4.11.3.3 Disconnector & Earth Switch – IEC 62271-102

- Dielectric tests on the main earth
- Dielectric withstand tests on control and auxiliary circuits
- Measurement of the resistance of the main circuit
- Tightness tests
- Design and visual checks
- Mechanical operating tests (including verification of early make, late break feature of bus-bar disconnector auxiliary contacts)
- Timing tests, coil checks etc

4.11.3.4 Current Transformer – IEC 60044-1/ IEC 60044-6

- Measurement of secondary winding resistance.

- Measurement of magnetizing current characteristics of all CTs.
- Determination of turn's ratio error for class PX CTs.
- Verification of knee-point voltage for class PX CTs.
- Determination of remanence factor and transient performance of TPY CTs
- Polarity test
- Measurement of insulation resistance
- Power frequency test on secondary winding.
- Determination of errors (Accuracy tests)
- Inter-turn overvoltage tests.

4.11.3.5 Voltage Transformer – IEC 60044-2/IEC 60186

- Polarity tests and verification of terminals
- Power frequency withstand tests on primary windings
- Power frequency withstand tests on secondary windings
- Power frequency withstand tests between sections
- Determination of errors
- Partial discharges measurement
- Measurement of insulation resistance
- Measurement of insulation resistance of auxiliary and control circuits
- Operating test and power frequency voltage test on disconnecting device
- Gas tightness tests
- Visual inspection.

4.11.3.6 Surge Arrestors

- Measurement of reference voltage;
- Residual voltage test;
- Measurement of power frequency withstand voltage on the complete arrester;
- Lightning impulse residual voltage on the complete arrester;
- Partial discharge test.
- Short circuit test
- Bending Moment test (Cantilever)
- Environmental tests.

4.11.3.7 Insulators

4.11.3.7.1 **Routine tests as per**

- IEC 60233 (BS 4963) for hollow porcelains
- IEC 60137 for bushings
- IEC 60168 and 60273 for high voltage post insulators
- IEC 60383 and IEC 60305 for cap and pin string insulators.

4.11.3.7.2 The performance of the components of the switchgear shall be substantiated by test data relevant to the particular designs offered.

4.11.3.7.3 Evidence of type tests shall also be submitted with the tender.

4.11.3.8 Local Control Cubicle

4.11.3.8.1 Major components of LCCs are to be tested and calibrated. Functional tests of LCCs to be carried out during factory acceptance tests are:

- Mechanical and visual inspection
- Control wiring check
- Measurement of insulation resistance
- Dielectric test
- Control circuit test, interlocks etc.
- Coil check test
- Sequence test
- Measurement of paint thickness, earthing etc.

4.12 Test Certificates:

a. Routine test certificates of bought out components shall be furnished.
b. Type test certificate on any equipment or component if so desired by the Owner shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

4.13 Tests after installation of complete GIS at Site

4.13.1 After installation and before being put into service, the GIS shall be tested in order to check the correct operation and dielectric integrity of the equipment as laid down in IEC 62271-203.

4.13.2 The successful bidder shall furnish a commissioning test plan and a statement method for the tests on site. Tests shall include the following:

1. Dielectric tests on the main circuits.
2. Dielectric tests on auxiliary circuits.
3. Measurement of the resistance of the main circuit.
4. Gas tightness tests.
5. Checks and verifications.
6. Gas quality verifications.
7. On site power frequency voltage withstand test with PD test.
8. Tests as per IEEE C37.122.1 clause 4.10.5
9. Functional & interlock tests for all items
10. Demonstration of operational compatibility with SCADA
11. Visual inspection, checks & verifications.
12. Mechanical operation tests of circuit breakers, disconnectors and earthing switches and high-speed earthing switches
13. Insulation resistance measurement

14. Tests on CTs and PTs
15. Tests on Surge Arresters

4.13.3 Required test equipment.

4.13.3.1 During the onsite tests, the supplier shall provide all necessary test facilities and equipment for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc.

5 MARKING, PACKING AND INSTRUCTIONS

5.3 Markings

5.3.1 The following types of nameplate shall be furnished in a convenient central location to provide information for operation and maintenance.

5.3.1.1 Gas Single Line Diagram showing all HV devices in a single line diagram with the gas sectionalizing of the GIS indicated. Also shown shall be the GIS nomenclature, a legend, Manufacturer's type and serial number and year of manufacture.

