

**TECHNICAL SPECIFICATION FOR SF-6 GAS INSULATED
METAL ENCLOSED SWITCHGEAR (GIS).**

1.0 GENERAL CHARACTERISTICS:

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its live constituent parts. It should be designed for indoor/outdoor (as specified) application with meteorological conditions at site. All parts of the switchgear should be single / three phase enclosed.

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

As the 220/110/66/33kV GIS is likely to be extended in future, the contractor shall make available during detailed engineering stage, all details such as cross section, gas pressure, extension conductor piece to extend existing bus bar and all required material etc. for design of adopter in future for extension of GIS on either side. GIS must be complete in all respects for future extension and there should be no requirement of any component/material of GIS from the present supplier at the time of future extension by another GIS manufacturer.

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

Sl. No.	Technical particulars	220 KV System	110 KV System	66 KV System	33 KV System
a)	Rated voltage	245 kV (rms)	123	72.5 kV (rms)	36
b)	Rated frequency	50 Hz	50Hz	50 Hz	50Hz
c)	Grounding	Effectively Earthed	Effectively earthed	Effectively earthed	Effectively earthed
d)	Rated power frequency withstand Voltage (1 min) line to earth	460 kV (rms)	230 kV (rms)	140 kV (rms)	70 kV (rms)
e)	Impulses withstand BIL (1.2/50/mic. Sec) line to earth	+ ₋ 1050 KVp	550 kVp	325 kVp	170 kVp
f)	Rated short time withstand current (1 sec)	50 kA (rms)	40 kA (rms)	40 kA (rms)	31.5 kA (rms)

g)	Rated peak withstand	125 Ka	100 kA	100 kA	78.75 kA
	current	(peak)	(peak)	(peak)	(peak)
h)	Guaranteed maximum gas losses for complete installation as well as for all individual sections in %	As per IEC-62271-203	As per IEC-62271-203	As per IEC-62271-203	As per IEC-62271-200
i)	Rated current normal/at site (at 50°C design ambient temperature)	As per BID schedule			
j)	Seismic level	Zone-II, as per IS-1893,Year 2002			

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 IEC-62271-203/ IEC-62271-200(for 33kV GIS)publications including their parts and supplements as amended or revised to date.

2.0 CODES AND STANDARDS:

- 2.1 Except as noted, all the equipments offered shall conform to the requirements of the latest editions of relevant standards published by the International Electro-technical Commission (IEC) . One set of the above IEC Standards in English version are to be supplied by the bidder to the owner at the time of submission of the bids.
- 2.2 The bus ducts shall be rated in accordance with and satisfy the requirements of the IEC standard. The capabilities of the bus ducts shall be given on a symmetrical current basis and the relevant IEC standards.
- 2.3 Compliance by the manufacturer with the standards of this specification does not relieve him from the responsibility of supplying switchgear and accessories of proper design, electrically and mechanically suitable for fulfilling the operating guarantees at the specified service conditions.
- 2.4 If, in the opinion of the bidder, there are any conflicts between the Codes & Standards, the data sheets and the specifications, the contradictions shall be brought to the attention of the owner. However, the requirement of this specification shall govern.

3.0 DEFINITIONS:

3.1 Assembly:

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

3.2 Bay:

Bay refers to the area occupied by one Circuit Breaker and associated equipments used to protect one Transformer/ feeders/ bus coupler in double bus scheme.

3.3 Compartment:

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

3.4 Enclosure:

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

3.5 Manual operations:

Manual operation means operation by hand without using any other source of power.

3.6 Module:

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

3.7 Reservoir:

When used in conjunction with GIS equipment reservoir refers to a large gastight volume.

SECTION-A

DESIGN AND PERFORMANCE REQUIREMENT OF 220kV / 110kV/66kV/33kV GAS INSULATED SWITCHGEAR AND ACCESSORIES

SECTION-A1:

1.0 DESIGN AND PERFORMANCE REQUIREMENTS:

- 1.1 The equipment offered shall be designed to operate satisfactorily and meet all requirements specified in Data Sheet A-1 of Section-B and site conditions.
- 1.2 The equipment shall be designed and manufactured in accordance with best engineering practice and shall be such as has been proved to be suitable for the intended purpose.

2.0 245kV, 110kV, 72.5kV & 33kV High voltage Circuit Breakers:

- 2.1 The equipment offered shall be designed to operate satisfactorily and meet all requirements specified in Data Sheet-A1 of Section-B.
- 2.2 The circuit breakers shall be capable of meeting the following duty requirements:
 - a) Interrupting symmetrical faults of magnitude specified in Data Sheet-A1.
 - b) Magnetising current breaking capacity specified in Data sheet A1 with maximum over voltage factor of 2.3 pu.
 - c) Line charging current breaking capacity specified in Data sheet A1 at 25 kV at no load with a maximum over voltage factor of 2.3 pu.
 - d) Short line fault current (Kilometric fault) interruption capacity with the source impedance behind 245kV, 110kV, 72.5kV & 33kV bus equivalent to a fault current 50/40/40kA RMS & 31.5kA RMS respectively.
 - e) Circuit breakers shall be rated for the operating duty, total break and make time specified in Data Sheet-A1.
 - f) Circuit breakers shall be provided with a minimum of 10 NO + 10 NC + 3 make before break auxiliary potential free contacts per pole exclusively for PURCHASER's use in external interlocking circuits.

- g) SF-6 breakers shall be of the single pressure puffer type/Vacuum interruption type.
- h) The breaker shall be virtually maintenance free.
- i) Circuit breakers shall be electrically interlocked with the isolators/ earthing switches in accordance with the PURCHASER's safety interlocking scheme. Design of circuit breakers shall be such that contacts shall not close automatically upon loss of gas pressure or of oil/air pressure (hydraulic/pneumatic mechanisms).
- j) The 245kV circuit breaker shall be isolated phase and/or three phase metal clad type for independent pole operation in case of 245kV Breaker and 3 pole operation (Gang operated) in case of 110kV, 72.5kV & 33kV Breaker. The circuit breaker shall have duplicate trip coils. They shall be electrically, mechanically, hydraulically and pneumatically trip free, where applicable, and anti-pumping with either or both of the duplicate trip circuits connected. A manual trip device shall be provided to open the breaker under control DC failure condition.
- k) Each circuit breaker shall be equipped with electrically separate two shunt trip systems per mechanism. If two trip coils are arranged to share a common magnetic circuit, the operation of either coil shall be independent of other, i.e., if one of the trip coils has been damaged or destroyed, it shall not affect the operation of the other.
- l) Facilities shall be provided with switchgear to enable timing tests to be carried out after switchgear has been charged with SF-6 gas. It should not be necessary to open up any gas section to make test connection to the circuit breaker primary terminals.
- m) The circuit breaker shall normally be suitable for remote electrical operation at 220V DC with either or both of the duplicate trip circuits connected. Pole discrepancy tripping shall be provided.
- n) The trip circuits including intermediate trip relays and coils shall be supervised and an alarm annunciated in case of a defective trip circuit for 245kV Circuit Breaker.
- o) The Circuit breaker shall meet all the double circuit transmission line 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.

Note: 33kV Circuit Breaker of Vacuum type is also acceptable.

3.0 HIGH VOLTAGE DISCONNECT SWITCHES (ISOLATORS) AND EARTHING SWITCHES:

3.1 245kV, 110kV, 72.5kV & 33kV Disconnect Switches (Isolators):

- (a) 245kV, 110kV, 72.5kV & 33kV isolators shall have a short time three second withstand rating of 50/40/40kA and 31.5kA rms respectively. Hand operated earth switches for maintenance shall be provided as indicated in single-line diagram and Data Sheet-A1 of Section-B. Isolators shall be motor operated and controlled from local control panel and from a remote point. Incoming isolators shall be provided with motor operated, high speed earthing switches as indicated in single-line diagram.
- (b) The isolators shall be capable of switching the capacitive charging current of switchgear and closed loop currents on bus bar changeover. The bus isolator shall be capable of carrying out 200 switching (200 close + 200 open) operations at rated current without requiring maintenance.
- (c) Disconnectors shall be suitable to switch the bus charging currents during their opening and closing and shall conform to all three test duties viz TD1, TD2 and TD3 as per Annexure-F of IEC: 62271-102. They shall also be able to make and break rated bus transfer current at rated bus transfer voltage which appears during transfer between bus bars in accordance with Annexure-B of IEC: 62271-102. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

3.2 Earthing switches:

- a) The 3-pole group operated high speed earthing switches shall be provided on the incomer side of feeders as per Data Sheet A1 of Section-B and as indicated in single line diagram. These earthing switches shall be motor operated and shall be suitable for local/remote operation fitted with stored energy device/spring to enable high speed of travel. Earth switch shall be fully interlocked with the associated isolator. In addition, high speed earthing switch shall be provided with an interlocking electromagnet for interlocking with remote end breaker.

