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TECHNICAL SPECIFICATION
FOR

400 kV / 220 kV / 132 kV / 66 kV/33 kV
GAS INSULATED SWITCHGEAR (GIS)

GETCO/ E/1,2,4,6,3 TS – GIS/ **R8B-June- 26**

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TECHNICAL SPECIFICATIONS FOR 400 kV /220 kV /132 kV /66 kV/33 kV GAS INSULATED SWITCHGEAR (GIS)

1.1 General:

The specification covers scope of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing before supply, transportation, delivery at destination, unloading & storage at site, site erection, site testing, commissioning and putting in to successful operation complete with all materials, support structures, anchoring bolts, accessories, commissioning spares & maintenance spares, special spanners, tools & tackles, any specific required ancillary services, SF6 Gas for first filling & spare, etc., for efficient and trouble free operation for 400 kV / 220 kV / 132 kV / 66 kV / 33 kV metal (aluminum alloy) encapsulated SF6 gas insulated switch-gear suitable for INDOOR / OUTDOOR installation.

The scope also covers provision of additional bays (without equipments) over and above bays shown in SLD, with foundations & earthing arrangements so as to install the bay module as and when required without any works pending except the procurement of the required bay module and other related equipments.

1.2 Design Concept, construction & performance & Safety of SF6 GIS:

1.2.1 It is understood that each manufacture has its own particular SF6 GIS design concept and it is not the purpose of this specification to impose unreasonable restrictions. However, in the interest of safety, reliability and serviceableness, the switch gear offered shall meet the following minimum requirements.

"The tender stage layout and equipment's minimum required ratings shall be as per the single line diagram and general layout enclosed. However, the ratings of equipment to be supplied shall be as per submitted type test reports. The supplier has to work out an optimum layout and building size considering the specific features of his product if any, but within overall dimensions of the plot."

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

Further more, 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 until the nearest protective relay has tripped. All grounding connections must remain operational during and after an arc fault.

Proper grounding for mitigating over voltages during disconnector operation shall be included.

Each section shall have plug-in modules or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.

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 SF6 handling should be accomplished with ease.

The ease of operation shall be ensured.

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.

The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall have deemed to be included.

1.2.2 Modular Design & Future extensions:

The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 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. All the three phases of the busbars and associated equipments 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 for 33 kV, 66 kV & 132 kV voltage class and phase wise separate metallic enclosures for 400 kV class. For 220 kV class enclosure it shall be single OR phase wise separate metallic type.

Irrespective of bus bar design, provision is to be made available for isolation of individual bay without disturbing adjacent bay.

1.2.2.1 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.

1.2.2.2 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, preferably for:

1) Bus bars
2) Intermediate compartment
3) Circuit breakers
4) Current transformers
5) Line/Bus disconnectors

6) Voltage transformers
7) Cable sealing End (CSE)
8) Gas Insulated bus duct section between GIS and XLPE cable/Overhead conductor
9) Gas insulated bus section between GIS and oil filled transformer or reactor (as applicable)

The bus enclosure & GIS shall be sectionalized in a manner that maintenance work on any bus dis- connector can be carried out by isolating and evacuating affected bay & affected DS connected bus bar only. In this condition, other bus bar & bays must be in energized condition.

1.2.2.3 **Gas barrier insulators shall be provided so as to separate bus bar compartment & the GIS bay unit**. Continuous Bus bar without compartmentalization is not allowed. These shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment.

Further, it is prohibited to work adjacent to a gas compartment while it is fully pressurized on the other side. For such cases, the gas pressure in the adjacent compartments needs to be reduced. Accordingly, dummy compartment shall be provided to accomplish above requirement.

1.2.2.3 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.

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. 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.

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

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

1.2.3 Maintenance and repair of a Circuit Breaker & other Equipments:

The arrangement of the equipment offered must provide adequate access for operation, testing, Repair and maintenance.

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.

The GIS shall be so designed that during breaker maintenance, only affected feeder can be shut down & both bus bars must be in energized condition. For achieving this requirement, adequate number of intermediate/dummy compartment, if required, shall be provided to ensure equipment & operating personnel's safety.

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

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

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

The GIS shall be designed, so as to take care of the VFT over voltages generated as a result of pre-strikes and re-strikes during isolator operation. Maximum VFT over voltages peak shall not be higher than rated lightning impulse withstand voltage (LIWV) of the equipment. Necessary measures shall be under taken by GIS manufacture to restrict maximum VFT over voltages lower than the LIWV. Manufacturer shall submit the study report of VFTO generated for GIS installation for **400 kV and above class.**

1.2.4 Interchangeability:

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

Each section shall have plug- in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of equipment. Inspection windows (View Ports) shall be provided for

Disconnect Switch and both type of earth switches i.e. Maintenance and fast operating.

1.2.5 Future Extension:

The modular design of GIS switch gear shall be capable of extension in the future on either end (i.e Both ends) 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 even if no future arrangement /space shown in tender layout. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect. 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.

The arrangement of the interface module/End piece shall be such as to facilitate future extension of any make without any modification on the existing equipment and shall not be required to move or dislocate the existing switchgear bays.

During detailed engineering stage, the EPC contractor shall make available the complete design detail of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc.

The Interface module /End piece shall be providing with Isolating link. The Isolating link shall be provided in such a way so that HV test can be performed on either side of the interface module separately, keeping other side of GIS remained isolated. Interface Module drawing with necessary detail shall be submitted for approval.

further the contractor who is extending the existing GIS installation, it shall be his responsibility to provide interface module matching with the existing GIS interface module. The drawing of existing GIS interface/end piece module shall be provided by the employer. However, it shall be the responsibility of contractor to verify the existing details during site visit.
The EPC contractor shall optimally utilize the space inside the GIS hall (including the extension portion) for accommodating the interface module being supplied under the contract.

1.2.6 The SF6 GIS shall be of INDOOR / OUTDOOR type. Indoor GIS shall be having degree of protection as IP-42 & IP- 55 for Outdoor GIS and suitable for the atmosphere of the location which is heavily polluted, windy, sandy desert & service condition indicated at 2.1.

1.2.7 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.

1.2.8 Service Continuity criteria in case of GIS equipment maintenance

Type of GIS Equipment Maintenance	Requirement
(1) Bus bar dis connector (Bus bar DS)	Only the affected feeder and the bus bar to which the affected bus bar DS is connected can be shutdown. The other bays (including those adjacent to the affected bay) shall still be energized.
(2) Circuit breaker	Only the affected feeder can be shutdown. Both bus bars shall still be energized.
(3) Current transformer	Only the affected feeder can be shutdown. Both bus bars shall still be energized
(4) Earthing switch next to the bus bar DS	Only the affected feeder and one bus-bar (in case of internal fault) can be shutdown.
(5) Extension	The Interface module/End piece (dummy compartment) **with isolating link shall** be provided at both the ends of each bus in order to maintain the service continuity of the bays adjacent to the extension point during bus bar connection so that during future extension at least one bus bars must be in energized condition with all the existing feeders shall still be energized. - The additional bays shall be tested separately before connecting to main GIS set up.

1.3 Specification requirements:

The 400 kV GIS switch-gear shall be with Double bus bar or One & half bus bar (as indicated in SLD/BOQ of respective tender) design having phase wise separate enclosure. The 220 kV GIS switch-gear shall be of Double bus bar design having either phase wise separate enclosure or three-phase common (single) enclosure. The 33, 66 & 132 kV GIS switch-gear shall be of a Double bus bar design having three-phase common (single) enclosure concept. 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 attached with respective tender.

1.4 Current Rating:

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

1.4.1 Capable of handling power to an extent of as to an ambient day-time mean temperature between – 5 deg C and + 50 deg C

1.4.2 a) The switchgear described in this specification is intended for 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.

1.4.2 b) The rating of the power transformer/s is given in SLD attached in respective tender.

1.5 Electrical, Mechanical and Thermal Capability:

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

1.6 Insulation level:

The switchgear and other equipment shall be designed for a maximum operating voltage and rated impulse withstand voltage as specified in cl. 2.3. The switchgear may require to be installed in an unmanned distribution network with predominantly over head interconnection or EHV cable as the case may be. Circuit breakers shall be capable of interrupting line, transformer, capacitor bank & cable charging currents of the magnitude indicated in the data schedules.

1.7 Physical arrangement:

1.7.1 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 GETCO need.

1.7.2 The arrangement of the switchgear offered must provide adequate access for checking and maintenance.

1.7.3 Optimized arrangements are required so as to reduce installation time, minimize maintenance & repair cost, provide ease of operation and facilitate future expansions.

1.7.4 For 400 kV voltage class GIS, wherever required, stairs, fixed ladder, platforms, and walkways for operation and maintenance access to the operating mechanism and monitoring devices should be provided to permit access. The structures shall be either aluminum or hot-dipped galvanized steel.

All the structure stairs, platforms, and walkways shall conform to the relevant occupational health and safety regulations and designed in accordance with the latest industry standards and guidelines. The platforms and walkways shall have anti-skid surfaces that can be walked on. Handrails shall be provided where necessary.

In addition to above, suitable portable scissor lift shall be provided for access of distant portion of GIS installation for all kV class GIS.

1.8 Gas Sectional Arrangement:

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

1.8.2 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.

1.8.3 It shall be ensured that circuit breaker enclosure will not include any other equipment in its gas compartment.

1.9 Expansion Joints and Flexible Connections:

1.9.1 The layout shall sufficiently take care to 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.

1.9.2 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 SF6 equipment, support structures or foundations.

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.

1.9.3 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. 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 and future extensions of the GIS.

1.10 Barrier and Non-Barrier Insulators:

1.10.1 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.

1.10.2 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.

1.10.3 The support insulators and section barriers / insulators shall be manufactured from the highest quality material. They shall be free form 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.

1.10.4 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.

1.10.5 Arrangement of section barriers/insulator with bus conductor shall be such that there shall not be any requirement for removal of adjacent bay while replacing of gas barriers.

1.11 Gas seals, Gas Density & pressure and other requirements:

1.11.1 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.

1.11.2 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.

1.11.3 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.

1.11.4 The rated pressure of the SF6 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.

1.11.5 The SF6 switch-gear shall be designed for use with SF6 gas complying with the recommendations of IEC – 60376 at the time of the first charging with gas.

1.11.6 Connections including bolts and nuts shall be adequately protected from corrosion and easily accessible with the proper tools.

1.11.7 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.

1.12 Gas Treatment Requirements:

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. In all gas compartments permanent efficient filters and desiccants shall be effective for the duration of time between major overhauls. Notwithstanding this, the insulators in the circuit breaker shall be made of epoxy resin composition that will resist decomposition products in contact with moisture.

1.13 Gas Monitoring Devices:

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 SF6 gas monitoring device shall have two supervision and alarm settings. 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.
The gas monitoring device shall monitor at least the following, locally and on remote.

i) "Gas Refill" Level- This will be used to annunciate the need for gas refilling.
ii) "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.
iii) Over pressure alarm level- This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.

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.

1.14 Conductors:

“The conductors shall be made of aluminum alloy 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 and continuous bus conductor is not acceptable. The surface of the connector fingers and conductor on such connections shall be silver plated. 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."

Design of bus conductor shall be such that during removal of any bay, only affected portion of conductor shall be disconnected from plug-in type connectors keeping adjacent bays and remaining portion of bus shall be in intact position.

1.15 Enclosures:

The enclosure shall be of continuous design and shall meet the requirement as specified IEEE 80 2013 (special considerations for GIS).

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

1.15.1 The metal enclosures for the SF6 gas insulated equipment modules shall be made from Aluminum alloy. Suitable anti corrosive paints shade 631 of IS: 5 or equivalent must be applied on the exterior of the enclosures. The enclosure shall be separate phase wise in case of 400 kV class GIS and shall be with Single Enclosure for three phases in case of 132 kV & 66 kV class GIS, while for 220 kV class enclosure shall be either single OR phase wise separate metallic type. The external fixtures should be made of corrosion-resistant material and should be capped wherever required.

Bidder shall provide adequate number of internal UHF sensors in the all offered 66 kV to 400 KV class GIS for PD measurement even if on line PD system is not in scope of supply and the number and location of these sensors shall be subject to approval of the purchaser. (external UHF sensors are not allowed)"

The number & location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (APPLICATION GUIDE FOR SENSITIVITY VERIFICATION for UHF PARTIAL DISCHARGE DETECTION SYSTEM FOR GIS). Offered numbers and location of UHF sensors shall be submitted based on above said criteria along with attenuation calculation for approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments.