5.3.1.2 GIS Rating / Name plate shall consists of:

- Manufacturer's name & address,
- GIS type & designation,
- Serial Number,
- Maximum ambient temperature,
- System frequency, Maximum continuous voltage,
- Maximum continuous current at 40^{o}C ambient temperature,
- Basic Impulse Level,
- Power Frequency one minute voltage,
- Short circuit current, rms.,
- Symmetrical Short time (rms) current & duration,
- Symmetrical Momentary current, peak,
- Total weight of gas at rated density,
- Rated gas pressure at 20^{o}C.
- Opening pressure of the bursting disc,
- Recommended moisture limits of insulation gas (PPMV),
- Auxiliary voltages,
- Contract/Purchase Order numbers,
- Total weight of the equipment.

5.3.2 Equipment nameplate containing nameplate rating information for all HV modules (like circuit breaker, disconnect switches, current transformer, voltage transformer, surge arrester, etc.) as required in relevant IEC.

5.3.3 Nameplates showing serial numbers and similar data specific to individual components shall be mounted on the components. Each instrument transformer must have its own rating plate mounted adjacent to each terminal box cover, will all terminal and ratio markings. Each bay auxiliary control cubicle must be identified with its designation to which it is assigned.

5.4 Shipment storage and installation

5.4.1 All equipment shall be suitably packed and protected during shipment/transportation. Each shipping unit shall be sealed in a clean dry condition with leak-tight shipping covers securely mounted for shipment. All covers to be removed during installation shall be clearly marked.

5.4.2 Each shipping section shall be carefully sealed and filled with dry gas to a slightly positive pressure to prevent the entrance of moisture and contamination. The packing method for the GIS equipment shall be standard and it shall be guaranteed that each component of the equipment will not be damaged, deformed or lost. The storage instructions shall be submitted by bidder for long term storage. Component requiring indoor storage shall be so identified.

5.4.3 Gas insulated switchgear (GIS) shall be properly packed to protect during ocean shipment, inland transport, carriage at site and outdoor storage during transit and at the site. Completely assembled bays (subject to transport limitations) of the GIS shall be transported as one shipment unit.

5.4.4 Packing materials shall be dust and waterproof. All packages shall be clearly, legibly and durably marked with uniform block letters on at least three sides. Fragile items like bushings, CTs, VTs, LAs and fully assembled bays shall be securely packaged and shipped in containers. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment wherever necessary.

5.4.5 As far as possible, transshipment should be avoided.

5.4.6 Impact recorders (Accelerometers) shall be provided on the packages to confirm thatGIS has not suffered any shocks during shipment, transport, handling, etc. The impact recorders readings are to be noted on receipt of equipment at site and reported to user & manufacturer, in case the readings are exceeding the permissible values. It shall be at discretion of user to accept or reject the same.

DOCUMENTATION AND TRAINING

Drawings Data & Manuals

Drawings, Data and Manuals shall be submitted with the bid and in quantities and procedures as specified in General Conditions on contract and/or elsewhere in this specification for approval.

Drawings to be submitted are:

1. Typical general arrangement drawings of the equipment indicating space requirement, room dimensions, crane capacity etc.
2. Technical Specifications of equipment and special tools explaining construction features, principle of operation, special features etc.
3. Comprehensive QAP, FQP, SLD, Gas schematic diagram, technical brochures, building requirements, earth mat design, list of recommended spares, special tools or fixtures, O&M manuals, environmental guide for handling SF_6 gas & decommissioning, estimated time schedule for installation & commissioning, bill of materials, and any other documents required for successful commissioning & operation of complete GIS.
4. Control and protection: block & principle diagram showing proposed scheme, layout & equipment arrangement drawings, catalogues & brochures of offered devices.