- b) The 3-pole group operated maintenance earthing switches shall be manual cum motor group-operated type. The motor operation of the maintenance earthing switches shall be possible from local control panel.

4.0 HIGH VOLTAGE CURRENT AND VOLTAGE TRANSFORMERS:

4.1 245kV, 110kV, 72.5kV & 33kV Current Transformers:

Current Transformers (CTs) shall be provided by the BIDDER for each phase of the 245kV, 110kV, 72.5kV & 33kV GIS as per single-line diagram. The secondary terminals of CTs shall be brought out in weatherproof cabinet and facility shall be provided for short-circuiting and earthing the CT secondary at the terminal box. The CTs shall be designed to operate satisfactorily and meet all requirements specified in Data Sheet-A1 of Section-B and shall conform to IEC-61869-1 & 2.

4.2 245 kV, 110kV, 72.5kV & 33kV Voltage Transformers:

Voltage Transformers as specified in Data Sheet-A1 of Section-B shall be supplied by the BIDDER for the incomer 220 kV cables and at the 245kV, 110kV, 72.5kV & 33kV buses. The VTs shall be designed to operate satisfactorily and meet all requirements specified in Data Sheet-A1 of Section-B and shall conform to IEC-61869-1 & 3.

4.3 198 kV, 96kV, 60kV & 30kV Lightning Arrestors:

Lightning Arrestors shall be provided at the 245kV, 110kV, 72.5kV & 33kV cable incomer and Transformer at GIS as per single line diagram. LA's shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The LA's shall be explosion proof.

4.4 Power Cable and Transformer exit bus duct Terminations/Interface with GIS:

4.4.1 GIS SF-6 Bus Duct Interconnection with Power Transformers:

- a) Where specified, the GIS switchgear shall be connected via SF-6 insulated duct and Air Bushings to transformers. The Air to SF-6 gas bushings will be supplied by the GIS manufacturer as a part of this contract.
- b) Compensators required for manufacturing tolerance, absorb vibrations and thermal expansions are part of the GIS supply.

4.4.2 Cable Termination:

- a) Where specified, GIS switchgear shall be connected via SF6 insulated duct and outdoor type cable end unit (cable termination chamber) to EHV cables. Some high voltage cables will be bottom entry type with suitable openings in the floor. Sufficient space must be provided on or around the switchgear to terminate and connect these cables. Suitable cable support and grounding facilities must be provided in this area.
- b) Cable connecting contact plates and the gas insulated terminal enclosure are part of the switchgear delivery. Stress cones and cable accessories are included in the cable suppliers scope. Cable termination chamber shall be supplied by GIS Vendor generally as per Fig.1 of IEC 62271-209 "*Cable connections for gas insulated metal enclosed switchgear for rated voltages of 72.5 kV and above*".
- c) Each cable feeder shall have facilities to isolate the cable end to apply a high voltage DC test probe for dielectric testing of the cable.
- d) GIS manufacturer shall be responsible for complete interface with cable terminations and shall guarantee the performance of the interface with cable terminations. The onus of accommodating a mutually agreeable solution for design and testing of this interface shall be on the GIS vendor.
- e) GIS manufacturer shall ensure that the supports of Power Cable termination chamber are designed in a manner to enable termination/ removal of the Power Cable without requiring dismantling/removal of the Cable termination chamber or its supports.
- f) 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 enclosure 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 also be submitted.

4.5 Mechanism Cabinets and Local Control Panels:

Local control panels to house all equipment to facilitate local control of breakers, isolators, and motorized earth switches shall be provided for each of the primary circuit/bay by the bidder. Each local control panel shall contain the local control and indication devices for associated circuit breakers, isolators and ground switches and DC protection fuses, links and supervisory relays.

These panels shall be used to house all relays, timers, etc., to realize interlocks among all circuit elements. Further, these panels shall be utilized for the purposes of marshalling the contacts, controls and instrumentation signals originating from gas insulated switchgear. Adequate annunciators shall be provided on the alarm for local indication. The supply of power and control cables and cabling from GIS up to local control panels shall be in BIDDER's scope. Prefabricated & terminated cable requiring minimum cable termination work at site (for interconnection between local control panel and GIS equipment) will be preferred. Control signals from remote shall be wired up to these panels. Onward cabling to individual equipment in the GIS shall be in BIDDER's scope. 20% spare terminals shall be provided for future use. The panel shall be self standing type and shall be mounted away from the GIS on the switch house floor but in the same room adjacent to each primary circuit or equipment for 220kV class GIS. For 66kV GIS mounted integrated type LCC Panels are also acceptable. The panels shall have easy access for wiring and relay/control devices.

4.5.1 Local control panels shall have following features:

- a) A mimic diagram, the discrepancy control/indicating switches and lockable local/off/remote switches mounted on or adjacent to the mimic diagram.
- b) Any interposing relays, auxiliary relays, timers as required.
- c) Indicating lamps.
- d) Fuses and links.
- e) Cable terminal blocks for terminating and marshalling auxiliary supply cables, control, indicating and alarm circuit cables from the switchgear and the remote control room.

f) A copper earth bus for connection to the station ground mat.-.

4.5.2 The electrical protection for primary circuits, i.e., feeders, transformers, busbar protection is in the Bidder scope. This protection will be mounted on panels located in a control room. All secondary control, protection and indication circuits from various individual items of SF-6 switchgear are to be cabled to local control panel. This cabling shall be provided as part of this switchgear contract. The cabling from local control panel to the remote control and relay panels is in the Bidder scope. The local control panel/marshalling kiosk shall not be directly mounted on the primary switchgear equipment.

4.5.3 The alarm and trips from the gas density/pressure monitoring devices shall be individually displayed on alarm facias mounted on the associated panels. In addition, on each panel associated with a particular primary circuit, repeat common alarms shall be provided indicating that an unhealthy condition exists on the bus bars.

The alarm facias are to be arranged in groups according to the nature of the alarm and the particular electrical phase, i.e., R, Y or B phase from which the alarm has originated. Inscriptions shall be engraved/printed on the alarm facias to identify the location of the alarm and a label shall be provided with each group to identify the nature of the alarm. The inscriptions shall be advised by the purchaser. This alarm/annunciation system shall be provided with Reset and Lamp test push buttons'.

Provision shall be made for accepting, resetting of alarm & annunciation system from remote.

Necessary provision shall be made by the supplier for giving indication for each type of fault at the remote end through potential free contacts.

4.5.4 The VENDOR shall prepare interconnection diagrams for the purpose of cabling between GIS, local control and marshallingkiosk (by VENDOR). Interconnection diagrams shall clearly show the terminal numbers on which external cables need be terminated.

4.6 The PURCHASER proposes to carry out Insulation Co-ordination/Fast Transient over voltage studies for the system. VENDOR shall furnish GIS component model parameters to enable PURCHASER to carry out these studies. VENDOR shall also review the results of the studies conducted by the PURCHASER.