However, adequacy of number of sensors and their location shall be verified at site as per recommendations of above CIGRE Document No. 654. In case during site testing, additional UHF sensors are required, the same shall be supplied & installed to complete the technical requirement.

The calibration and frequency response of PD couplers shall be as per relevant standard / Technical guideline. Data sheet shall be submitted for the UHF couplers meeting this requirement.

Bellow compensators shall be made of Stainless steel **or equivalent material as per Type tested design** 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.

1.15.2 Standard paint shade 631 of IS: 5 or equivalent shall be used with satin mat finish having high scratch resistance.

1.15.3 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.

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 preferably glossy white or in line with TTRs shall be used such that they will not deteriorate when exposed to the SF6 gas and other vapors, Arc products, etc., which may present in the enclosures.

1.16 General Finish and Cleaning:

1.16.1 The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness.

1.16.2 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 SF6 gas they must be thoroughly cleaned.

1.16.3 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.

1.16.4 Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished with GIS.

1.17 Gas filling and Evacuating Plant for 400 kV / 220kV / 132 kV / 66kV /33 kV GIS units (if indicated in BOQ of respective tender):

1.17.1 All apparatus necessary for filling, evacuating, and recycling the SF6 gas into and from the switch-gear equipment shall be suitable any maintenance work to be carried out.

1.17.2 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.

1.17.3 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.

1.17.4 The gas compartments shall preferably be fitted with permanent vacuum couplings through which the gas is pumped into or evacuated from the compartments.

1.17.5 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.

1.17.6 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 SF6 gas for compensation of possible losses during installation and service of 20 years shall be supplied. 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.

1.17.7 Gas filling and Evacuating Plant shall have gas storage facility of sufficient capacity.

1.17.8 SF6 Gas Processing Unit:

a) An SF6 gas-processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF6 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.

b) 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:
   i) Evacuation from a gas filled compartment using the vacuum pump,
   ii) Transfer of SF6 gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter;
   iii) Recirculation of SF6 gas in the storage tank through the drier,
   iv) Recirculation of SF6 gas in any switchgear or bus duct compartment through the drier and filter;
   v) Evaporating and filling SF6 gas,

vi) Drawing off and liquefying SF6 gas,
vii) A combination operation of filling SF6 gas into a gas system and evacuating a second gas system using the vacuum pump.

c) 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.

d) GA drawing and Schematic drawing for gas processing unit shall be submitted for approval.

1.18 Support Structures:

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams, *rollers,* 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.
Any scaffolding or a movable platform, required for maintenance, shall also be supplied.

All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 900 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable.

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.

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

1.19 Auxiliary Equipment:

The following items shall be included for a complete installation:

a) Control system including local control cubicles.
b) Cable and wiring between individual items of supplier supplied equipment.
c) Name plates.
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.

1.20 Safety Precautions:

1.20.1 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.

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

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

1.20.4 Interlocks:

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

The following functions shall be provided:

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

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

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

1.20.5.2 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.

1.20.5.3 All earthing connections must remain operational.

1.20.5.4 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.

1.20.5.5 To limit the effects of an internal arc the switch gear shall be suitably subdivided into individual arc and gas-proof compartments, preferably for

- Bus-bar together with bus-bar isolator and earthing switch
- Circuit breaker

- Line isolators and earthing switch, (Line, transformer)
- Instrument transformers.
- Intermediate compartment

1.20.6 The following requirements are to be followed.

1.20.6.1 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.

1.20.6.2 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.

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

1.21 Special tools, tackles and equipment:

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 if indicated in BOQ of respective tender.

1 Dew point measurement meter
2 SF6 gas leakage detector
3 Precision pressure gauge
4 Gas recovery unit with required accessories
5 On line PD monitoring system for 66KV, 220 kV & 400 kV GIS modules.
6 SF6 gas purity detector / analyzer for SO2, H2O, CF4, AIR etc.
7 Portable hand held PD measurement kit suitable for GIS along with required accessories
8 Air / gas humidity tester,
9 Breaker timing measurement kit

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

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 GETCO. No delay shall be permitted on account of the non availability of the HV test equipments.

1.22 Grounding of GIS:

1.22.1 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 GETCO during detailed engineering, in the event of an order.

1.22.2 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:

i) Connecting all GIS equipment, Bus duct, enclosures, control cubicles, supporting structures etc. to the ground bus of GIS
ii) Connecting ground bus of GIS to the ground mat risers.

1.22.3 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. 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.

1.22.4 Where operating mechanism cubicles are mounted on the switchgear, the grounding shall be made by separate conductor. Bay control cubicles shall be grounded through a separate conductor.

1.22.5 All conduits and control cable sheaths shall be connected to the control cubicle grounding bus. All steel structures shall be grounded.

1.22.6 Each removable section of catwalk shall be bolted to the support structure for ground continuity.

1.22.7 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.

1.22.8 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.

1.22.9 Provisions of IEC 517 & 694 regarding safeguards in grounding of connected cables, testing during maintenance and other safety measures shall be ensured.

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

1.23 Gas Insulated Bus:

GIB shall be designed based on the following criteria.

(1) Maximum weight of gas in a gas tight section of GIB shall not exceed 250 Kg .
(2) GIB shall be generally in horizontal layer. However, in exceptional circumstance GIB in vertical layers can be provided with the approval of employer.

(3) The minimum vertical ground clearance of GIB at road crossing shall be 8 meters.

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

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

(6) The GIB clear height outside the GIS hall in switchyard area shall be minimum 4 meter, so as not to obstruct easy access to GIB, movement of crane for maintenance work.

(7) For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.

(8) **Minimum number of bus duct lengths shall be used for entire GIS installation to optimize the spare requirement. same shall be reviewed & finalized during detailed engineering.**

(9) GIB inside GIS building shall be considered as a part of GIS equipment.

(10) Bus duct shall be supplied with bay wise packing with its conductor & other assorieries. Proper Marking on packing with packing list shall be provided to avoid site erection issues and to ensure minimize erection time.

2.0 Service Conditions:

2.1 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.

Max ambient temperature	:	50 deg C
Min. ambient temperature	:	-5 deg C
Max daily average ambient temperature	:	38 deg C
Max relative Humidity (%)	:	*As per IEC*
Max altitude above M.S.L (meters)	:	< 1000
Average Annual Rainfall (mm)	:	1000
Max wind pressure (kg./sq.mtr.)	:	130
Isokeraunic level (days/yr)	:	50
Average no. of rainy days / annum	:	120
Condensation	:	Occasional
Induced electromagnetic disturbance	:	1.6 kV
Creepage distance	:	31 mm/kV
Seismic Zone	:	Zone V
Acceleration due to gravity, g	:	0.5

2.2 System Particulars

2.2.1 Pole designation

2.2.1.1 Enclosure

2.2.1.1.1 Bus bar: i) Single for 33, 66 & 132 kV
ii) Separate phase wise for 400 kV
iii) Either Single OR separate phase wise for 220 kV

2.2.1.1.2 Bay : As above.

2.2.1.1.3 Enclosure material : Aluminum Alloy

2.2.2 Standards

REFERENCE STANDARDS

The GIS offered shall confirm to IEC 62271-203 and other relevant IEC standard except to the extent explicitly modified in the specification and shall be in accordance with requirement specified in GTP.

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

Common clauses for high voltage switchgear & control gear	:	IEC 60694
High voltage metal enclosed switchgear for 72.5 KV & above	:	IEC 62271-203
Specification for acceptance of new Sulphur Hexa fluoride	:	IEC 60376
Guide to checking of Sulphur Hexa fluoride taken from Electrical equipment	:	IEC 60480
Surge Arresters	:	IEC 60099
Over head line, Cable and Transformer Terminals Bushings for alternating voltages above 1000 V	:	IEC 60137
Cable connections for gas insulated metal enclosed Switchgear for rated voltages of 72.5 KV and above	:	IEC 60859
High voltage test techniques	:	IEC 60060
Insulation coordination	:	IEC 60071
Electrical Relays	:	IEC 60255
High voltage switches	:	IEC 60265
Partial discharge measurement	:	IEC 60270
Degree of protection	:	IEC 60529
Pollution levels	:	IEC 60815
EMC	:	IEC 61000
Use and handling of SF6 gas	:	IEC 61634

Standards for station grounding.	:	IEC 60364/60479/ IEEE 80
Pressure vessel code	:	CENELEC/SVDB
Recommendation for heat treated Aluminum alloy busbar material of the aluminum- magnesium-silicon type	:	IEC 60114
IEEE Guide for Gas-Insulated Substations	:	IEEE std C37.122.1-1993
Seismic design	:	IEC 693

2.2.3 Instrument Transformers **:** IEC 61869

2.2.4 Circuit Breaker

High voltage Alternating current circuit breakers	:	IEC 62271-100
Report on Synthetic testing of high voltage alternating Current Circuit breakers	:	IEC 60427

2.2.5 Disconnectors and earthing switch

Alternating current Disconnectors (isolators) and earthing Switch	:	IEC 60129 IEC 62271-102
Alternating current disconnectors, Bus transfer current Switching by disconnectors	:	IEC 61128
Alternating current earthing switches, Induced current Switching	:	IEC 61129

2.2.6 Artificial pollution test on HV insulators to be used on ac system : IEC 60507

2.2.7 Gas insulated metal enclosed switchgear for rated voltages of 72.5 kV and above : IEC 60517

2.2.8 Classification of degree of protection provided by enclosures : IEC 60529

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

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

2.3 Electrical data:

Rated System Voltage / Highest System/Equipment Voltage	kV	33/36	66 /72.5	132/145	220/245	400/420
One min. Power frequency withstand voltage	kV rms	70	140	275	460	610
Across open isolator	kV rms	80	160	315	530	610
Across the open gaps of CB	kV rms	70	140	275	460	520
Rated Lightning Impulse withstand voltage (1.2/50 µs peak value)						
Phase to phase	kVp	170	350	650	1050	1425
Phase to earth	kVp	170	350	650	1050	1425
Across open isolator	kVp	195	375	750	1200	1425 kVp + 240 kVp on opp. polarity
Across the open gaps of CB	kVp	170	350	650	1050	1425
Rated Frequency	Hz	50	50	50	50	50
Rated Continuous current at **50 ^{0}C** ambient temperature Bus bar	Amps	3150	2000	2000	3150/2500	4000
Feeder and Transformer Bay	Amps	2500	1600	1600	3150/2000	3150
Rated Short circuit Withstand current for 3 seconds	kA	40	40	40	50	63
Rated dynamic withstand current	kAp	100	100	100	125	157
Maximum Partial Discharge (at 1.1 Un)	pico-coulombs	5	5	5	5	5
System Neutral earthing		Solidly earth	Solidly earth	Solidly earth	Solidly earth	Solidly earth
Maximum SF6 Gas leakage rate per year	per year	0.5%				

Note: In case the type test reports of higher rating GIS or its associate equipment are submitted then offered rating shall be considered as per Type test reports.

2.3.1 Auxiliary Supply:

For control and signaling: 220 / 110 V DC (+10% & -20%)
For operation: 220/ 110 V DC (+10% & -20%) OR 440/ 230 V AC (+10% & -15%)
For other load: 440 / 230 V, AC (+10% & -15%)

The actual requirement of DC voltage, i.e. 110 V or 220 V, shall be mentioned in BOQ of respective tender.

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.

3 Detailed technical requirements for GIS Components:

3.1 Circuit Breaker:

3.1.1 General:

3.1.1.1 The GIS Circuit breaker shall be C2 – M2 class and comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC-62271-100 specifications

3.1.1.2 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

3.1.1.3 (A) 400 kV breakers shall be of separate phase wise enclosure whereas 132 kV/66/33 kV breakers shall be of three phase encapsulated type. For 220 kV class enclosure shall be either single OR phase wise separate metallic type.

(B) 400 kV Circuit breakers are to be supplied with Controlled Switching Device (CSD) compatible to SCADA remote operation with IEC 61850 protocols OR with PIR OR as indicated in BOQ of respective tender.