7.1.1 The following drawings & data for approval before commencement of supply:

1. A comprehensive Manufacturing Quality Assurance plan with effective quality assurance system.
2. Field Quality plan indicating instruction & procedures sequenced for storage, assemble, maintenance and disassembly.
3. Assemble and maintenance clearance requirements.
4. Dimensional general arrangement drawing showing disposition of various fittings, name plates indicating equipment ratings.
5. Structure Plan with details and loading
6. Foundation plan indicating loadings for all GIS equipment, supporting structure and anchor bolt arrangements.
7. Assembly drawing for erection at site with part numbers and schedule of materials transport/shipping dimensions with weights.
8. Control schematic and wiring diagrams.
9. Gas schematic diagram
10. Gas system installation procedures, gas handling procedures.
11. Grounding arrangement and ground bus details including Manufacturer's recommendation on grounding of reinforcement bars of column foundation.
12. Calculation of Voltage rise for GIS enclosure
13. Calculated point to point resistance for each assembly.
14. Calculation for Surge Protection

15. Design Calculations for bus-bar sizing, short circuit forces and vibration on Bus-bar & each equipment, thermal stability and losses.
16. Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
17. Operating instruction & manuals for GIS and its accessories
18. The manual shall clearly indicate method of installation, checkups and tests to be carried out before commissioning of the equipment.

7.2Training

7.2.1Duration of the complete training shall be 7 working days, covering minimum below specified curriculum. Any other specific area may be brought to notice and included

.

1. General Explanation for GIS
2. Layout and Architecture of GIS
3. Gas Sectionalisation of GIS
4. Construction of CB
5. Operating Mechanism of CB
6. Maintenance of CB
7. Overhaul of CB (Interrupting chamber)
8. Overhaul of CB (Operating Unit)
9. Construction of DS/ES
10. Maintenance of DS/ES
11. Overhaul of DS/ ES
12. Construction of Bus/ Cable head/ SF6 – air bushing
13. Maintenance of Bus/ Cable head/ SF6 – air bushing
14. Overhaul of Bus/ Cable head
15. Overhaul of various transformer connections
16. Operation of GIS with SCADA
17. Construction & Maintenance of Lightning Arrester
18. Construction & Maintenance of VT/CT
19. Construction & Maintenance of Local control panel
20. Erection of GIS at site.
21. Installation & Testing of GIS at site
22. Type tests of GIS
23. Routine tests of GIS.
24. Faults simulation of GIS
25. Localization of GIS fault.

7.1.2 Bidder shall at his cost arrange for the above training facilities.

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ANNEX A: Guaranteed Technical Particulars *(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, four customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)*

GUARANTEED TECHNICAL PARTICULARS FOR 33kV GIS

Sr No	Particulars	Units	To be Filled by BIDDER
1	**General**		
2	Name of manufacturer (OEM)		
3	Country of Origin		
4	Delivery from (location)		
5	Type & Designation		
6	Type tested at		
	Name of Laboratory		
	Address of laboratory		
7	Installation (indoor or outdoor)		
8	Standards applicable		
9	No. of Phases		
10	Single or Three Phase design		
11	**Configuration**		
i	Number of Feeder bays		
ii	Number of transformer bays		
iii	Number of Bus coupler bay		
iv	GIS to transformer connection		
v	GIS to Feeder connection		
vi	Number of VT		
vii	Number of SA		
	Future extension possibility		
12	**Service conditions**		
i	Ambient Air Temperature	^{0} C	
ii	Max Temperature	^{0} C	
iii	Min Temperature	^{0} C	
iv	Daily Average Temperature	^{0} C	
v	Solar Radiation	W/m^2	
vi	Altitude above MSL	m	
vii	Pollution class		
viii	Creepage distance	mm/kV	
ix	Relative humidity		
x	Condensation		
xi	Vibration level		
xii	Noise level		
xiii	Induced Electromagnetic Disturbance	kV	
xiv	Seismic conditions		

a	Vertical		
b	Horizontal		
13	**Enclosure**		
i	Code of pressure vessel		
ii	Type of manufacturing		
iii	Design temperature	^{0}C	
iv	Material		
v	Material grade & applicable standard		
vi	Outside diameter	mm	
vii	Minimum Wall Thickness	mm	
viii	Painting Shade & Thickness		
a	- External	mm	
b	- Internal	mm	
ix	Degree of Protection		
x	Inductance	H/m	
xi	Capacitance	pF/m	
xii	Resistance	Ω/m	
xiii	Expansion Bellow		
a	Material		
b			
	Min allowable adjustable displacement		
	Longitudinal	mm	
	Transverse	mm	
xiv	Sealing system		
a	Type		
xv	Estimated life in years		
xvi	Barrier		
a	Material		
b	Dielectric strength		
14	**Support Structure**		
i	Material		
ii	Minimum thickness of galvanizing	µM	
iii	Foundation channels /Anchor bolts		
15	**Grounding**		
i	Grounding Material		
ii	Grounding of complete GIS		
iii	Grounding of individual compartment		
iv	Grounding at flange joints		
16	**System Parameters**		
i	Highest System voltage	kV	
ii	Rated voltage of System	kV	
iii	Rated voltage of Equipment	kV	
iv			
	Rated Insulation level Phase to Earth and between Phases		
a	One Min Power Frequency withstand voltage	kV rms	
b	Switching impulse withstand voltage		
	- Phase to Earth	kVp	