SECTION-A2

0.0 CODES AND STANDARDS:

- 0.0 Except as noted, all the equipments offered shall conform to the requirements of the latest editions of relevant standards published by the International Electro-technical Commission (IEC) . One set of the above IEC Standards in English version are to be supplied by the bidder to the owner at the time of submission of the bid.
- 0.1 The bus ducts shall be rated in accordance with and satisfy the requirements of the IEC standard. The capabilities of the bus ducts shall be given on a symmetrical current basis and the relevant IEC standards.
- 0.2 Compliance by the manufacturer with the standards of this specification does not relieve him from the responsibility of supplying switchgear and accessories of proper design, electrically and mechanically suitable for fulfilling the operating guarantees at the specified service conditions.
- 0.3 If, in the opinion of the bidder, there are any conflicts between the Codes & Standards, the data sheets and the specifications, the contradictions shall be brought to the attention of the owner. However, the requirement of this specification shall govern.

SECTION-A3

1.0 AVAILABILITY REQUIREMENTS:

- 1.0 The high voltage gas insulated switchgear, bus ducts and accessories shall be designed for maximum reliability and availability.
- 1.1 The BIDDER shall ensure and specifically confirm that failure of any one component in a circuit and the subsequent repair/testing shall not require shut down/outage of any other circuit of the GIS.
- 1.2 It shall be possible to remove a component of the GIS (in particular main buses) without requiring the dismantling/shutdown of any other circuit of the GIS. Repair or replacement of any one component or set of components shall not call for simultaneous outage of both sets of main bus bars.
- 1.3 The BIDDER shall ensure and specifically confirm that while carrying out the erection, commissioning and testing of the additional bays in future, outage of the complete station will not be required.
- 1.4 The design ambient temperature considered for continuous rating of the equipment shall be 45°C.
- 1.5 Provision shall be made in the two main buses of the GIS, so that in the event of a fault in one part of one of the main buses, other part of this bus can be sectionalized by means of detachable device and taken back in service (by means of installing end covers in the healthy part of the main bus).
- 1.6 Void.

SECTION-A4

1.0 LAYOUT REQUIREMENT:

- 1.1 It is intended that the GIS shall be located indoors. The interconnection between Transformer bushings to GIS shall be outdoor and line termination to GIS shall be indoor/outdoor and will be expected to operate effectively within the extreme ambient temperature limits of +5°C & +45°C.
- 1.2 The GIS will be mounted on concrete foundations. All necessary supporting framework and base plates shall be provided by the BIDDER. Mounting details for this framework shall be enclosed with the bid.
- 1.3 The enclosed Layout plan drawing gives the space availability for the GIS at proposed sub-station. The BIDDER shall specifically review the area indicated by visiting the site and confirm suitability of the equipment offered to fit into the space shown providing enough space and access for erection, operation & maintenance and also including area required for future extensions. Deviations if any shall be highlighted in the bid with technical reasons.
- 1.4 The BIDDER shall also indicate preferred handling arrangements for the equipment offered.
- 1.5 The bidder shall submit the design & construction proposal of the building along with necessary information, data and drawings in the techno-commercial bid according to the complete requirements.

SECTION-A5

1.0 MAINTENANCE & OPERATION REQUIREMENTS:

1.1 PURCHASER's Standard Practices require that the Station Operator on routine inspection is expected to be able to check pressure gauges, breaker and disconnect switch position, etc., from permanently installed platforms and catwalk without opening doors, covers, etc. Also, when a breaker is made available for maintenance, the Station Operator is required to remove controls from the breaker, observe directly the open isolation, carry out the earthing operation, tag the isolating switches and valves and otherwise guarantee safe conditions. The operator must do this without the use of fuse-pullers, screwdrivers, portable ladders or any other tools. The platforms, catwalks, ladders and associated support structures shall be in BIDDER's scope of supply. Access to the isolating switches and in particular hand operated maintenance earthing switches should be easily available. Catwalks provided if any, shall have free access without any control/power cables hampering the working space. All mechanisms shall be such that manual operation can be carried out by maintenance personnel without undue inconvenience. The manual earth switches shall be suitable for convenient operation by the maintenance personnel.

1.2 Maintenance Tools:

1.2.1 BIDDER shall give details with price of various tools required for maintenance, viz., SF-6 handling station, temperature compensated pressure switch, testing device and moisture measuring device etc.

1.2.2 The BIDDER shall offer a Gas Service Cart to meet the following minimum requirements:

- a) A pre-assembled and self-contained gas service cart which shall include all equipment required to perform the following functions:
 - i. Extraction of air or SF-6 gas from compartments and creating vacuum in the compartment.
 - ii. Compression, air-cooling and injection of SF-6 gas.
 - iii. Drying and filtering of SF-6 gas to remove arc induced decomposition products or any other impurities.

- iv. Pressurizing GIS compartments to the full rated capacity.
 - v. Storage of SF-6 gas.
- b) The cart shall be complete with piping, valves, safety and relief devices, instrumentation, controls, starters for power supply and pressure houses of suitable design, quality and length for connection to various components of GIS. Every required part of the GIS shall be accessible when gas cart is employed.
 - c) The cart shall be constructed sturdily with steel frame and shall have casters or wheels suitable for use indoors. Any details of specific handling equipment for the cart, viz, rails of crane shall be furnished in the bid.
 - d) The storage capacity and operating rates of the various functions shall be selected considering requirement of each and every equipment in GIS.
 - e) A field test to the satisfaction of the ENGINEER shall be performed at site to establish the acceptability of the gas service cart.
 - f) The gas cart shall be capable of creating vacuum in the gas enclosure as required for erection/maintenance of the switchgear. The gas cart should be capable of achieving minimum 0.05 milibar vacuum and it shall not take more than 4 hours to achieve this vacuum in the largest sized compartment of the switchgear.
 - g) A power supply cable of adequate length wound on a drum provided with smooth bearings shall be provided with the gas service cart.
- 1.2.3 In addition to the gas cart, BIDDER shall offer pressure gauges, SF6 gas moisture measuring device, SF6 gas leak detectors, anti- static gun (to remove charge from the insulators), instrument for checking calibration, SF6 gas density switch, instrument for repairing and recalibrating defective SF6 gas density switch, instrument for testing and fault detection of the cards for protection, interlocking, etc., wrenches and tools to meet the specific maintenance and operational requirement of the GIS.
- 1.3 BIDDER shall include supply of start-up, essential and maintenance spares in separate schedules. BIDDER shall indicate in details spare required for five years of operation.
- 1.4 The successful BIDDER shall furnish detailed erection, commissioning, operation and maintenance manuals, in neatly bound volumes to the PURCHASER.

- 1.5 PURCHASER's preventive maintenance practice includes systematic inspection, overhaul and testing. It must be possible to remove and test a single circuit element without removing another element, hence the compartmentalized arrangement shall be provided.
- 1.6 Provision shall be made for incorporating a test bushing at various locations to facilitate site testing. The earthing switches should be insulated to permit easy checking of the operating times of circuit breakers and also measurement of contact resistances. BIDDER shall give details of facility provided for easy testing of various equipment/circuit elements.
- 1.7 The necessary arrangement for removal of power transformer without interference with adjacent parts/bus ducts shall be provided.
- 1.8 The BIDDER shall ensure that the gas cylinders and enclosures meet the requirement of Indian Statutory Authorities. The gas cylinders shall be of seamless type and shall conform to BS-5045/IS-7311, Part-I. Welded cylinders shall not be acceptable. The valves fitted to the cylinders shall conform to IS-3224/BS-341, Part-I. The cylinders shall be inspected and certified by either Bureau Veritas or Lloyds. All desired test reports and design data as follows shall be furnished for approval of Statutory Authorities at least three months prior to FOB despatch of the gas cylinders:
 - a) Name of the Manufacturer and standard applicable.
 - b) Serial number of gas cylinders.
 - c) Physical tests, chemical analysis and hydraulic test results and date of last hydraulic stretch test.
 - d) Material thickness certificate.
 - e) Details of the valves fitted to the cylinders.
 - f) Inspection Certificate from Bureau Veritas/Lloyds.
 - g) Laboratory report of gas analysis.
- 1.9 The filling ratio of the SF₆ gas in the cylinder shall be such that the pressure developed at 65°C is less than the test pressure of the cylinder.
- 1.10 The GIS supplier shall ensure that the gas cylinders to be supplied are as per Schedule-I of Gas Cylinders Rules 1981 of the Government of India.
- 1.11 The gas cylinders shall be despatched by the BIDDER only after specific approval from the purchaser, which will be conveyed on receipt of approval from statutory authorities.