(C) 33 kV Circuit breakers shall be Gas insulated type only, Vacuum type interrupter shall not be allowed.

3.1.1.4 Ratings of the circuit breaker shall be as per enclosed technical parameters.

3.1.1.5 They should be shipped as a completed three-phase unit within a complete bay module.

3.1.1.6 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. The ON/OFF latches shall be mechanically

interlocked with each other. The circuit breaker shall be completely factory assembled, adjusted and tested.

3.1.1.7 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.

3.1.1.8 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.

3.1.1.9 The breakers are to be restrike-free.

3.1.1.10 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.

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.

1. The circuit breaker shall be capable of interrupting the steady and transient magnetizing current as per follows:

Voltage level	Transformer rating	Rating in MVA
400KV	400/220/33kV	167 to 500
220 kV	400/220/33kV	167 to 500
	220/132kV	100 to 150
	220/66kV	50 to 160
	220/33	125
	220/11	25 to 50
132 kV	220/132kV	100 to 150
	132kV/66kV	50 to 100
	132/33kV	50
	132/11kV	25
66KV	220kV/66 kV	50 to 160
	132kV/66KV	150 to 100
	66kV/11KV	5 to 20

2. Circuit breakers shall be able to switch in and out the for following rating shunt reactor in line with IEC 62271-110

Voltage level	Reactor rating in MVAR
400KV	50 to125
220 kV	25

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.

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 cubicle

The minimum guaranteed nos. of maintenance free operations of complete GIS shall be 10000 nos. **at no load & comply M2 class as per latest IEC.**

3.1.1.11 The Drive shall have sufficient stored energy for completing **O-C-O** with auxiliary power switched off.

3.1.1.12 Circuit breakers, being an arcing device, shall not house any passive device like current transformer in its housing. **However, CT may be placed in circuit breaker enclosure for 132kV & 66kV GIS.**

3.1.1.13 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.

3.1.2 Contacts

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

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

Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducers.

3.1.3 Closing Devices

3.1.3.1 The closing coils shall be suitable for operation at any voltage between 110% and 85% of the nominal control voltage measured at the device terminals

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

3.1.4 Tripping Devices

3.1.4.1 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.

3.1.4.2 Each circuit-breaker shall be equipped with two shunt trip system. The one shunt trip system shall be electrically separated from the other system.

3.1.4.3 An emergency hand tripping (mechanical) device shall be provided in the operating mechanism.

3.1.5 Anti-Pumping

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.

3.1.6 Operating Mechanism

3.1.6.1 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. 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.

Spring Operated Mechanism:

a) 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.
b) As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.
c) After failure of power supply to the motor, at least O-C-O operations of the circuit breaker shall be possible.
d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.
e) Motor rating shall be such that it requires only about 30 seconds for fully charging the closing spring.
f) Closing action of the circuit breaker shall compress the opening spring ready for tripping.
g) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation. and an indication of this shall be provided in the local control cabinet & SAS

h) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
i) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

j) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
k) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.
l) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.
m) An overload relay shall be provided for protection of the spring charging motor.

Hydraulic Operated Mechanism:

a) 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.
b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.
c) 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.
d) The mechanism shall be suitable for at least O-C-O operations after failure of AC supply to the motor.

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

3.1.6.2 The mechanism shall be in a dust proof (IP 55) box for outdoor and IP 42 for indoor installation respectively of Gas Insulated Switchgear.

One vermin-proof, sheet steel cubicle of adequate size shall be provided for housing the operating mechanism, aux relays, control and auxiliary equipment and for terminating all control, alarm and auxiliary circuits in suitable terminal boxes. The control cubicle shall be provided with hinged doors with provision for locking and removable cable gland plates for bottom cable entry. Viewing windows shall be provided for observation of the instruments without opening the enclosure. Suitably engraved nameplates shall be provided to identify all equipment in the control cubicle.

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

Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings.

Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

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

3.1.7 Auxiliary Switches:

Each breaker shall have auxiliary switches with adequate number of NO and NC contacts all wired to terminals located in the local control cubicle of the circuit breaker bay. Additional 10 NO (Normally open) & 10 (Normally Close) auxiliary contacts for future use should be provided & wired up to terminal block of LCC.

3.1.8 Indicating Devices:

3.1.8.1 Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed.

	Status	**Colour**
Open position	**Open**	**Green**
Closed position	**Closed**	**Red**

3.1.8.2 Each circuit-breaker shall be provided with an operation counter to record the number of tripping operations performed. The counter may be located at the local control cubicle.

3.1.8.3 All position indicators and counters shall be readable at a convenient elevation i.e. from the place of operation.

3.1.9 Gas Connections:

Necessary valves and connections shall be provided to assure ease in handling the SF6 gas.

3.1.10 Timing Test:

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

Testing facilities:

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

3.1.11 Principal Parameters:

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

Sr No.	Particulars	33 kV/66 kV/132 kV/(220 kV)/400 kV
1)	Enclosure	Single/Single / Single / (Single or separate phase wise) / separate phase wise
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	36kV/ 72.5 kV/145 kV/245 kV/420 kV
4) a	Rated current (Line, Trans & Reactor)	2500A/1600A/1600A/3150 or 2000A/3150A
b	Rated current (Bus bar & Bus coupler)	3150A/2000A/2000A/3150A or 2500A/4000A
5)	Rated frequency	50 Hz
6)	Rated short-circuit breaking current/ Duration	40/40/ 40 / 50 / 63 kA rms 3 sec
7)	Rated break-time	3 cycle
8)	Rated short-circuit making current	100/100/100/125/157 kAp
9)	Difference for simultaneity of 3 poles	4 ms (Max.)
10)	Rated insulation level under minimum SF6 gas pressure	
a)	Power frequency withstand voltage	70/140/275/460/520 kVrms
b)	Lighting impulse withstand voltage Switching impulse voltage	170/350/650/1050/1425 kVp NA/NA/NA/NA/1050 kVp (As per IEC 62271-1)
9)	Rated operating sequence	O-0.3s-CO-3min-CO
10)	Type of operating mechanism for circuit Breaker	Spring – Spring/hydraulic/combined
11)	Rated control voltage - Closing coil - Tripping coil	 110/220 VDC 110/220 VDC
12)	Mechanical Endurance class	M2
13)	Electrical Endurance class	E1
14)	Restriking probability class	C2
15)	Rated line charging breaking current	10/10 /50/125/400 A (Max. over breaking capacity voltage factor 1.5 PU)
16)	Rated cable charging breaking current	50/125/160/250/400 A
17)	Rated capacitor bank switching current	400/400/400/400/400 A
18)	Rated out of phase making and breaking current in % of rated short circuit breaking	As per applicable IEC

	current	
19)	Characteristic for short line fault related to rated short circuit breaking current	As per IEC 62271 - 100
20)	TRV characteristics	As per IEC 62271 - 100
21)	Inductive current breaking capability	Switching No Load current of transformer
22)	First pole to clear factor	As per IEC 62271 - 100
23)	Opening time in ms	Not more than 40
24)	Closing time in ms	Not more than 100
25)	Noise level at the base of CB	As per NEMA standard
26)	No of tripping coils per breaker	2
27)	No of closing coils per breaker	1

3.1.12 Controlled Switching Scheme:

Controlled switching shall be provided for GIS as per indicated in BOQ of respective tender.

The circuit breaker shall be suitable for the application *(As indicated in BOQ of respective tender)* of controlled switching with consequent optimization of switching behavior, when:

a. Switching off & on of the Line
b. Switching off & on of the Transformer
c. Switching off & on of the Shunt Reactor

The controlling relay shall also record and monitor switching operations and make adjustments to the switching instant to optimize switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from switching events.

Calculations and related test reports of scheme proving rating for duties specified above shall be furnished in the bid. The calculations shall take care of requirements of programming etc for setting switching for various duties like long line, Shunt reactor, power transformer and time setting.

The proposed scheme should be designed keeping in view all the system parameters of GETCO and applicability with various operations. Circuit Breaker on which CSD is to be provided along with all the other connected equipment's viz, Transformer, reactor, CT-PT, LA Disconenctor CVT, wave trap etc. is not supposed to be Mal functioned or failed due to this scheme. The CSD supplier shall be responsible for any such unwanted event. The very advantage of provision of controlled switching should not be spoiled due to any design defect. All the preliminary literatures on this scheme should be provided with the bid. Bidder shall provide all the detailed documents, function diagrams, calculations and design criteria etc.

The controlled switching relay shall be communicable and shall be supplied with all the original customized licensed software, I/O cards, required cables, etc., for communication with computer.

Any modification required in control & relay panel as per Controlled switching device scheme requirement shall be in the scope of bidder

1. Technical Requirement for controlled switching device:

a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified.

b) The CSD shall have functions for switching ON & OFF the circuit breakers.

c) The CSD shall get command to operate the breakers manually. The controller shall be able to analyze the current and voltage waves available through the signals from secondary's of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

d) The CSD shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker, the CSD must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than ± 0.5 ms.

e) The CSD should have display facility at the front for the display of settings and measured values.

f) The CSD shall be PC compatible for the setting of various parameters and down loading of the settings and measured values, date, time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.

g) The controller shall be suitable for current input of 1 ampere from the secondary of the CTs. and 110 V or 220V (Ph to Ph) from the PTs or CVTs. The CSD shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.

h) The CSD shall have time setting resolution of 0.1 ms or better.

i) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering of the scheme.

j) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

k) The provision for bypassing the Controlled switching device shall be provided through BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit Breaker. Alternatively, in case of any non-operation of the CSD after receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.

l) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

2.0 TESTS

2.1 Type Tests

All the CSDs offered shall be fully type tested for following, as per relevant standard latest editions at the NABL accredited or Government approved laboratory of the eligible country.

A. Dielectric withstand test (IEC-60255-5)

1. Power frequency voltage withstand
2. Impulse voltage withstands

B. Electromagnetic immunity tests

1. 1 MHz burst (IEC- 60255-22-1)
2. Electrostatic discharge (IEC- 60255-22-2)
3. Radiated electromagnetic field (IEC- 60255-22-3)
4. Fast transient / burst immunity test (IEC- 60255-22-4) /IEC61000-4-4)
5. Surge immunity test (IEC- 61000-4-5)

6. Conducted disturbances induced by radio frequency fields (IEC- 61000-4-6)
7. magnetic field test (IEC- 61000-4-8,9 & 10)
8. Ripple on Dc power supply (IEC 61000-4-17

C. Electromagnetic interference tests (IEC- 60255-25)

1. Conducted emission test
2. Radiated emission test

D. Mechanical test

1. Vibration test (IEC- 60255-21-1)
2. shock test (IEC- 60255-22-2)
3. bump test (IEC- 60255-22-2)
4. Seismic test (IEC- 60255-22-3)

E. Environment test

1. Cold test (IEC-60068-2-1)
2. dry heat test (IEC-60068-2-2)
3. Damp heat test steady state (IEC-60068-2-3)
4. Damp heat cyclic(IEC-60068-2-30)

The Bidder shall furnish ONE set of all above type test reports for the offered CSD along with the offer. The type test reports shall not be older than **10 years** and shall be valid as on the last date of submission of bid.

However, the purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative. For this purpose, the Bidder may quote unit rates for carrying out each type test.

IMPORTANT NOTE: In case of non-submission of some of the type test reports, the bidder shall confirm the submission of same before commencement of supply, without affecting delivery schedule, from NABL accredited laboratory, free of cost. In absence of this confirmation, the offer will be evaluated as non-submission of type test report.

2.2 ACCEPTANCE AND ROUTINE TESTS

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of purchaser's representative including following test in line with CIGRE TB.264

1. Dielectric withstand (IEC-60255-5)
2. Functional performance tests: Close at voltage zero & voltage peak as well as open at a specified voltage & current phase angle
3. Check of parameter setting procedure
4. Self-check

5. Alarm and signaling
6. Additional function such as event recording, communication etc.

Tests on Controlled Switching Device on every application from the offered lot.

3.2 Disconnector Switches and Maintenance Grounding switches:

3.2.1 General:

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

3.2.1.2 Disconnect switches shall be gang operated and separate phase wise for 400 kV, Single or separate phase wise for 220 kV and three phase encapsulated for 132/66 kV/33 kV, 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.