	- Between Phases	kVp	
c	Lightning Impulse withstand voltage	kVp	
iv	Rated Frequency	Hz	
v	Rated current in Amp	kA	
vi	Rated current at 50 °C (equipment)	A	
vii	Rated current at 50 °C (bus bar)	A	
viii	Rated short circuit withstand current	kA rms	
a	Duration	s	
b	Peak	kAp	
ix	Enclosures withstand time for an internal fault.	s	
x	Estimated total energy loss at		
	100 % of rated capacity	kW	
	75 % of rated capacity	kW	
	50 % of rated capacity	kW	
	25 % of rated capacity	kW	
xi	Measures taken to minimize Over Voltage		
xii	Phase labeling		
xiii	**Auxiliary supply (AC Voltage Frequency; DC voltage)**		
	- Operation	V	
	- Control	V	
	- Illumination & heater	V	
17	**Delivery conditions**		
i	Bays fully assembled at works		
ii	Dimensions of longest section for transportation		
iii	Weight of heaviest package		
iv	Pressure of SF6 gas during transportation		
v	SF6 gas monitoring system provided during transportation		
18	**Bus Bar**		
i	Configuration (Single / Double)		
ii	Nos of Phases		
iii	Material		
iv	Size		
v	Rating		
vi	Current density adopted		
vii	Current density as per type test report		
viii	Short time current withstand rating in kA		
ix	Duration		
x	Resistance per phase		
xi	Surge impedance		
xii	SF6 immersed insulator		
a	Material		
b	Dielectric strength		
xiv	Maximum Partial Discharges measured at HSV		
19	**SF6 Gas**		
i	Applicable standard		
ii	Quantity of SF6 Gas of complete GIS at filling pressure	Kg	

iii	Quantity of SF6 Gas of **largest** compartment GIS at filling pressure	Kg	
iv	Nos of Gas compartments		
v	Quantity of SF6 Gas of individual compartment GIS at filling pressure	Kg	
vi	Maximum permissible dew point	^{0}C	
vii	Composition of Gas		
a	SF6 > 99.90 % by weight		
b	Air < 500 ppm by weight (0.25 vol.-%)		
c	CF4 < 500 ppm by weight (0.1 vol.-%)		
d	H2O < 15 ppm by weight (0.012 Vol-%)		
e	Mineral oil < 10 ppm by weight		
f	Acidity in terms of HF < 0.3 ppm by weight		
g	Hydrolysable fluorides In terms of HF < 1 ppm by weight		
	PRESSURE	MPa	
Vii	Design pressure		
a	Circuit breaker		
b	Other compartments		
ix	Rated filling pressure		
a	Circuit breaker		
b	Other compartments		
x	Type tested pressure.		
a	Circuit breaker		
b	Other compartments		
xi	Routine test pressure		
a	Circuit breaker		
b	Other compartments		
xii	Operating pressure of PRD		
a	Circuit breaker		
b	Other compartments		
xiii	Alarm Pressure		
a	Circuit breaker		
b	Other compartments		
c	CB lock out Pressure		
d	Over pressure signaling		
xiv	Maximum SF6 Gas leakage rate	% per year	
xv	Density Monitor to be provided for each Individual gas compartment.		
20	**Circuit Breaker**		
i	Applicable standard		
ii	Type		
iii	Designation		
iv	Operating Mechanism type		
v	Nos. of phases		
vi	Rated current in Amp		
vii	Mechanical Endurance class		