2.00 Partial discharge Monitoring system (UHF type) and Dew point meter:

Portable PD meter and Dew point meter shall be offered as per relevant schedule of BPS and shall be considered forevaluation of Bid. The specifications are enclosed at Annexure A1.

Technical specification for Dew point meter

The meter shall be capable of measuring the dew point of SF6 of the circuit breaker /GIS equipment. It should be portable and adequately protected for outdoor use. The meter shall be provided with dew point hygrometer with digital indication to display the dew point temperature in degree C, degree F or PPM. It should be capable of measuring the corresponding pressure at which dew point is being measured.

The measurement and use of the instrument must be simple, direct without the use of any other material/chemical like dry ice/acetone etc. It should be battery operated with rechargeable batteries.

Technical specifications:

1. Measuring range: upto –100 degree C dew point.
2. Accuracy : ± 2 degree C.
3. Display: 4 digit LCD of 0.5 inch. high.

TECHNICAL SPECIFICATION FOR PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR

1.0 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, CT's and PT's.

1. It shall be capable for measuring PD in charged GIS environment as EHV, which shall have bandwidth in order of 100MHz - 2 GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. The instrument should also be able to detect partial discharge in cable joints, terminations.
2. Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. Software for display and diagnosis of PD signals and an expert software system for accurate interpretation of cause of PD shall also be supplied and installed by the contractor.

2.0 Technical Specification:

- 2.1 Measurement shall be possible in noisy environment.
- 2.2 Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.
- 2.3 Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.
- 2.4 The equipment shall be battery operated with built in battery charger. It shall also be suitable for 230 volts AC/50 Hz input.
- 2.5 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 certificates and the list of users shall be supplied along with the offer.
- 2.6 Instrument shall be supplied with standard accessories i.e, relocatable sensors with mounting arrangement, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic and expert interpretation software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.
- 2.7 The function of software shall be covering the following:
 1. Data recording, storage and retrieval in computer.
 2. Data base analysis.
 3. Template analysis for easy location of fault inside the GIS.
 4. Evaluation of PD measurement i.e, Amplitude, Phase synchronization etc.
 5. Evaluation of bouncing/ loose particles with flight time and estimation on size of particle.
 6. Report generation.
- 2.8 To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.
- 2.9 Supplier shall have “Adequate after sales service” facility in India.
- 2.10 Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS.
- 2.11 Instrument shall be robust and conform to relevant standard.

TECHNICAL SPECIFICATIONS FOR SF6 GAS LEAKAGE DETECTOR

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

SECTION-B

TECHNICAL SPECIFICATION OF HIGH VOLTAGE GAS INSULATED SWITCHGEAR & ACCESSORIES:

1.0 SCOPE:

1.1 This specification covers requirement of High Voltage Gas Insulated Switchgear up to 245 kV.

2.0 CODES AND STANDARDS:

2.1 The design, material, construction, manufacture, inspection, testing and performance of the high voltage gas insulated switchgear (GIS) and bus ducts shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to latest applicable International Standards.

3.0 SWITCHGEAR ASSEMBLY:

3.1 The switchgear assembly shall essentially consist of following items specified in subsequent clauses.

3.1.1 Circuit breakers.

3.1.2 Disconnect Switches (Isolators) and earth switches.

3.1.3 Voltage and Current Transformers.

3.1.4 Lightning Arresters.

3.1.5 SF6 exit bus duct interface with Power transformers and UG Cables.

3.1.6 Cable chamber for termination of Power cables.

3.1.7 Isolated or 3-phase main bus enclosures and accessories for both indoor and outdoor application.

3.1.8 Local control panels and mechanism cabinets.

3.1.9 SF6 gas sufficient for the entire switchgear including loss during installation + 10% extra SF6 gas.

- 4.0 **GENERAL REQUIREMENTS OF GAS INSULATED SWITCHGEAR & BUS DUCTS:**
- 4.1.0 General Construction:
- 4.1.1 The arrangement of the individual switchgear bays shall be such as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.
- 4.1.2 The equipment shall be constructed with all necessary compensators to allow for thermal expansion and spacers or bellows with telescopic bus bars to allow for the removal of sections with the minimum of disturbance.
- 4.1.3 The station shall be complete with all-necessary supports, platforms, ladders, staircases, catwalks, mechanism cabinets and internal cable raceways etc. Suitable maintenance/operation platform shall be provided between each bay and at the end bays.
- 4.1.4 It is required that the three phases of each bay shall be arranged side by side. Segregated phase blocks of equipment in which one phase of each switchgear bay is mounted in a separate block is not acceptable. The arrangement of equipment offered must provide adequate access for operation, testing & maintenance. The space around the cable sealing end boxes must be sufficient to allow cables to be made off or dismantled after the switchgear has been erected, without imposing bending stress at the cable end. Mechanism cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.
- 4.1.5 The bus duct may be of bolted flange or welded construction. Type of construction shall be specified by BIDDER.
- 4.1.6 The equipment and connection within each compartment shall be so arranged as to allow removal and replacement of any section with minimum disturbance to adjacent pressurized sections. Provision of bus sectionlizers/detachable device/bellow etc mustbe made in the main bus bar for ease of removal of a bay/component.
- 4.1.7 In the event of a fault in any one element of the GIS, it is a firm requirement that subsequent repairs/testing shall be possible to be carried out without affecting any other element and outage of any other bay/circuit or bus bar shall not be required. It shall be clearly brought out in the bid, regarding arrangement made for providing an additional insulator/gas section in the bus bar side isolator/earth switch to enable repairs of another failed isolator

without requiring an outage of the second bus bar during repair/testing etc. Alternative arrangement if any shall also be clearly brought out in the bid.

- 4.1.8 The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminium/copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.
- 4.1.9 The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. The internal components shall be maintenance free for at least 10 years. Routine replacements of insulating gas shall not be required in intervals of less than ten years.
- 4.1.10 The two main bus bars shall be provided with a gas barrier in the middle with provision of independent gas monitoring and filling etc. In addition, provision shall be made in the two main buses of the GIS, so that in the event of a fault in one part of one of the main buses, other part of this bus can be sectionalised by means of detachable device and taken back in service (by means of installing end covers in the healthy part of the main bus).

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

- 4.1.11 Minimum assembly work shall be required during installation. Completely factory assembled switchgear bays that require only cable and overhead line connections at site will be preferred.
- 4.1.12 The fully enclosed bus bars shall be made from electrolytic drawn copper or aluminium alloy. These bus bars and other current carrying equipment shall be rated for the continuous current of the switchgear under the maximum ambient design temperature as indicated without exceeding their permissible temperature rise. The capabilities of the bus duct shall be given on a symmetrical current basis and the relevant IEC standards.

The thermal ratings of all current carrying parts shall be minimum for three secs. for the rated symmetrical short circuit current.

4.2.0 Equipment Description:

- 4.2.1 The quantity of SF6 switchgear and bus duct to be offered shall be in accordance with the requirements based on single line/typical site plan /layout drawings enclosed to this specification.
- 4.2.2 The typical site plan/typical layout plan of proposed station, enclosed is only for visualizing the concept of design of 220 KV/110kV/66kV/33kV GIS station. Vendors must bid on the typical site plan/layout specified. They shall also submit detailed proposal based on typical layout/site plan drawings. In addition an alternative or modified proposal which employ a similar design concept but can show definite technological and/or economic advantages over the layout provided, may also be submitted.
- 4.2.3 It is recognized that, during installation in the switchgear building or on to outdoor foundation in case of bus ducts, some form of protection might be desirable in order to prevent moisture or dirt entering the equipment. BIDDER shall advise the type of protection needed and indicate whether it would be provided as part of the contract, or remain the property of the BIDDER. A price is required, as a separate item, for the supply of such housing, for maintenance purposes.
- 4.2.4 The bus duct routing is not final and could change as the station design is finalized. Therefore, addition and deletion prices must be quoted for lengths of bus duct, elbows and bushing assemblies' etc.
- 4.2.5 It is essential for the purposes of tender evaluation that all tenderers submit a base quotation on the exact quantities specified including the exit bus duct interconnection with the transformer/ UG Cable.