3.2.1.3 Maintenance earthing switches shall be gang operated and separate phase wise for 400 kV, Single or separate phase wise for 220 kV and three phase encapsulated for 132/66 kV/33 kV, 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.

3.2.1.4 Disconnect switches and grounding switches shall have electrical and Mechanical interlocks to prevent grounding switch from closing on an energized section.

OR Disconnect switches and grounding switches shall have electrical interlocks to prevent grounding switch from closing on an energized section. However, pad locking arrangement shall be provided to have mechanical interlock manually.

Interlocks with other bays for bus transfer switching shall be done through bay control cubicles. Actuation of the emergency manual operating device shall also disable the electrical control. Disconnectors in open condition shall be secured against reclosure.

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. 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. 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.

Intraday and interlay interlocking shall be provided.

Electrical interlocking arrangement shall be fail-safe type.

Mechanical interlocks for isolator & Earthing Switch shall be fail-safe type.

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

3.2.1.6 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. 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. 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.

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

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

3.2.1.9 Duty requirements:
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.

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.

Short Circuit Requirements:

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.

3.2.1.10 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.

3.2.2 Operating Mechanism:

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

3.2.2.2 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.

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

3.2.2.4 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.

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

3.2.2.6 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. 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.

Dis-connector /earth switch shall be motorized.

3.2.3 Auxiliary Switches:

All disconnecting switches shall be provided with electrically independent auxiliary switch, directly driven by the common operating shaft. Each disconnect switch and grounding switch shall furnish with sufficient Nos. of NO – NC as per entire scheme requirement. Additional 6 NO (Normally open) & 6 (Normally Close) auxiliary contacts for future use should be provided & wired up to terminal block of LCC.

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

3.2.4 Position Indicators:

3.2.4.1 Mechanically connected position indicators shall be provided externally to permit observation of close/open position of the disconnect switch and grounding switch. The place of Position Indicators should be easily visible from the place of operation of respective equipment.

Position Indicator	Status	Color
Open position	Open	Green
Closed position	Closed	Red

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

3.2.5 Technical Data Requirements for disconnector:

Sr No.	Particulars	Parameters
1)	Enclosure	Single/Single / Single / (Single or separate phase wise) / separate phase wise
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	36/72.5 / 132 / 245 / 420 kV
4)	Rated current (A) (Feeder)	2500/1600 /1600/**3150 or 2000A** /3150 A
	Rated current (Bus bar & Bus coupler)	3150A/2000A/2000A/3150A or 2500/4000A
5)	Rated short-time current Duration	40/40/ 40 / 50 / 63 kA rms 3 sec
6)	Rated control and operating voltage	As per clause 2.3.1
7)	Type of operating mechanism	Motor operated
8)	Type	Mechanically & electrically ganged operated

9)	Rated insulation level	
a)	Power frequency withstand voltage	
	- phase to phase, between phases	70/140/275/460/520 kV rms
	- Across the isolating distance	80/160/315/510/610 kV rms
b)	Lightning impulse withstand voltage	
	- phase to phase, between phases	170/350/650/1050/1425 kV peak
	- Across the isolating distance	195/375/750/1200/1665 kV peak
10)	Mechanical Endurance Class	M2
11)	Bus transfer switching capability (% of rated current)	80 % (max. 1600A)
12)	Rated bus charging current	0.1 A /0.2 A/0.25 A/0.3 A

3.2.6 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.

3.3 Fast Acting Grounding Switches:

3.3.1 General:

3.3.1.1 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 IEC 60129, 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.

3.3.1.2 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.

3.3.1.3 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.

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

3.3.1.5 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.

3.3.1.6 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.

3.3.2 Operating Mechanism:

3.3.2.1 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.

3.3.2.2 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.

3.3.2.3 Motors shall be suitable for operation at any voltage between 85% and 110% of the rated auxiliary voltage, measure at the motor terminals.

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

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

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

3.3.2.7 **The operating mechanism design shall be such that during the operation of the High speed motor operated earthing switch, 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. Similarly, the springs must assist during the opening operation to give quick breaking feature.**

High speed earth switch shall be motor drive spring charged mechanism.

3.3.3 Auxiliary Switches

Each of the fast acting grounding switch shall be furnished with sufficient Nos. of NO – NC as per entire scheme requirement. Additional 6 NO (Normally open) & 6 (Normally Close) auxiliary contacts for future use should be provided & wired up to terminal block of LCC.

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

3.3.4 Position Indicators

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.

Position Indicator	Status	Color
Open position	Open	Green
Closed position	Closed	Red

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

3.3.5 Test Facility

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.

High speed earthing switches shall be capable of interrupting line coupling currents upon opening and in worst conditions closing.

3.3.6 Technical Data Requirement

[A] High Speed Earthing Switch:

Sr. No.	Particulars	33kV/66kV/132kV/(220kV)/400kV
1)	Enclosure	Single / Single / (Single or separate phase wise) / separate phase wise
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	36/72.5 /145/ 245 / 420 kV
4)	Rated short-time current	40/40/ 40 / 50 / 63 kA rms 3 sec
5)	Rated peak withstand current	100/100/100/125/157 kAp
6)	Type of operating mechanism	Motor operated
7)	Rated control and operating voltage	As per clause 2.3.1
8)	Power frequency withstand voltage	70/140/275/460/520 kV rms
	across the open gap	80/160/315/510/610 kV rms
9)	Lightning impulse withstand voltage	170/350/650/1050/1425 kV peak
	across the open gap	195/375/750/1200/1665 kVpeak
10)	Electrical Endurance class	E1
11)	Rated induced current switching capability	As per IEC 62271 – 102 class B

[B] Maintenance Earthing Switch : 33kV/66kV/132kV/220kV/400kV

1)	Enclosure	Single / Single / (Single or separate phase wise) / separate phase wise
2)	Enclosure material	Aluminum Alloy
3)	Rated voltage	36/72.5 /145/ 245 / 420 kV

4)	Rated short-time current	40/40/ 40 / 50 / 63 kA rms 3 sec
5)	Type of operating mechanism	Motor operated
6)	Electrical Endurance class	E0
7)	Mechanical Endurance Class	M1 for 33 kV to 220kV, M2 for 400KV
8)	Power frequency withstand voltage	70/140/275/460/520 kV rms
	across the open gap	80/160/315/510/610 kV rms
9)	Lightning impulse withstand voltage	170/350/650/1050/1425 kV peak
	across the open gap	195/375/750/1200/1665 kV peak

3.4 Current Transformers:

3.4.1 General

3.4.1.1 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-61869 specifications.

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

3.4.1.3 The current transformer shall be ring / toroid type, multi ratio with fully distributed secondary windings with accuracy as per IEC 60185, incl. IEC-61869, multi core as per requirement.

3.4.1.4 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.

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

3.4.1.6 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.

3.4.1.7 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.

3.4.1.8 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. CT shall be provided with effective electromagnetic shields to protect against high frequency transients typically I-30 MHz.

3.4.2 Rating and Diagram Plates

Rating and diagram plates shall be provided. The information to be supplied on each plate shall be as specified in the relevant IEC specification, which shall be given for the tap for which the rated performance is specified and for each transformer core.

3.4.3 Technical Data Requirements for Current Transformers:

33 kV class CT - Bay wise core requirement considering 125 MVA 220/33 KV 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
Feeder bay								
1	Metering	1200-800-400 / 1	15 VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection	1200-800-400 / 1	10VA	5P	10	--	--	--
3	**Differential**	1200-800-400 / 1	10VA	**PX**	--	**950V @1200/1**	**30 mA $$ (Vk/2)**	--
220/33 kV Transformer bay (LV)								
1	Metering	2500-1500 / 1	15 VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection	2500-1500 / 1	15VA	5P	10	--	--	--
3	Differential Protection	2500-1500 / 1	--	**PX**	--	1200 V @2500/1	30 mA $$ (Vk/2)	--**
4	Spare	2500-1500 / 1	--	**PX**	--	1200 V @2500/1	30 Ma $$ (Vk/2)	--**
Bus coupler / Bus Sectionalizer bay								
1	Metering	2500-1500 / 1	15 VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection	2500-1500 / 1	15VA	5P	10	--	--	--
3	Spare	2500-1500 / 1	15VA	5P	10	--	--	--
STN. Transformer bay (HV)								
1	Metering	200-100 / 1	15 VA**	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection	200-100 / 1	10VA**	5P	10	--	--	--
3	Differential Protection	200-100 / 1	--	**PX**	--	300V @ 200/1	25 mA $$	< 5Ω** @200/1
4	Spare	200-100 / 1	--	**PX**	--	300V @ 200/1	25 mA $$	< 5Ω** @200/1
Tariff metering CT								
1	Tariff Metering	1200- 800-400 / 1	5 VA	0.2 S	5	--	--	--

66 kV class CT - Bay wise core requirement considering 20 MVA 66/11KV Transformer

Core No	Purpose	Ratio	Out put 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
	Feeder bay							
1	Metering	**600-300 / 1 or 1200-600-300/1**	15 VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		10VA	5P	10	--	--	--
3	**Differential**		**PX**	-	-	**650V@600/1 or 950V@1200/1**	**30 mA**	**≤ 10Ω**
	20 MVA, 66/11KV Transformer bay (HV)							
1	Metering	200-100 / 1	15VA**	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection	200-100 / 1	10VA**	5P	10	--	--	--
3	Differential Protection	200-100 / 1	--	**PX**	--	100 to 400V	100mA (at 100V) to 200mA (at 400V)	< 5Ω
4	Spare	200-100 / 1	--	**PX**	--	100 to 400V		< 5Ω
	Bus coupler bay							
1	Metering	**600-300 / 1 or 1200-600-300/1**	15 VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		10VA	5P	10	--	--	--
3	Spare		10VA	5P	10	--	--	--

Note:

** - Final CT core sizing shall be derived during detailed engineering and got approved.

$$ - Magnetizing characteristics of HV & LV CT cores to be utilized for differential protection shall be matched to minimize spill current and shall be got approved.

66 kV class CT - Bay wise core requirement considering 50 /100 / 160MVA Transformer for 220 /66 kV 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
	Feeder bay							
1	Metering	**600-300 / 1 or 1200-600-300/1**	15VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		10VA	5P	10	--	--	--
3	**Differential**		**PX**	-	-	**650V@600/1 or 950V@1200/1**	**30 mA**	**≤ 10Ω**

	5 MVA STN. Transformer bay (HV)							
1	Metering	100-50 / 1	5 VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		10VA**	5P	10	--	--	--
3	Differential Protection		--	**PX**	--	60V to 100V	125 mA (at 60V) to 250mA (at100V)	< 1.5Ω (at 50A)
4	Spare		--	**PX**	--	60V to 100V		<1.5Ω (at 50A)
	Transformer bay (LV)							
1	Metering	1200- 600 /1 OR 1500-1200 / 1	15VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		15VA	5P	10	--	--	--
3	Differential Protection		--	**PX**	--	950V	30 mA	≤ 10Ω
4	Spare		--	**PX**	--	950V	30 mA	≤ 10Ω
	Bus coupler bay							
1	Metering	1200- 600 /1 OR 1500-1200 / 1	15VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		10VA	5P	10	--	--	--
3	Spare		10VA	5P	10	--	--	--

Note:

** - Final CT core sizing shall be derived during detailed engineering and got approved.

$$ - Magnetizing characteristics of HV & LV CT cores to be utilized for differential protection shall be matched to minimize spill current and shall be got approved.