viii	Electrical Endurance class		
ix	Restrike probability class		
x	Rated SC breaking current		
xi	Rated SC breaking current - single phase test		
xii	Rated Line charging breaking current		
xiii	Rated Cable charging breaking current		
xiv	Capacitor bank switching capability		
	BC1		
	BC2		
xv	Inductive current		
xvi	Reactive current		
xvii	Out of phase making & breaking current		
xviii	Rated short line fault current		
xix	TRV characteristic		
xx	First Pole to Clear factor		
xxi	Nos. of interrupters per phase		
xxii	Type of arc control device provided if any		
xxiii	Type of arcing contacts		
xxiv	Material of main contact		
xxv	Material of Arcing contacts		
xxvi	Filter material		
xxvii	Timings of operations		
a	- Opening at nominal control voltage		
	- Opening at minimum control voltage		
B	Closing time at nominal control voltage		
Xxviii	Maximum pole discrepancy time		
	Tripping		
	Closing		
Xxix	Rated operating duty cycle		
xxx	Tripping Coils		
	- No of coils		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
	- Resistance		
Xxxi	Closing Coil		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
	- Resistance		
xxxii	Spring Charging Motor		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
xxxiii	Spring charging time at rated Aux supply		
xxxiv	Spring charging time at min Aux supply		
xxxv	Maintenance required after nos. of operation at		
i	No load		

ii	Rated current		
iii	25% of rated SC current		
iv	50% rated SC current		
v	Rated SC current		
e	Provision of anti-pumping		
f	No of operations after switching off of motor		
	Aux. supply		
xxxvi	Provision of Manual trip		
xxxvii	Electrical interlocking		
xxxviii	Padlocking		
xxxix	Type of Operation counter provided		
21	**DISCONNECTORS**		
i	Applicable standards		
ii	Type		
iii	Rated current in Amp for		
	- Bus disconnector		
	- Line disconnector		
	- Transformer disconnector		
	- PT disconnector		
Iv	Maximum Current that can be safely interrupted by the Isolator (Amp).		
	- Inductive		
	- Capacitive		
v	Rate Short time withstand Current in kA for 3 sec	kA	
vi	Rated peak short time Current	kAp	
vii	Rated bus charging current	A	
viii	Type of contacts		
ix	Material of contacts		
x	Current Density at minimum cross section (A/mm2)	A/mm^2	
xi	Rated lightning impulse withstand voltage across the open gap	kVp	
xii	Rated Power Freq withstand voltage across the open gap	kV rms	
xiii	Mechanical Endurance class		
xiv	Type of Operating Mechanism		
xv	Operating Motor details		
	- Type		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
xvi	Operating Time		
	- Closing		
	- Opening		
xvii	Mechanical indication on drive shaft		
22	**Maintenance Grounding Switch**		
i	Applicable standards		
ii	Type		
iii	Rate Short time withstand Current in kA for 3sec		

iv	Rated peak short time Current	kAp	
v	Rated lightning impulse withstand voltage across the open gap	kVp	
vi	Rated Power Freq withstand voltage across the open gap	kV rms	
vii	Type of Operating Mechanism		
viii	Operating Motor details		
	- Type		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
ix	Operating Time		
	- Closing		
	- Opening		
x	Mechanical indication on drive shaft		
23	**Fast Acting Grounding Switch**		
i	Applicable standards		
ii	Type		
iii	Rate Short time withstand Current in kA for 3 sec		
iv	Rated peak short time Current kAp		
v	Rated induced current switching capability		
	Rated capacitive current switching capability		
vi	Rated lightning impulse withstand voltage across the open gap kVp		
vii	Rated Power Freq withstand voltage across the open gap kVrms		
viii	Electrical Endurance class		
ix	Type of Operating Mechanism		
x	Operating Motor details		
	- Type		
	- Rated Voltage		
	- Rated Current		
	- Rated Watts		
xi	Operating Time		
	- Closing		
	- Opening		
xii	Mechanical indication on drive shaft		
24	**Current transformers**		
i	Type		
ii	Material		
iii	Position of Current Transformer		
iv	Reference Standard		
v	Rated Continuous thermal current		
vi	Rated Short Time current		
vii	Duration		
a	**Feeder Bay CT**		
i	Metering Core		
	- Ratio		