4.3.0 SF-6 Gas Density and Pressure:

The nominal operating pressure of SF6 insulated 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 and to ensure that there is no chance of the gas liquefying at the lowest ambient temperature. The initial gas pressure or density at the time of charging the equipment shall provide a sufficient margin above the minimum allowable pressure for the plant to be safely operated for a reasonably long period before recharging is necessary. The Gas density monitor shall be provided phase wise for GIS of single phase enclosure type and combined for GIS of 3 phase enclosure type. Each gas compartment shall be provided with an individual gas density monitor.

4.4.0 SF-6 Gas Purity:

4.4.1 The SF-6 Gas insulated metal clad switchgear shall be designed for use with SF-6 gas complying with the recommendations of IEC-60376, 60376A & 60376B at the time of the first charging with gas. All SF-6 gas supplied, as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.

4.4.2 Molecular sieve or activated alumina or other absorbent for removal of SF6 arc products and moisture absorbents shall be provided in each gas compartment.

4.4.3 The SF-6 gas shall have the following characteristics:

i.	Physical properties	Colourless, odourless, non-toxic & non-flammable
ii.	Density at 20°C and at one Bar	6.08 g/litre
iii.	Electric strength	2.5 times that of nitrogen
iv.	Compatibility	Up to temperature of about 180°C, its compatibility with material used in electrical construction shall be similar to that of nitrogen.
v.	Toxic impurities	SF6 gas shall comply with requirements of the tests as per Clause 2.2 of latest version of IEC-60376.
vi.	Dew point	Between – 40 & – 41°C
vii.	Impurities	SF-6 shall not have impurities more than the maximum allowable quantities given below

<u>Impurity group:</u>	
a) CF4	0.05% Maximum permitted
b) Oxygen + Nitrogen (Air)	0.05% concentration mass by mass
c) Water	15 ppm

d) Acidity expressed as HF	0.3 ppm
e) Hydrolysable fluorides expressed as HF	1.0 ppm
f) Oil content	10 ppm
viii. Preferred cylinder size	40 lt.
ix. Type of cylinder	Seamless type

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

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

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

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

4.5.0 **Permanent Gas Treatment Devices:**

4.5.1 Means shall be provided inside each enclosure for treating the SF6 gas by the use of dessicants, driers, filters, etc., to remove impurities in the gas.

4.5.2 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.

4.6.0 **SF-6 Gas Monitoring Devices:**

4.6.1 All gas compartments must have their own independent gas supervision and alarm system. Each gas supervision circuit shall be equipped with a temperature compensated gas density or

density monitoring device with associated pressure gauge, test connection point and maintenance connection point and the same shall be easily accessible.

The VENDOR shall provide individual temperature compensated gas density monitoring devices with associated pressure gauge(s) which continuously monitor and display the gas density and pressure in each of the individual gas compartments as follows:

- a) “Gas Refill” Level:
This will be used to annunciate the need for gas refilling. The VENDOR shall provide two sets of potential free contacts for remote indication/annunciation.
- b) “Breaker Block” Level:
This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the device contact shall trip the breaker and block the closing circuits.
- c) Zone trip level:
This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with the requirement.
- d) Over pressure alarm level:
This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.

4.6.2 The gas density and pressure sensitive devices, together with all relays supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. 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.

4.6.3 Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciation's the remote panels. The BIDDER will be advised of the grouping required after the contract has been placed. Provision shall be made for display of gas pressure of all individual gas compartment in the SAS HMI; alternatively, Gas pressure monitoring HMI shall be provided for display of Gas pressure of individual compartment and the same shall be mounted in the monitoring room.

4.6.4 BIDDER shall advise if the breakers are suitable for breaking the load current even if SF-6 gas pressure has reduced to atmospheric pressure.

4.7.0 **Hydraulic Monitoring Devices:**

Hydraulic pressure systems where applicable, shall be monitored as follows:

4.7.1 “Hydraulic first level”: this gives an alarm if the hydraulic pressure drops below minimum closing pressure. Two sets of potential free contacts are required per accumulator or high-pressure reservoir.

4.7.2 “Hydraulic second level”: this will give an alarm indication if the pressure drops below the minimum operable pressure, i.e., mechanism locks out. Blocking shall be in accordance with clause 4.6.1 (b) above.

4.7.3 “Loss of N2”: This will give an alarm in case the pressure exceeds a maximum level indicating loss of N2 gas of hydraulic storage cylinders.

4.7.4 “Hydraulic Motor Run Incomplete” – Hunting of pump motor due to small leak, one alarm per motor.

4.7.5 “Hydraulic Motor Run Excessive” – Excessive running of motor, one alarm per motor.

4.7.6 “Motor trip” and “Supply failure” conditions shall also be monitored.

4.7.7 The above alarms are considered the minimum acceptable, and the BIDDER shall provide additional monitoring as required for the satisfactory operation of the equipment. The alarm indications and monitoring of the hydraulic mechanism heaters shall be in accordance with the specific requirements.

4.7.8 In the event that non-biodegradable fluids are used, the BIDDER shall provide containment trays to prevent a spillage and indicate the same in the bid.

4.7.9 BIDDER should indicate additional price for annunciating hydraulic over pressure as an option.

4.8.0 **VOID**

4.9.0 **Sectionalisation:**

4.9.1 The GIS assembly shall consist of separate modular compartments eg. Circuit breaker compartment, bus-bar compartments filled with SF-6 gas and separated by gas tight partitions so as to minimise risk to human life, allow ease of maintenance and limit the effect of gas leaks failures and internal arcs etc. The assembly shall consist of completely separate, pressurized sections. The switchgear gas enclosures must be sectionalised, with gas-tight barriers between sections or compartments.

These compartments shall be such that maintenance on one feeder may be performed without de-energising the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personal in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

4.9.2 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 refilled before and after maintaining any item of equipment. **Main bus bars and bus disconnectors shall not form common gas sections for 220kV class GIS.** Further, disconnectors, circuit breakers, current transformers, voltage transformers, cable chambers, transformer exit bus ducts shall be preparably separated from adjacent compartments by gas tight barriers & same shall conform to Manufacturer design & IEC requirements.

4.9.3 VENDOR shall provide the necessary end covers/cover plates to enable removal of an element of substation and to restore the enclosure in order to resume operation of the rest of the substation. End covers/cover plates required for independent testing of the removed bay shall also be provided.

4.9.4 The arrangement of gas sections or compartments shall be such that it is possible to extend existing bus bars without having to take out of service more than one bus bar at any given time.

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

4.9.6 In the event of interconnection of gas sections by means of external piping, each enclosure shall be provided with means of isolation from other gas compartments as well as means of filling up the SF₆ gas such that gas evacuation/filling in one gas compartment shall not require gas evacuation/filling of any other compartment.

4.9.7 The mass of gas in all the individual compartments at rated nominal density shall be indicated in the bid.

4.10.0 **Support Insulators and Section Barriers:**

4.10.1 Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.

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

4.10.2 The switchgear, which shall be of modular design, shall have either single phase or three phase enclosure. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF₆ breakdown under arcing conditions.

4.10.3 The support insulators and section barriers/insulators shall be manufactured from the highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall be sufficiently strong to ensure that the conductor spacing and clearances are maintained when short circuit faults occur.

4.10.4 Tests shall be carried out during the manufacture of the switchgear to ensure that all insulators and barriers are free of partial discharge at a voltage, which is at least 20% greater than the maximum service voltage.

4.10.5 The gas section barriers shall not be specifically designed to collapse and act as pressure relief devices. The gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier i.e., with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over pressure, at least equal to the operating pressure of the relief devices, that could be attained with a persistent internal arc fault.

4.11.0 Gas Seals:

All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all normal pressure, temperature, electrical load and fault conditions. The sealing provided between flanges of two modules/enclosures shall be such that long term tightness is achieved.