66 kV class CT – TARIFF METERING - ONE WINDING CT (FOR HT CONSUMER)								
Ratio shall be decided by R&C department as per consumer demand								
1	Tariff Metering	--- / 1	5 VA	0.2 S	5	--	--	--
66 kV class CT – TARIFF METERING - TWO WINDING CT (FOR HT CONSUMER)								
Ratio shall be decided by R&C department as per consumer demand								
1	Tariff Metering	--- / 1	5 VA	0.2 S	5	--	--	--
2	Relaying	--- / 1	15 VA	5 P	**10**	--	--	--

132 KV class CT - Bay wise core requirement considering 50 / 100 / 150 MVA Transformer

Core No	Purpose	Ratio	Out put 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
	Feeder bay							
1	Metering	600-300-150/1	15VA	0.5	≤5	--	--	--
2	Main-1 DPS		--	**PX**		600V	25mA	≤ 6Ω
3	Dir. O/C-E/F Protection		15VA	5P	10	--	--	--
4 & 5	Spare		--	**PX**	--	600V	25mA	≤ 6Ω
	Transformer LV Bay (HV-LV)							
1	Metering	600-300-150/ 1 OR 1200-600-300/1	15VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		15VA	5P	10	--	--	--
3	Differential Protection		--	**PX**	--	600V	25mA	≤ 6 Ω / 12Ω
4 & 5	Spare		--	**PX**	--	600V	25mA	≤ 6 Ω / 12Ω
	Bus coupler bay							
1	Metering	600-300-150/ 1 OR 1200-600-300/1	15VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		15VA	5P	10	--	--	--
3	Bus bar Protection		--	**PX**	--	600V	25mA	≤ 6 Ω / 12Ω
4 & 5	Spare		--	**PX**	--	600V	25mA	≤ 6 Ω / 12Ω

220 KV class CT - Bay wise core requirement considering 100 /125/160 / 315 / 500 MVA Transformer

Core No	Purpose	Ratio	Out put 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
	Feeder bay							
1	Metering	1200-600-300/1 OR 1500-1200-600/1	15VA	0.5	≤5	--	--	--
2	Main-1 DPS		--	**PX**		1400V	25mA	≤ 12Ω
3	Main-2 DPS		--	**PX**		1400V	25mA	≤ 12Ω
4	Bus bar Protection		--	**PX**		1400V	25mA	≤ 12Ω
5	Spare		--	**PX**		1400V	25mA	≤ 12Ω

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1	Metering	2000-1000-500/1	15VA	0.5	≤5	--	--	
2	Main-1 DPS			**PX**		2000V	25mA	≤ 12Ω
3	Main-2 DPS			**PX**		2000V	25mA	≤ 12Ω
4	Bus bar Protection			**PX**		2000V	25mA	≤ 12Ω
5	Spare			**PX**		1400V	25mA	≤ 12Ω
	Transformer (HV – LV) Bay							
1	Metering	1200-600-300/1 OR 1500-1200-600/1	15VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		--	**PX**		1400V	25mA	≤ 12Ω
3	Differential Protection		--	**PX**		1400V	25mA	≤ 12Ω
4	Bus bar Protection		--	**PX**		1400V	25mA	≤ 12Ω
5	Spare		--	**PX**		1400V	25mA	≤ 12Ω
	Bus coupler bay/ Bus **sectionalizer bay**							
1	Metering	1200-600-300/1 OR 1500-1200-600/1	15VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		--	**PX**		1400V	25mA	≤ 12Ω
3	Bus bar Protection		--	**PX**		1400V	25mA	≤ 12Ω
4	Spare		--	**PX**		1400V	25mA	≤ 12Ω
1	Metering	3000-2000-1000/1 [VK, Im & Rct shall be decided during detailed engineering]	15VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		--	**PX**		2000V	25mA	≤ 16Ω
3	Bus bar Protection		--	**PX**		2000V	25mA	≤ 16Ω
4	Spare		--	**PX**		2000V	25mA	≤ 16Ω

220 kV class CT – TARIFF METERING - ONE WINDING CT (FOR HT CONSUMER)

Ratio shall be as per BOQ/ decided by R&C department as per consumer demand

Core No	Purpose	Ratio	Output burden	Accuracy class	Instrument security factor		
1	Tariff Metering	--- / 1	5 VA	0.2 S	5	--	--

Note: For Tariff metering, Secondary terminal Box shall be Separate and sealable.

400 KV class CT - Bay wise core requirement considering 315 / 500 MVA Transformer

Core No	Purpose	Ratio	Out put 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
	Feeder bay							
1	Metering	2000-1000-500/1 OR 3000-2000-1000-500/ 1	15VA	0.5	≤5	--	--	--
2	Main-1 DPS		--	**PX**		2000V	30mA	≤ 10Ω / 15 Ω
3	Main-2 DPS		--	**PX**		2000V	30mA	≤ 10Ω / 15 Ω
4	Bus bar Protection		--	**PX**		2000V	30mA	≤ 10Ω / 15 Ω
5	Spare		--	**PX**		2000V	30mA	≤ 10Ω / 15 Ω
	Transformer bay (HV)							
1	Metering	2000-1000-500/1	15VA	0.5	≤5	--	--	--
2	Dir. O/C-E/F Protection		--	**PX**		2000V	30mA	≤ 10Ω
3	Differential Protection		--	**PX**		2000V	30mA	≤ 10Ω
4	Bus bar Protection		--	**PX**		2000V	30mA	≤ 10Ω
5	Spare		--	**PX**		2000V	30mA	≤ 10Ω
	Bus coupler bay/Bus sectionalizer bay							
1	Metering	2000-1000-500/1 OR 3000-2000-1000-500/1	15VA	0.5	≤5	--	--	--
2	Non - Dir. O/C-E/F Protection		--	**PX**		2000V	30mA	≤ 10Ω
3	Bus bar Protection		--	**PX**		2000V	30mA	≤ 10Ω
4	Spare		--	**PX**		2000V	30mA	≤ 10Ω

3.5 Voltage Transformer:

3.5.1.1 SF_6 insulated:
Each voltage transformer shall be metal enclosed, SF6 insulated inductive type in accordance with relevant IEC 61869 The location, polarity, ratios, and accuracy shall be as specified.

3.5.1.2 Construction:
VTs should be in segregated compartment and not forming a part of bus bar. 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.

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 gasket joint so that the transformer housing is grounded to the GIS enclosure. 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.

3.5.1.3 Covers and shields:

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.

3.5.1.4 Primary and secondary terminals:

Primary and secondary terminals should have permanent markings for identification of polarity, in accordance with IEC. The secondary terminals of voltage transformers shall be placed outside the high voltage enclosures, and the secondary leads of all the voltage transformers shall be wired up to terminals mounted in suitable & accessible terminal boxes.

3.5.1.5 Provision shall be made for grounding of the secondary windings inside the local control cubicle.

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

3.5.1.7 Technical Data Requirement:

SN	Particulars	Parameters
1	Rated voltage	33/66kV/132/220kV/400kV
2	Highest system voltage	36/72.5/145/245/420 kV
3	Rated frequency	50 Hz
4	P F (dry) withstand voltages	70/140 /275/460/610 kV
5	Voltage factor	1.2 continuous
6	1.2/50 micro sec. lightning impulse withstand voltage	170/350/650/1050/1450/kVp
7	Earthing	Effective

400/220/132 kV class Bus /Line CVT/PT Core Details				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{400/220/132kV/\sqrt{3}}{110V/\sqrt{3}}$	100 VA	0.5
2	Protection	$\frac{400/220/132kV/\sqrt{3}}{110V/\sqrt{3}}$	100 VA	3P

3	Protection	$\frac{400/220/132kV/\sqrt{3}}{110V/\sqrt{3}}$	100 VA	3P
4	Spare	$\frac{400/220/132kV/\sqrt{3}}{110V/\sqrt{3}}$	100 VA	3P

66 kV class Bus/Line PT Core Details				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	0.5
2	Protection	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P
3	Spare	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P

66 kV class Bus PT (1 –Winding) Core Details- TARIFF METERING For HT Consumers				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Tariff Metering	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	10 VA	0.2

66 kV class Bus PT (2-Winding) Core Details- TARIFF METERING For HT Consumers				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Tariff Metering	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	10 VA	0.2
2	Protection	$\frac{66KV/\sqrt{3}}{110V/\sqrt{3}}$	100 VA	3P

400 kV class Line CVT Core Details				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{400KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	0.5
2	Protection	$\frac{400KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P
3	Protection	$\frac{400KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P

220/132 kV class Line CVT Core Details				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{220/132KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	0.5
2	Protection	$\frac{220/132KV/\sqrt{3}}{110V/\sqrt{3}}$	50 VA	3P

220 kV Tariff metering PT				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{220kV/\sqrt{3}}{110V/\sqrt{3}}$	10 VA	0.2

33 kV class Bus PT Core Details				
Core	Purpose	Ratio	**Burden**	Class of accuracy
1	Metering	$\frac{33KV/\sqrt{3}}{110V/\sqrt{3}}$	**50 VA**	0.5
2	Protection	$\frac{33KV/\sqrt{3}}{110V/\sqrt{3}}$	**50 VA**	3P
3	Spare	$\frac{33KV/\sqrt{3}}{110V/\sqrt{3}}$	**50 VA**	3P

33 kV class Bus PT (1 –Winding) Core Details- TARIFF METERING For HT Consumers as per Schedule /BOQ		
Ratio	**Burden**	Class of accuracy
$\frac{33KV/\sqrt{3}}{110V/\sqrt{3}}$	**10 VA**	0.2

Note: 1. However, actual requirements of burden for Instrument Transformers (CT & PT both) shall be finalized during detailed engineering.

1. Any change in the parameters of CT & PT required at the time of detailed engineering will have to be incorporated without any extra cost.

3.6 Bushings:

Outdoor bushings shall be provided for connection of conventional external conductors to SF6 GIS if asked in general layout plan. Bushing shall be polymer type only. Necessary valid type test reports as per relevant applicable standards shall be submitted.

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.

All the bushings shall have an impulse & power frequency withstand level that is higher or equal to the level specified in cl. 2.3.

Only SF6 insulated composite silicon bushings will be accepted. The terminals on the outdoor bushings shall be a solid stem with dimensions specified.

3.7 Metal-Enclosed Surge Arresters:

360 kV, 20 kA, Cl-4 / 198 kV, 10 kA, Cl-3 / 120 kV, 10 kA, Cl-3 / 60 kV, 10 kA, Cl-3 / 30kV, 10kA, CL-2 hermetically sealed, Gapless, ZnO, Surge arrestor, suitable for use with GIS, for each phase, at the 400 kV/220kV/132kV/66kV line underground cable entry terminals of GIS shall be provided, if indicated in SLD/BOQ of respective tender. Each Surge Arrester shall be provided with self leakage current monitoring device at convenient elevation. Location of SF6 Surge Arrester shall be as per tender drawings.

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

Surge Arresters, if any provided, shall be of either the “plug-in” construction or the disconnect-link type and be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system while the system is being dielectrically tested. The metal housing of the arrester shall be connected to the metal enclosure of the GIS with a flanged, bolted joint.

The ground connection shall be sized for the fault level of the GIS. It shall be insulated from the GIS-enclosure and grounded externally to permit periodic maintenance and monitoring of the leakage current.

If the arresters are not equipped with removable links, special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the arrester.

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

3.8 Insulating Gas and gas leakage rate:

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

The quality of new filled-in SF6 gas shall meet the following requirements in line with IEC 60376.

Content	**Specification**	**Analytical methods (for indication only, not exhaustive)**	**Precision**
Air	2 g/kg [note 1]	Infrared absorption method	35 mg/kg
		Gas-chromatographic method	3 – 10 mg/kg
		Density method	10 mg/kg
CF4	2 400 mg/kg [note 2]	Gas-chromatographic method	9 mg/kg
H2O	25 mg/kg [note 3]	Gravimetric method	0.5 mg/kg [note 3]
		Electrolytic method	2 – 15 mg/kg
		Dew point method	1 °C
Mineral oil	10 mg/kg	Photometric method	< 2 mg/kg
		Gravimetric method	0.5 mg/kg [note 5]
Total acidity expressed in HF	1 mg/kg [note 4]	Titration	0.2 mg/kg
S02	< 1ppmv	-	-

NOTE 1 2 g/kg is equivalent to 1 % vol under ambient conditions (100 kPa and 20 °C [1]). **NOTE 2** 2400 mg/kg is equivalent to 4 000 µl/l under ambient conditions (100 kPa and 20 °C [1]). **NOTE 3** 25 mg/kg (25 mg/kg) is equivalent to 200 µl/l and to a dew point of –36 °C, measured at ambient conditions (100 kPa and 20 °C [1]). **NOTE 4** 1 mg/kg is equivalent to 7,3 µl/l under ambient conditions (100 kPa and 20 °C [1]). **NOTE 5** Depending on the sample size

Reuse or recycling of removed gas:

The supplier should provide guidelines or recommended practices for the reuse or recycling of SF6 gas removed from the equipment. 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. Clear instructions shall be provided by bidder about handling, recycling & treatment of new and used SF6 gas.