	- Output Burden		
	- Accuracy Class		
	- ISF		
ii	Protection Core -1		
	- Ratio		
	- Output Burden		
	- Accuracy Class		
	- ALF		
iii	Protection Core -2		
	- Ratio		
	- Output Burden		
	- Accuracy Class		
	- ALF		
b	**Transformer Bay CT**		
i	Metering Core		
	- Ratio		
	- Output Burden		
	- Accuracy Class		
	- ISF		
ii	Protection Core -1		
	- Ratio		
	- Output Burden		
	- Accuracy Class		
	- ALF		
iii	Protection Core -2		
	- Ratio		
	- Accuracy Class		
	- Minimum Knee Point Voltage at highest ratio		
	- Maximum Excitation Current at Vk		
	- Maximum Resistance at highest ratio		
iv	Protection Core -3		
	- Ratio		
	- Accuracy Class		
	- Minimum Knee Point Voltage at highest ratio		
	- Maximum Excitation Current at Vk		
	- Maximum Resistance at highest ratio		
c	**Bus Coupler Bay CT**		
i	Metering Core		
	- Ratio		
	- Output Burden		
	- Accuracy Class		
	- ISF		
ii	Protection Core -1		
	- Ratio		
	- Burden		
	- Accuracy Class		
	- ALF		
iii	Protection Core -2		

		- Ratio		
		- Burden		
		- Accuracy Class		
		- ALF		
25		**Voltage Transformer**		
		Type		
		Position of Voltage Transformer		
		Reference Standard		
		Rated Over Voltage Factor – Continuous		
		Short Time Over Voltage Factor		
		Duration		
		Partial Discharge Level		
		Thermal Rating of Primary Winding		
26		**Line & Bus VT**		
i		Metering Core		
		- Ratio		
		- Output Burden		
		- Accuracy Class		
ii		Protection Core -1		
		- Ratio		
		- Output Burden		
		- Accuracy Class		
iii		Protection Core -2		
		- Ratio		
		- Output Burden		
		- Accuracy Class		
27		**Enclosed Surge Arrester**		
ii		Name of Manufacturer		
iii		Arrester Class & Type (with mfr type designation)		
iv		Applicable Standard		
v		Rated system voltage (kV)		
vi		Rated Arrester Voltage (kV)		
vii		Max continuous operating voltage (MCOV) – (kV)		
viii	i)	Nominal Discharge Current (KA) with 8/20 Micro-second wave		
	ii)	Max resistive component of cont current at MCOV-mA crest		
	iii)	Max capacitive component of cont current at MCOV - mA crest		
ix		Long Duration Discharge Class		
x		Min. Energy Discharge Capability (KJ/KV rating)		
xi		Max. switching current impulse residual voltage (KVP)		
		1000 Amps	kVp	
		250 Amps	kVp	
xii		Pressure Relief Class KA (rms)		
xiii		High Current short duration impulse withstand level with 4/10 micro-second wave (KA) peak		

xiv	Over –voltage withstand capability – KV		
a)	100 Seconds		
b)	10 Second		
c)	1.0 Second		
d)	0.1 Second		
e)	Reference Voltage (KV)		
f)	Reference Current (KA)		
xv	Surge counter		
xvi	Leakage monitor		
28	**Local Control Cubical**		
i	Name of Manufacturer (OEM of GIS)		
ii	Location in GIS		
iii	Material		
iv	Sheet Thickness		
v	Degree of Protection		
vi	Padlocking arrangement		
vii	Major components of LCC		
	- Bay control mimic diagram		
	- Control Switches		
	- Indicating lamps		
	- Position indicators		
	- Annunciation scheme		
	- Auxiliary relays		
	- Contact multiplication relays		
	- System parameters display		
	- Heater with thermostat		
	- Interface terminal blocks for relaying & protection		
29	**GIS to Line connection**		
i	Nos of XLPE cable can be terminated		
ii	Type of cable termination required		
30	**GIS to Transformer connection**		
i	Nos of XLPE cable can be terminated		
ii	Type of cable termination required		
31	**Maintenance**		
I	Maximum down time for replacement or removal of any part		
ii	Maximum down time for degassing and re-filling he biggest compartment		
iii	Time between two refilling of SF6 gas.		
iv	Recommended period for overhauling		
v	Operation and Maintenance manual attached		
vi	Nearest local service centre		
vii	Minimum time of availability of local service		
viii	Availability of spares at local service centre		
ix	List of recommended spares attached?		
x	List of recommended special tools etc attached?		
xi	List of commission spares attached?		
Xii	List of maintenance spares attached?		