4.12.0 Expansion and Flexible Connections:

4.12.1 Expansion joints or flexible connections shall be provided in the metal enclosures to absorb the actual or relative thermal expansion and contraction of the SF₆ equipment as well as structures, foundations and floors on which the equipment is mounted, resulting from variations in the temperature of the switchgear equipment. Either expansion joints which will directly absorb any longitudinal expansion of the metal enclosures or flexible connections which will absorb the relative movement between adjacent items of equipment as a result of expansion are acceptable, except in the case of long bus bar or duct installations. In this case expansion joints shall definitely be provided at suitable intervals in the metal enclosures.

4.12.2 If expansion joints are provided, all items of equipment shall be securely fixed to the support structures, foundations or floor. If flexible connections are provided, the switchgear shall be fixed to one point only with the remainder of the equipment free to move.

4.12.3 The expansion joints or flexible connections should be capable of absorbing other small externally applied forces, eg. earth tremors, without any damage to the equipment.

4.12.4 The number and position of expansion joints or flexible connections are to be determined by the BIDDER to ensure that the complete installation will not be subjected to any expansion stresses which could lead to distortion or premature failure of any piece of the GIS equipment, support structure or foundations.

- 4.12.5 Expansion joints, flexible connections and adjustable mountings shall also be provided to compensate for tolerances in the manufacture of associated equipment to which the GIS may be connected and 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 switchgear by means of long SF6 bus bar or duct installations.
- 4.12.6 The joints shall be provided with external fittings to ensure that the flexible enclosure walls and the conductors of the expansion joint are not subjected to the normal standing longitudinal compression or tension forces that may exist in the equipment. These external fittings shall transmit all the forces across the joint and shall be symmetrically spaced around the enclosure to ensure that no bending forces are set up at the joint.
- 4.12.7 The electrical connection across the expansion joint or flexible connections shall be made by means of multiple contact connectors, preferably the same as that to be provided at the joints between the separate gas compartments. The surface of the connection fingers and conductor tubes in such connections shall be silver plated. No loss in area of contact below the minimum required should be experienced during the maximum possible expansion.
- 4.12.8 Electrical continuity of the connection for all enclosures across bolted joints/expansion/flexible connections shall be achieved.
- 4.12.9 **Adequate provision shall be made to allow the thermal expansion of the conductors and of differential thermal expansion between conductors and the enclosures. The bellow shall be metallic (preferably of stainless steel) of following types or other suitable equivalent arrangement shall be provided wherever necessary.**
- 1. Lateral /Vertical mounting units; These shall be inserted as required, between section of busbars, (on transformers) and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.**
 - 2. Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperatures variations.**
 - 3. Parallel compensators: These shall be provided to accommodate large linear expansion and angle tolerance.**

- 4. Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerance.**
- 5. The electrical connections across the bellows or compensating units shall be made by means of suitable connectors.**

4.13.0 **Metal cladding:**

- 4.13.1 The metal clad enclosures for the SF₆ gas and circuit elements shall be made from non-magnetic material to prevent losses and heating from magnetic hysteresis in the case of single-phase enclosures. The type of material and thickness shall also be such as to keep heating due to induced circulating currents to a minimum.
- 4.13.2 The material and thickness of the enclosure shall be in compliance with IEC-62271-203/IEC-62271-200(for 33kV GIS).
- 4.13.3 Routine test on each enclosure shall be conducted as per IEC-62271-203/ IEC-62271-200(for 33kV GIS) at the manufacturer/sub supplier's premises and test reports shall be , furnished for review during FAT.
- 4.13.4 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.
- 4.13.5 The enclosure shall be of continuous design and shall meet the requirement as specified in clause No.10 (special considerations of GIS) of IEEE-80, Year 2000. The enclosure shall be sized for carrying induced current equal to the rated current of the Bus.The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.
- 4.13.6 The fabricated metal enclosures shall be of Aluminium alloy having high resistance to corrosion, low electrical losses and negligible magnetic losses. All joint surfaces shall be machined and allcastings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.
- 4.13.7 The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. The removed interrupter assembly

must be easily and safely accessible for inspection and possible repairs.

- 4.13.8 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.
- 4.13.9 The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.
- 4.13.10 The average intensity of electromagnetic field shall not be more than 50 micro-Tesla. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.
- 4.13.11 The bidder shall furnish the following information regarding the loosely distributed metallic particles within the GIS encapsulation.
 - Calculations of critical field strength for specific particles of defined mass and geometry.
 - The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification elsewhere.
- 4.13.12 The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.
- 4.13.13 Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

- Gas Insulating System:

- A. Loss of Gas Density.
- B. Loss of Heater power (if required).
- C. Moisture in Gas.
- D. Any other alarm necessary to indicate deterioration of the gas insulating system.

- Operating System:

- 1.0 Low operating pressure.
- 2.0 Loss of heater power.

- 3.0 Loss of operating power.
- 4.0 Loss of control voltage.
- 5.0 Pole Disordance.

4.13.14 (a) Temperature rise of current carrying parts shall be limited to the values stipulated in IEC-60694, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure shall not exceed 20°C above the ambient temperature of 50°C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted up to 30°C above the ambient of 50°C.

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

4.13.15 **Pressure Vessel requirements:**

a) **The enclosure shall be designed for the mechanical and thermal loads to which it is subjected to in service.**

b) **Each pressure filled enclosure shall be designed and fabricated to comply with requirements of the applicable pressure vessel codes and based on the design temperature and design pressure as defined in IEC .**

c) The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure vessel). **Each enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute. The bursting strength of Aluminium casting has to be at least 5 times the design pressure. A bursting pressure shall be carried out at 5 times the design pressure as a type test on each type of enclosure.**

4.13.16 Enclosure shall withstand the full rated fault currents during arcing faults at 50kA/40kA, without puncturing for at least 300 m sec. For a fault cleared in more than 300 m sec. fragmentation of enclosure/uncontrolled ejection of solid material shall not take place.

4.13.17 Design calculation or proof test report to demonstrate strength of enclosure at designed pressure and design temperature shall be furnished.

4.14.0 **Finish of Interior Surfaces and Cleaning:**

- 4.14.1 The finish of interior surfaces of the metal clad enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall be such that they will not deteriorate when exposed to the SF6 gas and other vapours, arc products, etc., that may be present in the enclosures. They shall also not contain any substances, which could contaminate the enclosed SF6 gas or affect its insulating properties over a period of time. Measures taken to eliminate conducting particles shall be brought out clearly in the bid.
- 4.14.2 The equipment shall be manufactured and assembled at the Manufacturer's works under conditions of the utmost cleanliness.
- 4.14.3 The BIDDER shall indicate in the bid the finish, which will be used for interior of pressurized bus duct enclosure.
- 4.15.0 **Protective Finish/Corrosion Protection:**
- 4.15.1 The switchgear shall be treated and protected to withstand at least five years of operation under site conditions without sustaining significant corrosion or attacks from fungus or rodents.
- 4.15.2 The exterior surface finish shall be selected in agreement with the PURCHASER to minimize the effect of solar radiation on continuous rating. The protective finish shall prevent deterioration due to corrosion, humidity, temperature, ageing and weather etc., under site conditions.
- 4.15.3 All exterior surfaces shall be cleaned and painted before leaving the factory with one coat of approved primer and two coats of finish paint approved for the equipment. The underside of all surfaces bearing upon the concrete foundation shall be given two coats of approved primer. Extra paint for retouching shall be supplied by the manufacturer. The paint shade shall be as aircraft grey shade 693 of IS-5 and subject to PURCHASER's approval.
- 4.15.4 Supporting framework shall be hot dip galvanized.
- 4.15.5 Gas monitoring and service piping including all fittings and armatures shall be made of copper, brass or stainless steel.
- 4.15.6 Joints of different metals that could lead to electrolytic corrosion must be avoided.
- 4.15.7 Before the metal clad enclosed sections are joined together and charged with the SF6 gas they must be thoroughly cleaned.