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides, and water contents as per IEC:60376, 60376A & 60376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas.

SF6 Gas filled inside GIS before charging is fresh SF6 Gas, hence it shall be considered as new Gas which shall be tested as per IEC 60376. Hence during commissioning measured purity, dew point, air, hydrolysable fluorides, and water contents shall be in line with IEC:60376, 60376A & 60376B.

Gas bottles should be tested for leakage during receipt at site.

Components may be filled with N2 for transportation and refilled with SF6 at site.

3.9 Gas sections:

The GIS enclosures shall be divided into several gas sections separated by gas-tight barriers. Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section. Location of gas barrier insulators is to be clearly discriminated outside the enclosure by a band of distinct colour normally used for safety purposes.

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. 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.

For the purpose of gas monitoring and maintenance, the GIS shall be divided into various individual zones in each bay. The CB gas zone shall be independent from all other gas compartments and shall meet the requirement of relevant IEC.

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.

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.

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.

All gas compartments shall be fitted with static filter material containers that will absorb residual and entering moisture inside the high voltage enclosures. Filters inside the breaker compartment shall also be capable of absorbing gas decomposition products resulting from the switching arc.

3.10 Technical specification for portable PD monitoring system for gas insulated switchgear (Applicable if mentioned in BOQ of respective tender):

3.10.1 General:

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

It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation shall be on acoustic technique and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and PTs etc., with the hot sticks.

Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.

3.10.2 Technical Specification:

1.1 Measurement shall be possible in noisy environment.

1.2 Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.

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

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

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

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

1.7 The function of software shall be covering the following:

- Data recording, storage and retrieval in computer
- Data base analysis
- Template analysis for easy location of fault inside the GIS
- Evaluation of PD measurement i.e. Amplitude, Phase Synchronization etc.
- Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
- Report generation

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

1.9 Supplier shall have “Adequate after sales service” facility in India.

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

1.11 Instrument shall be robust and conform to relevant standard.

3.11 GIS Connection:

3.11.1 GIS to Transformer/ Reactor:

1) <u>For 400/220 kV Transformers</u> (As specified in SLD / SECT DRG / BOQ):

(A) 400 & 220 kV side: by SF6 to air bushing to OIP condensers bushing of transformer by conductor. GIS SF6 to air bushing shall be polymer type only.

OR

(B) 400 & 220 kV side by GIS SF6 to OIP condenser bushing by GIS bus duct. OR 220 kV side by GIS SF6 to XLPE cable (220 kV, single or twin, 1C x 1200 mm^2.) GIS SF6 to air bushing shall be polymer type only.

OR

(C) Any Combination from (A) & (B).

2) <u>For 220/66 kV Transformers</u> (As specified in SLD / SECT DRG / BOQ):

(A) 220 & 66 kV side: by GIS SF6 to air bushing to OIP condensers bushing of transformer by conductor. GIS SF6 to air bushing shall be polymer type only.

OR

(B) 220 & 66 kV side by GIS SF6 to OIP condenser bushing by GIS bus duct OR by GIS SF6 to XLPE cable (220 kV, single or twin, 1C x 1200 mm^2/66 kV, 2 run of 1C x 630 mm^2). GIS SF6 to air bushing shall be polymer type only.

OR

(C) Any Combination from (A) & (B).

3) <u>For 220/132 kV Transformers</u> (As specified in SLD / SECT DRG / BOQ):

(A) 220 & 132 kV side: by GIS SF6 to air bushing to OIP condensers bushing of transformer by conductor. GIS SF6 to air bushing shall be polymer type only.

OR

(B) 220 & 66 kV side by GIS SF6 to OIP condenser bushing by GIS bus duct OR by GIS SF6 to XLPE cable (220 kV, single or twin, 1C 1200 mm^2/ single or twin, 1C 132 kV 1000 mm^2). GIS SF6 to air bushing shall be polymer type only.

OR

(C) Any Combination from (A) & (B).

4) <u>For 132/66 kV Transformers</u> (As specified in SLD / SECT DRG / BOQ):

(A) 132 & 66 kV side: by GIS SF6 to air bushing to OIP condensers bushing of transformer by conductor. GIS SF6 to air bushing shall be polymer type only.

OR

(B) 132 & 66 kV side by GIS SF6 to OIP condenser bushing by GIS bus duct OR by GIS SF6 to XLPE cable (132 kV, single or twin, 1C 1000 mm^2/66 kV 2 X 630 mm^2) GIS SF6 to air bushing shall be polymer type only.

OR

(C) Any Combination from (A) & (B).

5) For 220/33 kV Transformers (As specified in SLD / SECT DRG / BOQ):

The connection between GIS and high voltage cable at GIS end shall be done through cable termination / cable sealing end. GIS SF6 to air bushing shall be polymer type only. 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.

For transformer end connection the cable termination on structure shall be provided outdoor, if specified in schedule of requirements.

When the SF6 to the bushing of an oil-insulated transformer / reactor is connected, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's /reactor's foundations are absorbed by the expansion fittings.

3.11.2 GIS to Line:

400, 220, 132 kV class: by GIS SF6 to air bushing to line termination gantry by conductor. GIS SF6 to air bushing shall be polymer type only. (As specified in SLD / SECT DRG / BOQ.)
OR
220, 132, 66 kV & 33kV class: by GIS to XLPE cable (220 kV – single or twin, 1C, 1200 mm^2, 132 kV - single or twin, 1C, 1000 mm^2, 66 kV - single or twin, 1C, 630 mm^2), 33 kV – 3C, 500 mm^2 to line termination gantry by conductor. (As specified in SLD / SECT DRG / BOQ.)

3.11.3 SF6 GIS to XLPE Cable Termination:

Cable termination kit (CSE) shall be supplied by GIS OEM/EPC contractor. The ducts and the casing shall be suitable f or the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.
The SF6 GIS to XLPE cable termination shall conform to IEC-859 (latest edition). The provision shall be made for a removable link. The gap created when the link is removed & should have sufficient electric strength to withstand the switchgear high voltage site tests.
The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer. All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.
The opening for access shall be provided in each phase terminal

enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The typical arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall be submitted along with offer.

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

The design of the cable end box shall fully comply with the IEC standard. The type and size of cable is specified. All end cable modules shall be suitable for connecting single core, XLPE specified cable.

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. Provision shall be suitable for terminating GETCO Approved cable.

3.12 Local Control Cubicle (LCC):

3.12.1 General

One local control cubicle (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.

The LCC shall be mounted separately as shown in tender drawing in LCC room only (LCC mounted on GIS module/bay is not allowed). The LCCs 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 switchgear in front of the related circuit breaker.

LCC & GIS modules shall be supplied with readymade plug in socket wiring & ferruling to avoid much wiring during commissioning.

The LCCs shall be installed indoor/ outdoor and care must be taken with the design to ensure that all LCCs are drip and splash proof. The LCCs shall also be dust and vermin proof. LCC shall comply degree of protection class IP-42 for Indoor & IP-55 for Outdoor installation according to IEC60529. 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.

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

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

Safe station operation is ensured through following base functions.

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

3.12.2 Required features for conventional Local Control Cubicles (LCCs):

The LCCs shall be provided with following basic requirements:

a) Dual DC supply arrangement shall be provided.
b) 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 switch 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. shall be provided by way of MFM
- Contact rating of each Control switch shall be matched with respective switchgear DC load requirement.
- Each Control switch / Interposing relay / other component utilized in scheme shall have at least one set of spare contact which are utilized in scheme over and above all the interfaces of Local as well as Remote.

c) Any interposing relays and control switches associated with the circuit breakers disconnect switches, grounding switches etc.
d) The alarm and indication for devices specified e.g. gas, DC & AC supervision.
e) Fuses and links. These shall be installed in the interior of the LCCs
f) Terminal blocks for the terminating and marshalling 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.
g) 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.
h) A fluorescent lamp and a duplex convenience outlet rated 230 V AC, 15 amps with ground fault interrupter shall be installed in each LCC.
i) The Local control cubicle shall be fitted with pre wired interface terminal blocks for connection to user’s control & protection panels. The interface includes CT & PT inputs for protection & Measuring system, Protection trip 1 & 2 signals, Aux switch contacts etc.
j) Control Switching Device (CSD) for Circuit Breakers shall be accommodated in LCC only and not in Control & Relay Panel (CRP).

k) Following minimum numbers of potential free contacts over and above the breaker scheme shall be provided to meet the requirements of SCADA:

For total control, monitoring, supervision and operation from SCADA system potential free contacts shall be provided for each and every interface of Switchgear status, Control, Monitoring, Interlocking, Alarms, Troubles etc. and all other interfaces considered in LCC which are mandatory.

[I.] 33 kV, 66 kV, & 132 kV CB:

1) Pressure switch shall be provided with following minimum numbers of potential free contacts for breaker gas monitoring *in SCADA / control panel* over and above provided for scheme.
   (a) SF6 gas pressure normal – *minimum* 1 NO or 1 NC plus one spare
   (b) SF6 gas pressure low – *minimum* 2 NO or 2 NC plus one spare
   (c) SF6 gas pressure lockout - *minimum* 2 NO or 2 NC plus one spare
   (d) **Zone Trip' level – Will be decided during detail Engineering of LCC drawings**

2) Following minimum numbers of potential free contacts are required to be provided for breaker monitoring in SCADA / control panel; over and above provided for breaker scheme:

   (a) Breaker spring charge – *minimum* 2 NO or 2 NC plus one spare
   (b) Control supply DC1 & DC2 fail, Motor MCB Trip, CB AC supply fail indication contacts Plus one spare.
   (c) Local remote switch – *minimum* 1 NO or 1 NC plus one spare for each position i.e. Local & Remote
   (d) CB ready status for Auto reclose for 145 kV - *minimum* 1 NO or 1 NC plus one spare
   (e)**TNC Switch - minimum 3 plus one spare for each position i.e. Trip & close**
   (f) **Overload contact - minimum 1 NO or 1 NC plus one spare**
   (g) ***Other interfaces if any***

3) Similarly, potential free contacts for SF6 Gas monitoring of other switchgears and compartments as per requirement.

In any condition scheme requirement shall be fulfilled.

[II.] 220 KV CB & 400 kV CB:

1) Pressure witch shall be provided with following minimum numbers of potential free contacts for breaker gas monitoring status; over and above provided for breaker scheme:

   (a) SF6 gas pressure normal – *minimum* 2 NO or 2 NC plus one spare
   (b) SF6 gas pressure low – *minimum* 3 NO or 3 NC plus one spare
   (c) SF6 gas pressure lockout - *minimum* 3 NO or 3 NC plus one spare
   (d) Zone Trip' level – Will be decided during detail Engineering of LCC drawings

2) Following minimum numbers of potential free contacts are required to be provided for breaker monitoring in SCADA / control panel; over and above provided for breaker scheme:

(a) Breaker spring charge – *minimum* 3 NO or 3 NC plus one spare
(b) CB ready status for Auto reclose -3NO or 3NC plus one spare
(c) Pole Discrepancy Operated - *minimum* 3NO or 3NC plus one spare
(d)Control supply DC1 & DC2 fail, Motor MCB Trip, CB AC supply fail indication contacts plus one spare.
(e) Local remote switch – *minimum* 1 NO or 1 NC plus one spare for each position i.e. Local & Remote
(f) TNC Switch - minimum 3 plus one spare for each position i.e. Trip & close
(g) Overload contact - minimum 1 NO or 1 NC plus one spare
(h) Other interfaces if any

3) Similarly, potential free contacts for SF6 Gas monitoring of other switchgears and compartments as per requirement.

In any condition scheme requirement shall be fulfilled.

3.12.3 Wiring Requirements

i. Each circuit breaker shall have control suitable for operation on 110 V/220 V 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.
ii. Wiring shall be complete in all respects to ensure proper functioning of the control, protection, and monitoring and interlocking schemes.
iii. DC circuit for trip coil 1 & 2 shall be wired separately.
iv. Wiring shall be done with flexible 1100V grade, FRLS, PVC insulated, switchboard wires with minimum 1.5 mm^2 stranded copper conductor however, based on functional requirement higher size shall be provided. *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.*
v. Each wire shall identify at both ends with permanent markers bearing wire numbers as per Contractor's wiring diagram.
vi. Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
vii. *Minimum 1 set of spare contacts as utilized contacts shall be provided for each and every component of LCC whose contacts are utilized in schematics.*
viii. All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired up to terminal blocks in the control cubicle.
ix. 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, auxiliary AC & DC supply shall be disconnecting link type.
x. Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
xi. 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.