4.16.0 **Indication and Verification of Switch Position:**

- 4.16.1 Indicators mounted external to the equipment, shall be provided on all circuit breakers, isolators and earth switches which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkage and shall be mounted in a position where they are clearly visible. The positions shall be designated as 'open' and 'close' and the use of colours to designate breaker position is not acceptable.
- 4.16.2 The BIDDER shall offer equipment fitted with viewing ports on each disconnect and ground switch, suitable for viewing and illuminating the position of the switch. Viewing ports shall be of a type whereby the open/close position can be checked without any danger to the eyes should a flashover occur at that time.
- 4.16.3 Bidder shall also indicate Unit price for deletion of the viewing ports.
- 4.16.4 BIDDER shall also indicate alternative facility which bidder can provide, to ensure checking at site by Purchaser's operators that the circuit is not energized.

4.17.0 **Pressure Relief device:**

- 4.17.1 Pressure relief devices shall be provided in each gas section to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs.
- 4.17.2 Pressure relief shall be achieved either by means of rupture diaphragms venting directly into the atmosphere. Suitable guards and deflectors shall be provided to prevent pieces of diaphragm from flying out or any dangerous SF₆ arc product gases escaping, in a manner that could endanger personnel who may be present.

Contractor shall submit to the owner the detailed criteria/design regarding location of pressure relief devices/rupture diaphragms.

- 4.17.3 The enclosure and barrier insulators shall be designed to prevent rupturing in the event of a service failure. Each insulator shall withstand the pressure rise due to an internal arcing fault on one side and with vacuum on the other side.

4.18.0 **Supply of SF₆ Gas:**

The contract shall include the supply of all the SF₆ gas necessary for filling and putting into commercial operation the complete

switchgear installation being supplied including loss during installation. In addition, ten percent of the total SF6 gas required for the GIS shall be supplied as spare and shall be included in the contract.

4.19.0 SF6 Gas Maintenance Plant:

- 4.19.1 The entire plant necessary for filling and evacuating the SF6 gas in the switchgear equipment shall be supplied with the contract to enable erection and maintenance work to be carried out. This shall include all the necessary gas receivers for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed when carrying out maintenance or repair work on the switchgear and associated equipment of at least one complete bay. The necessary compressor to remove SF6 gas from the compartments, vacuum pump to create a vacuum inside the compartment before SF6 gas filling operation, dust and moisture filter shall form a part of the plant.
- 4.19.2 Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with facilities for lifting and moving with the overhead cranes.
- 4.19.3 The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes & valves for coupling up to the switchgear for filling or evacuating all the gases. The design of the plant, valves, couplings, connections, etc., must be of such a standard that leakage of any SF6 gas during the filling and evacuating processes is kept to an absolute minimum. The arrangement of valves, couplings and pipe work shall also be such as to prevent accidental loss of gas to the atmosphere.
- 4.19.4 The plant shall have facilities for drying air and SF6 gas or any other gases with which the switchgear compartment may be temporarily filled during the process of filling with SF6 gas.
- 4.19.5 Each of the gas compartments shall be fitted with permanent non-return valves through which the gas is pumped into or evacuated from the compartments.
- 4.19.6 Details of the gas filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be given in the bid.

- 4.19.7 The mobile auxiliary plant complete with necessary hoses and couplings etc., for purifying and drying SF6 gas in the switchgear gas compartments shall be provided with the contract.
- 4.19.8 The auxiliary gas purification and drying plant shall preferably be combined as a single unit with the gas filling and evacuating plant.
- 4.19.9 Details of the plant and its operation and whether any instruments for testing the purity of the SF6 gas are automatically provided with the plant shall be submitted along with the bid.
- 4.19.10 Bidder shall advise the Purchaser regarding requirements of special gas masks and protective clothing required during fault repair of GIS to protect personnel from SF6 decomposition products. Unit prices for supply of these items shall be given in the bid.

4.20.0 SF6 Gas Leakage Detecting Instruments:

- 4.20.1 Separate prices shall be quoted for portable SF6 gas leakage detector. The portable SF6 gas leakage detector shall be lightweight and provided with long flexible probe to enable detection of SF6 gas leakage from hard to reach areas.
- 4.20.2 The Bidder shall furnish details/catalogues regarding the features of the portable SF6 gas detector offered by him.

4.21.0 Special Requirements for Transformer Connections (If applicable):

The connection between the SF6 equipment and transformers must be capable of withstanding the maximum amplitudes of vibration both in the longitudinal and transverse plane. A flexible conductor connection and enclosure must be provided in the coupling between the switchgear and the transformer which is capable of withstanding the vibrations indicated by the transformer manufacturer, without failure during the reasonable lifetime of the equipment. The transformer bushings must be oil-tight, gas-tight and pressure resistant.

4.22.0 Design of the Interface (If applicable):

When interfacing of GIS and transformer from different VENDOR is required, an interface design meeting will be held among transformer VENDOR, GIS VENDOR and the PURCHASER. The onus of accommodating a mutually agreeable solution for the design and testing of this interface shall be on the GIS VENDOR.

4.23.0 Assembly of Interface (If applicable):

Representatives of the VENDOR and PURCHASER shall each inspect and approve the field assembly of the interface.

4.24.0 Mechanical Force on Bushing Terminals in case of Cl. 4.21.0:

Outdoor bushings must be capable of withstanding a cantilever force applied to the terminal of at least 600 Kgs (6 KN).

4.25.0 Bushings:

4.25.1 All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the level specified in the specific requirements.

4.25.2 Porcelain if used for the manufacturer of bushing shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

4.25.3 Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects. Bushings shall be designed to have ample mechanical strength and rigidity for the conditions under which they will be used. All bushings of identical ratings shall be interchangeable.

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

4.25.5 All iron parts shall be hot dip galvanized and all joints shall be airtight. Surface of the joints shall be trued-up; porcelain parts by grinding and metal parts by machining. Bushing design shall be so as to ensure uniform compressive pressure on the joints.

4.25.6 All current carrying contact surfaces shall be silver faced. Silver facing shall not be less than one mil. in thickness.

4.25.7 Bushings shall satisfactorily withstand the insulation level specified.

4.25.8 A Test tap shall be provided for measurement of Capacitance & Power Factor. The flange shall be made of weather resistant,

- corrosion proof material. Suitable arrangement for connection of flange to ground shall be provided.
- 4.25.9 The terminal clamp of the bushing shall be made from hot dip tinned electrolytic grade copper.
- 4.26.0 **Earthing:**
- 4.26.1 The MANUFACTURER shall provide a “Main Ground Bus Earth mat”, rated 50kA for 3 sec., to which all intentionally earthed parts of the assembly must be connected.
- 4.26.2 It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.
- 4.26.3 Earthing pads shall be provided for at-least two paths to earth from the “Main Earth Bus” or each metallic enclosure and auxiliary equipment designated for connection to the station earth grid. The VENDOR shall provide data to assure that the connections from the “Main Earth Bus” to the station earth will not interfere with required enclosure current paths or any operational feature of the assembly. A copper earth bar, located near the control cable entrances of all main and auxiliary equipment, shall be provided for the purpose of terminating the shield of each control cable.
- 4.26.4 Provision shall be made for future extension and/or connection to earth buses of other interconnecting switchgear.
- 4.26.5 The BIDDER shall be responsible for supplying all earthing materials required for bonding all the equipment and steelwork included in this contract to the main station earth mat also to be provided by the BIDDER.
- 4.26.6 The design of the earth system and connection to the switchgear equipment shall also be compatible with the circulating currents that are present in the switchgear metal cladding. On the design of the earth mat mesh, the VENDOR shall provide full details of the circulating currents expected to flow in the earth mat system.
- 4.26.7 Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.
- 4.26.8 Earth switches, voltage transformers, panels and kiosks, shall be bonded to the earthing system as specified in the relevant previous clauses.

4.26.9 All steelwork, access decking and gangways, handrails, etc., shall also be effectively bonded to the earthing system.

4.26.10 The design of the earthing system along with the station earth mat shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and fault conditions. Detailed earthing drawings shall be prepared for the complete installation which shall be provided under this contract and submitted to the PURCHASER for approval.

4.26.11 The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:

- a) The touch potential at any part of the enclosure is less than 65 V.
- b) The induced current during normal operation is prevented from entering the earthing grid.