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

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

xiv. 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 cubicles or terminal boxes.

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

xvi. 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.

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

xviii. 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.

3.12.4 Connections within the GIS and their LCCs:

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.

All cables shall be shielded and adequate for their application (indoor / outdoor). The cables shall be fire retardant low smoke.

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

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.

3.13 Name plates:

Name plates of the following types shall be furnished in a convenient central location to provide information for operation and maintenance.

a) 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.

b) GIS Rating / Name plate:

Manufacturer's name & address, type & designation, Sr. No, 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

c) 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.

d) 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.

3.13.1 Bidder shall specify the number of skilled / semi-skilled / unskilled persons, supervisors and Engineers required to be deputed for complete erection, testing, commissioning of GIS.

3.14 Type Tests:

Following type test reports from NABL laboratory, as specified in IEC standard 62271 – 203 & 62271-100 (amended up to date) shall be submitted for the offered type, rating of GIS invariably with the technical bid. Bid without type test reports will not be considered for evaluation. The type test reports shall not be older than 15 (Fifteen) years and shall be valid as on the last date of submission of bid.

1. Tests to verify the insulation level (Lightning impulse, switching impulse and power frequency withstand test with PD in line with IEC 62271-203.
2. Dielectric tests on auxiliary circuits.
3. Tests to prove the radio interference voltage (RIV) level (132 kV to 400 kV class)
4. Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
5. Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
6. Tests to verify the making and breaking capacity of the included switching devices.

A. Circuit breakers

i. Basic Short circuit duty tests (T10, T30, T60, T100a, T100s)
ii. Short line fault test (L60, L75, L90)
iii. Single phase test
iv. Out of phase making & breaking test
v. Capacitive current switching test
vi. Shunt reactor current switching test (For 220kV & 400KV Class)

B. Dis- connectors

i. Bus Transfer Current Switching Test

C. Fast acting earth switch

i. Short circuit making test
ii. induced current switching test

7. Tests to prove the satisfactory operation of the included switching devices.
8. Tests to prove the strength of enclosures.
9. Verification of the degree of protection of the enclosure.
10. Gas tightness tests
11. Electromagnetic compatibility tests (EMC).
12. Additional tests on auxiliary and control circuits.
13. Tests on partitions.
14. Tests to prove the satisfactory operation at limit temperatures.
15. Tests to prove performance under thermal cycling and gas tightness tests on insulators.
16. Corrosion test on earthing connections (if applicable).
17. Tests to assess the effects of arcing due to an internal fault.
18. Tests on solid dielectric components (operating rods, spacers, etc)
19. Seismic test / Calculation
20. Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)
21. Tests on CTs and PTs (On Primary & secondary) As per IEC 61869
22. Test on surge arresters
23. Test on control switching devices/PIR
24. **Type test for SF6 to Air bushings *#**

***The type test validity of SF6 to Air bushings is as per GIS type test validity i.e.15 Years**
 # Validity for Hollow Insulator for SF6 to Air bushings is 10 years.

IMPORTANT NOTE:

1. All the type test report as per IEC 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 otherwise GIS of higher rating as per submitted type test reports shall be offered. Bidder shall invariably confirm to carry out the required type test/s, before commencement of supply, without affecting delivery schedule, free of cost, at NABL approved laboratory.

2. In case of non-submission of some of the type test reports, or type test reports of which validity is over, the bidder shall submit pending type test report/s from NABL accredited laboratory, in the event of an order, before commencement of supply without affecting delivery schedule, free of cost to GETCO. Confirmation for above shall be invariably submitted along with technical bid.

NOTES for various bidders:
If GIS is offered from foreign country, valid type test reports from their offered principle (foreign) country works will be considered.

If GIS is offered from India & submitted Type test reports of principle (foreign) country works, **then bidder has to submit confirmation that Indian manufacture will provide same design and follow same process by which parent company /collaborator has manufactured the GIS equipment**.

Clause 3.15 Routine / Acceptance Testing:

During manufacture and on completion, all equipment shall be subjected to the Routine tests as laid down in IEC Standard IEC 62271-203. All the acceptance tests shall be carried out in presence of GETCO representative on complete bay of GIS for each type of modules Tests shall include the following:

1. Dielectric test on the main circuit.
2. PD test
3. **DCRM test**
   1) Dynamic contact resistance measurement for each breaker shall be obtained with the help of a suitable DCRM kit to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating control voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be arranged by the EPC contractor at his own cost. After completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to GETCO.
   2) During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and open operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics including velocity, injected current, trip/close coil current shall also be recorded along with DCRM test.
4. Tests on auxiliary and control circuits.
5. Measurement of the resistance of the main circuit.
6. Tightness (leakage) test.
7. Design and visual checks.
8. Functional tests
9. Tests on auxiliary circuits, equipment and interlocks in the control mechanism.
10. LCC – Complete functional & interlock test as per approved drawings with LCC

duly connected to respective Bay GIS module in all respect.

11. IR test
12. HV test
13. Test on CTs & PTs
14. Test on surge arrester
15. Test on control switching devices/PIR
16. PD sensor sensitivity check for each PD sensor during commissioning before HV & PD test.

3.16 Test Certificates:

a. Certified reports of all the tests carried out at the works shall be furnished in required number copies for approval of the Owner.
b. The equipment shall be dispatched from works only after receipt of Owner/ Purchaser's written dispatch clearance & approval of the test reports.
c. Routine test certificates of bought out components shall be furnished.
d. 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.

3.17 Tests after installation of complete GIS at Site:

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. 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. Test on control switching devices/PIR
16. DCRM test (as per Clause 3.15.3 A & B)
17. PD sensor sensitivity check for each PD sensor during commissioning before HV & PD test.

3.17.1 Required test equipment

During the on-site 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.

Method of Statement (MOS) / procedure of ON-SITE high voltage testing with PD measurement shall be submitted.

3.18 Spares:

Bidder shall supply spares as indicated in BOQ of respective tender.

3.19 Drawings, Data, Manuals & calculations:

Drawings, Data, calculations and Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions on Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

To be submitted with the Bid:

1. Schedule of Guaranteed Technical Particulars
2. All the type test reports as per specification.
3. Typical general arrangement drawings of the equipments indicating space requirement, room dimensions, crane capacity etc.
4. Technical Specifications of equipment and special tools explaining construction features, principle of operation, special features etc.
5. 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 SF6 gas & decommissioning, estimated time schedule for installation & commissioning, bill of materials, and any other documents required for successful commissioning & operation of complete GIS.

6. Control and protection:
   Block & principle diagram showing proposed scheme, layout & equipment arrangement drawings, catalogues & brochures of offered devices.

   In absence of above technical documents, bid shall be evaluated accordingly.

Successful bidder shall submit 3 sets of spiral bound volume of following drawings & data for approval/ information before commencement of supply:

1. A comprehensive Manufacturing Quality assurance plan with effective quality assurance system. (MQP)
2. Field Quality plan indicating instruction & procedures sequenced for storage, assemble, maintenance and disassembly. (FQP)
3. Gas Schematic diagram (GAS SLD)
4. GIS general arrangement drawings (Plan & section view) including 3D drawing
5. GIS component drawing
6. Interface modules drawing for GIS extension
7. Rating and name plate drawing

8. SF6 to air bushing /Cable termination drawing
9. Bay wise Bus duct drawings including 3D drawing (Plan & Section views for all offsets/bends)
10. LCC GA & Schematic drawings
11. GIS support structure drawing
12. GIS platforms & walkway drawings
13. GIS key diagram enlisting and marking each and every GIS module clearly & separately identifiable (Indoor & Outdoor)
14. Method Statement along with sequential instruction for dismantling and assembling of all major components of GIS exhibiting service continuity requirement
15. Conductor detachment procedure for GIS and Busbar.
16. Capacity calculation of EOT crane for GIS hall
17. Method statement/ procedure of ON SITE high voltage testing with PD measurement and Switching Impulse test
18. Seismic Analysis Report
19. Study report of VFTO
20. Assemble and maintenance clearance requirements.
21. Dimensional general arrangement drawing showing disposition of various fittings.
22. Structure Plan with details and loading
23. Foundation plan indicating loadings for all GIS equipment, supporting structure and anchor bolt arrangements.
24. Assembly drawing for erection at site with part numbers and schedule of materials Transport/shipping dimensions with weights.
25. Gas system installation procedures and gas handling procedures.
26. Grounding arrangement and ground bus details including Manufacturer's recommendation on Grounding of reinforcement bars of Column foundation.
27. Calculation of Voltage rise for GIS enclosure
28. Calculated point to point resistance for each assembly.
29. Design Calculations for Bus-bar sizing, Short circuit forces and vibration on Bus-bar & each equipment, thermal stability and losses.
30. Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
31. Operating instruction & manuals for GIS and its accessories
32. The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment.
33. The bidder shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.

The bidder may note that the drawings, data and manuals listed herein are minimum required only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.

All drawings shall be prepared by using AutoCAD and documents shall be generated using Electronic version. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in AutoCAD 2010 and MS office format as applicable for Owner's future reference. Also AutoCAD version of Main GA drawings is to be submitted for Owner's layout finalization.

3.20 Maintenance:

The operational integrity of the GIS switchgear shall not subject 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. 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. Provision of functional testing of the close and trip coils, auxiliary switches, pressure and control switches etc. shall be provided. Following minimum maintenance period shall be accepted.

(a) Circuit breaker: 5000 closing and opening or 20 interruptions 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.

The bidder shall provide the services of experienced persons, supervisors, engineers, experts, etc., for complete specified work for satisfactory operation. Successful bidder shall depute his expert to site annually for the period of FIVE years from date of commissioning, to inspect GIS for carrying out status evaluation of GIS performance. This is intended to share the operational challenges and confirm the maintenances followed by GETCO.

The bidder shall have dedicated localized after sales & service team which should be capable any activity to operate complete GIS satisfactorily.

3.21 GIS Building:

The GIS building, if it is a part of schedule of requirements, shall comply with the requirements of Civil specifications.

For 400/220 KV sub-station, 220 /66 KV sub-station and 220/33 KV sub-station, two GIS buildings are required.
For 66/11 KV sub-station, only one GIS room is required.

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.

3.22 Design information to be submitted by bidder:

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

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

3.23 Guaranteed and technical particulars as called for in attached SCHEDULE 'A' shall be furnished along with the technical bid.

3.24 Training:

Training to Ten (10) persons of GETCO on construction, installation, commissioning and O&M shall be imparted by bidder free of cost. Duration 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.

Bidder shall at his cost arrange for the above training facilities and in addition shall bear all living expenses plus inland travel expenses of all the trainees. The Purchaser shall only pay to and fro passage of the trainees.

3.25 Shipment storage and installation:

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities.

All equipments shall be suitably packed in wooden box with proper marking on each item (Bay & phase wise) 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. 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.

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.

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.
As far as possible, transshipment should be avoided.

Impact recorders (Accelerometers) shall be provided on the packages to confirm that GIS 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.

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

Blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site which may on later stage necessarily be used during repair and maintenance shall remain the property of GETCO. Balance blanking plates, caps, seals, etc shall be returnable to the contractor.

If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period.

Any seals, gaskets, ‘O’ rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer’s works for repair.

The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungal growth. The scope of providing the necessary protection, storing on raised platform, as required etc. is included in the works to be performed by the contractor. Cost of the raised platform for temporary storage is deemed to be included in overall cost. The raised platform needs to be made ready before arrival of GIS equipment at site. The contractor may use the available storage areas at site with permission of site in charge.

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

For the purpose of release of payment linked to receipt and physical verification in case of GIS equipment it shall mean random opening and physical verification of one number of packing unit of each type of main equipment (i.e. GIS CB/ISO/ES/PT/LA etc.) for each voltage level. Thereafter proper re-packing of the GIS unit shall be ensured as per manufacturer recommendation.

Installation

During Civil works of GIS Hall including internal cable trench shall be completed along with GIS hall sealing in all respects before taking up the installation and it shall be ensured that Ventilation System is operational and all dust and dirt in the hall are removed. The GIS hall needs to be in positive pressure before starting Installation.

The installation area shall be secured against entry of unauthorized personnel. Only certified manufacturer's engineer and supervisor shall undertake the erection works. Engineers and supervisors of the manufacturer shall submit authorization and competency certificate to GETCO.

Un-packaging of GIS modules shall be done outside the GIS hall and in no case module to be taken inside GIS hall with packing.

All assembly work shall be done by qualified personnel only who are to be identified and list submitted to GTECO site before starting of erection work.

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

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

Installation of flanges shall be done immediately after removal of transport covers and O Rings shall be properly stored and taken out only before installation. O Rings are also to be cleaned before use with manufacturer authorized cleaning agent.

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

Approved Field Quality Plan shall be followed during site work

3.26 Quality Assurance:

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

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.

(ii) Requirements for New bidders with proposed manufacturing facilities in India and foreign bidders under JV:

(1) Bidder is allowed to source critical components of GIS from parent company of outside India in line with QR Criteria and Government guideline. During manufacturing GETCO will carry out stage inspection at bidder's factory as per approved MQP. This bidder shall have all time real factory in India.

(2) In-house laboratory must be established within the factory for carrying out FAT to be carried out at bidder's works only. No FAT will be allowed for any of the test to be offered at any other laboratory than bidders works even accredited by NABL.

(3) Bidder is not allowed to re-assemble GIS equipment or bay by mere flange assembly.

(4) Bidder shall have to offer FAT of (supplied GIS from principal factory) at principal factory works and for balance (GIS supplied from India) from their Indian factory works.

(5) Bidder shall not be eligible to apply for any another category for next tenders until their product is rolled out from India works and have completed satisfactory operation of six months.

BIDDING SCHEDULE
(To be filled in and signed by the Bidder)

SCHEDULE 'A'

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR GAS INSULATED SUBSTATION

The bidder must fill up all the points of GTP for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

Sr No	Particulars	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**	**400 kV**	**220 kV**	**132 kV**	**66 kV**	**33 kV**
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	Ambiant Air Temp. in Deg. C					
ii	Max Temp. in Deg. C					
iii	Min Temp. in Deg. C					
iv	Daily Average Temp. in Deg. C					
v	Solar Radiation W/sq mtr					
vi	Altitude above MSL, in mtr					
vii	Pollution class					
viii	Creepage distance, in mm/kV					
ix	Relative humidity					
x	Condensation					
xi	Vibration level					
xii	Noise level					
xiii	Induced Electromagnetic Disturbance, in kV					
xiv	Seismic conditions					

a	Vertical					
b	Horizontal					
13	**Enclosure**					
i	Code of pressure vessel					
ii	Type of manufacturing					
iii	Design temperature in Deg.C					
iv	Material					
v	Material grade & applicable standard					
vi	Outside diameter in mm					
vii	Minimum Wall Thickness, in mm					
viii	Painting Shade & Thickness					
a	- External					
b	- Internal					
ix	Degree of Protection					
x	Inductance in H/mt					
xi	Capacitance in pF/mt					
xii	Resistance in Ohm/mt					
xiii	Expansion Bellow					
a	Material					
b	Min allowable adjustable displacement Longitudinal Transverse					
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					
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**	**400 kV**	**220 kV**	**132 kV**	**66 kV**	**33kV**
i	Highest System voltage in kV					
ii	Rated voltage of System in kV					
iii	Rated voltage of Equipment in kV					
iv	Rated Insulation level Phase to Earth and between Phases					
a	One Min Power Frequency withstand voltage kVrms					
b	Switching impulse withstand voltage, kVp					
	- Phase to Earth					
	- Between Phases					
c	Lightning Impulse withstand voltage, kVp					
iv	Rated Frequency					

v	Rated current in Amp					
vi	Rated current at 50 °C (equipment) in Amp					
vii	Rated current at 50 °C (bus bar) in Amp					
viii	Rated short circuit withstand current kArms					
a	Duration in sec					
b	Peak, kAp					
ix	Enclosure withstand time for an internal fault in sec.					
x	Estimated total energy loss at					
	100 % of rated capacity					
	75 % of rated capacity					
	50 % of rated capacity					
	25 % of rated capacity					
xi	Measures taken to minimize Over Voltage					
xii	Phase labeling					
xiii	**Auxiliary supply (AC Voltage, Frequency; DC voltage)**					
	- Operation					
	- Control					
	- Illumination & heater					
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**	**400 kV**	**220 kV**	**132 kV**	**66 kV**	**33 kV**
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, in kg	
iii	Quantity of SF6 Gas of **largest** compartment GIS at filling pressure, in kg	
iv	Nos of Gas compartments	
v	Quantity of SF6 Gas of **individual** compartment GIS at filling pressure, in kg	
vi	Maximum permissible dew point, in Deg.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	in MPa in kG/sqcm
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, in	

	% per year					
xv	Density Monitor to be provided for each Individual gas compartment.					
20	**Circuit Breaker**	**400 kV**	**220 kV**	**132 kV**	**66 kV**	**33 kV**
i	Applicable standard					
ii	Type					
iii	Designation					
iv	Operating Mechanism type					
v	Nos. of phases					
vi	Rated current in Amp					
	- **Feeder bay CB**					
	- **Bus coupler CB**					
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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					
vi	Rated peak short time Current, kAp					
vii	Rated bus charging current, in Amp					
viii	Type of contacts					
ix	Material of contacts					
x	Current Density at minimum cross section (A/mm^2)					
xi	Rated lightning impulse withstand voltage across the open gap, kVp					
xii	Rated Power Freq withstand voltage across the open gap, kVrms					
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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 lightning impulse withstand voltage across the open gap, kVp					
vi	Rated Power Freq withstand voltage across the open gap, kVrms					
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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**	400 kV	220 kV	132 kV	66 kV	33 kV
	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**	400 kV	220 kV	132 kV	66 kV	33 kV
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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 250 Amps					
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**	400 kV	220 kV	132 kV	66 kV	33 kV
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**	400 kV	220 kV	132 kV	66 kV	33 kV
i	Nos of XLPE cable can be terminated					
ii	Type of cable termination required					
30	**GIS to Transformer connection**	400 kV	220 kV	132 kV	66 kV	33 kV
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					

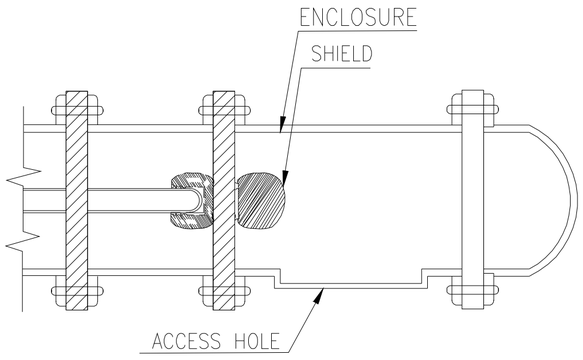
ii	Maximum down time for degassing and re-filling the biggest compartment	
iii	Time between two refilling of SF6 gas.	
iv	Recommended period for overhauling	
v	Operation and Maintenance manual attached	
vi	Nearest local service centre	
vii	Minimum time of availability of local service	
viii	Availability 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?	

GIS EXTENSION PROCEDURE

CONCEPTUAL GIS INTERFACE MODULE DRAWING

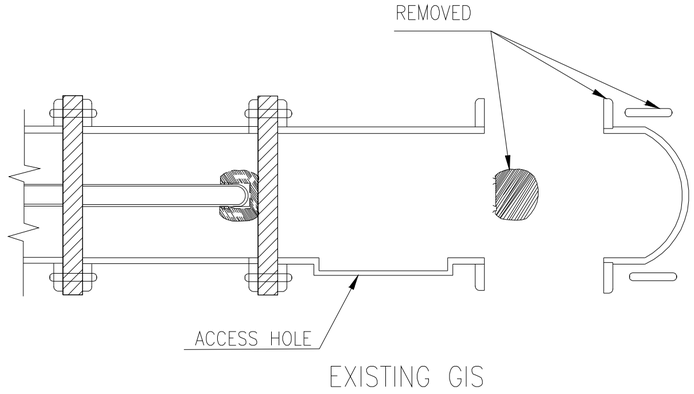
1

NORMAL CONDITION



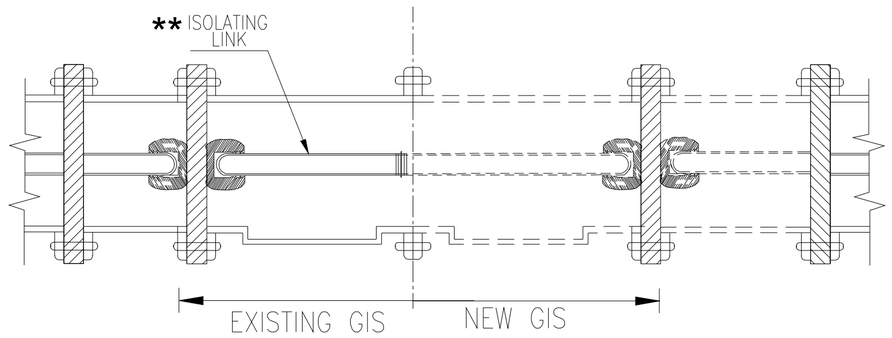
2

CONDITION DURING EXTENSION OF GIS



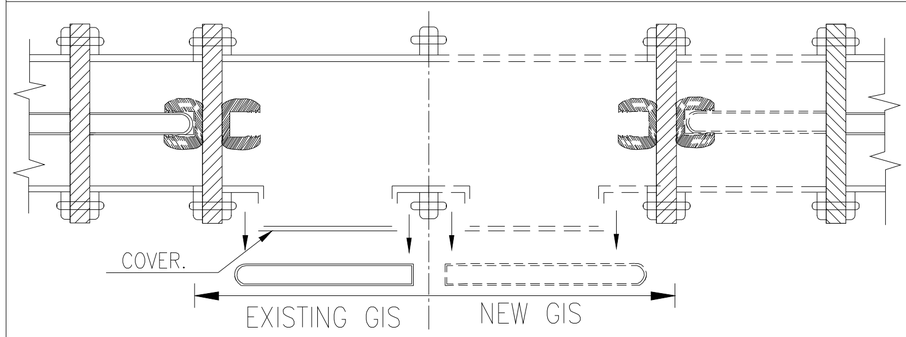
3

AFTER EXTENSION



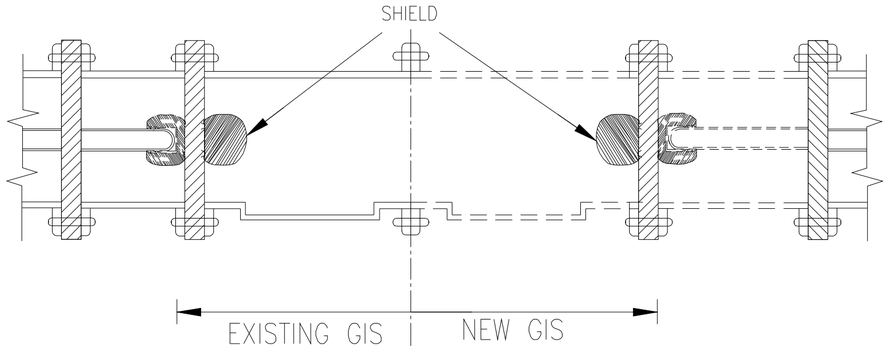
4

REMOVAL OF ISOLATING LINK FOR HV TEST



5

HIGH VOLTAGE TEST SITUATION ON NEW/EXISTING GIS



NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH MODEL TECHNICAL SPECIFICATION FOR GIS.
2. THIS IS A CONCEPTUAL DRAWING ONLY, INTERFACE MODULE DRAWING FOR DIFFERENT PROJECTS SHALL BE DEVELOPED BY RESPECTIVE GIS MANUFACTURERS.
3. ** LOOSE ISOLATING LINK SHALL BE PROVIDED BY EXISTING GIS MANUFACTURERS.

GUJARAT ENERGY TRANSMISSION CORPN.LTD.
S.P.VIDYUT BHAVAN, RACE COURSE,
VADODARA - 390 007

TITLE: GIS INTEFACE MODULE DRAWING

DRG. NO:	REV:
GETCO/GIS/INTERFACE/MODULE/01	R0