4.26.12 Station earth mat has to be provided by the bidder for which detailed calculation and drawings to be furnished.

4.26.13 Grounding:

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

The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The GIS supplier must supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The GIS supplier is also required to supply all the earthing conductors and associated hardware material for the following:

- a) Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc., to the ground bus of GIS.
- b) Grounding of transformer, CVT, SA and other outdoor switchyard equipments/structures etc.

The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The

grounding continuity between each enclosure shall be effectively interconnected with Cu/Al bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

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

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

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

The contractor shall provide suitable measures to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/counter discontinuous SF6/Air termination, SF6/Transformer or Reactor termination, SF6/HV cable bushing etc., to mitigate transient enclosure voltage.

4.27.0 **Earthing Tester:**

As an additional measure for the safety of personnel, it shall be possible to ascertain that the particular section of the plant is de-energized before an earth switch is closed onto the conductor.

4.28.0 **Interlocks:**

All interlocks required between circuit breaker, disconnect and earth switches shall be provided by the BIDDER. These shall take the form of an electrical interlock scheme operated from auxiliary

switches attached to the mechanisms of the above equipment. The logic relays for this scheme shall be in BIDDER's scope of supply and shall be mounted in a local control panels.

4.29.0 **Future Extension:**

4.29.1 The equipment provided for an initial installation shall be designed and arranged to permit the erection and testing of extension units with the minimum of down time and redundant equipment.

4.29.2 It shall be possible to carryout the erection, testing & commissioning of the future bays without requiring shut down to the complete station.

4.29.3 Each line-up of the switchgear shall be suitable, and prepared for future extension on either end without any drilling, cutting or welding on the existing equipment. To add future bays, it shall not be necessary to move or dislocate the existing switchgear bays.

4.30 **INTERFACES AND FUTURE EXTENSIONS:**

4.30.1 For future extension with another GIS product, the successfulbidder shall supply information preferably in the form of drawings giving sufficient information to enable such an interface to be designed at a later stage. The procedure to ensure confidentiality of the design details shall be agreed between the purchaser and successful bidder.

The interface should concern bus bars or bus ducts only, and not direct connections to "Active" devices such as circuit breakers or disconnectors. For Future extensions, it is recommended that the interface incorporates facilities for installation and testing of the extension to limit the part of the existing GIS to be re-tested and to allow the connection to the existing GIS without further di-electric testing (refer to clause C.3 of IEC) it shall be designed to withstand the rated insulation levels across the isolating distance.

The responsibility for testing the existing GIS will be with the purchaser.

4.31 **Foundation Channels & Supporting frame work:**

4.31.1 All supporting steel structures above finish floor level forswitchgear bays, including overhead line and cable terminations, transformer bus duct support, etc., shall be a part of Bidder's supply.

4.31.2 The BIDDER shall provide suitable foundation channels for grouting into the foundation floor to support the switchgear

assembly. Necessary supporting framework, levelling screws, inspection platforms etc., shall be provided by the BIDDER to fasten the switchgear base frames to the foundation channels. BIDDER shall submit drawing showing all details of the foundation channels on the civil guide drawing.

4.32 Maintenance:

- 4.32.1 Purchaser's preventive maintenance practice includes systematic overhaul and inspection, as well as inspection after a certain number of automatic opening operations. Station components shall be installed and arranged to facilitate realistic access for maintenance and removal of equipment, with a minimum amount of disturbance to other equipment.
 - 4.32.2 Suitable maintenance/operation platforms/catwalks shall be provided for each bay.
 - 4.32.3 It must be generally possible to remove a single circuit element (breaker, disconnect switch, bus insulator) without removing another element. Circuit breaker interrupter unit shall be removable from its tank without moving the tank or any other element. Further, disconnect switch contacts shall be accessible through inspection windows. It should be permissible to remove a short piece of bus between elements in order to remove an element.
 - 4.32.4 For routine inspection and possible repairs, all elements shall be accessible without removing support structures. The removal of individual enclosure parts, or entire breaker bays, shall be possible without disturbing the enclosures of neighboring bays.
- 4.33.0** Following graph shall be provided which shows the guaranteed insulation performance for the equipment offered
- (a) Break down voltage Vs Time graph in the time range of 0.5 to 1000 micro secs.

4.34.0 Temperature Rise:

Temperature rise of enclosure and conductor shall be such that the final temperature does not exceed the values specified in Data Sheet-A1 for specified site conditions including the effects of solar radiation. BIDDER shall provide test reports/calculations to prove this.

4.35.0 Gas Leakage:

The guaranteed maximum gas leakage rate from any single compartment of GIS to atmosphere and between compartments shall not exceed 0.5% per year for service life of the equipment.

4.36.0 Losses:

Manufacturers shall provide details of the losses at rated current.

4.37.0 Welding, Nuts and Bolts:

4.37.1 All welding shall conform to the requirements of relevant IEC standards and shall be performed by a fully certified fabricator or suitable submerged arc welding machines. At least 10% of all welds must be subjected to non-destructive testing by X-rays or ultrasound and all records there of must be made available on request.

4.37.2 When drawings are submitted for approval, VENDOR shall indicate the following:

- a) Type of weld.
- b) Procedure employed.
- c) Inspection applied.

4.37.3 Details of bolt sizes and threading shall be clearly shown on the appropriate drawings. Where self-locking type of nuts are used, they shall be of the re-usable type. Pressed type nuts are not acceptable.

4.38.0 High Voltage transients:

High Voltage Transients from switching operations and internal faults are coupled to the external sheath of the GIS. Since, the effects of these transients on people are not known operating personnel are required to avoid contact with the sheath during switching operations. Such a restriction is considered undesirable and the supplier may therefore provide devices and techniques, which may reduce such hazard or new techniques to reduce transients to an acceptable safe level.

4.39.0 Electric Overhead Crane:

EOT Crane of suitable capacity shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection and maintenance of GIS equipments.

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

The frame for 220/66kV GIS hall shall have capacity of minimum 5T safe working load & minimum height of crane shall be 8M or as per actual requirement whichever is higher

4.40.0 IDENTIFICATION & RATING PLATE:

Each bay shall have a nameplate showing

- a) A listing of the basic equipment from air entrance bushing to GIS bus (such as a breaker, disconnectors grounding switches, current transformers, voltage transformers and bushings).
- b) A schematic diagram indicating their relative locations
- c) Each module shall have its own Identification & rating plate.

The rating plate marking for each individual equipments like circuit breaker, disconnectors grounding switches, current transformer, voltage transformer, surge arrester etc shall be as per their relevant IEC.

5.0 HIGH VOLTAGE CIRCUIT BREAKERS:

5.1.0 General:

5.1.1 The circuit breakers shall be isolated phase and/or 3 Phase metal clad type for independent pole operation in case of 245KV Breaker and three pole operation (gang operated) in case of 110kV, 72.5KV & 33kV Breaker and shall have duplicate trip coils. They shall be electrically, mechanically, hydraulically and pneumatically trip free where applicable and anti-pumping with either or both of the duplicate trip circuits connected. A manual emergency trip facility is required to be provided.

5.1.2 The circuit breaker shall be suitable for remote electrical operation at 220V DC as specified in the Specific Requirements, with either or both of the duplicate trip circuits connected. Pole discrepancy tripping shall be provided.

5.1.3 The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. This procedure may not involve the removal or dislocation of adjacent bay enclosure parts. Checking the contact condition of the interrupter elements must be possible without disturbing any other gas compartment. Safe replacement of breaker interrupters must be possible while the adjacent bays are "live".

5.1.4 The nameplate shall display the actual site rating of the equipment.

Note: The 33kV Circuit Breaker of VCB type is also acceptable.

5.2.0 Duty Cycle (Operating Mechanism):

Circuit Breaker shall be C₂-M₂ class as per IEC-62271-100. The BIDDER shall tender for circuit breakers which have local storage sufficient for the standard duty cycle of OPEN-CLOSE-OPEN (OCO)

operations and the stored energy mechanism cabinet shall be so insulated that during an AC station service failure, at an ambient temperature of 35°C, there shall not be less than OCO stored operations remaining after three hours.

Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on effectively grounded system, with transmission lines of lengths and characteristics as indicated in Section Project and perform make and break operations as per the stipulated duty cycles satisfactorily.

5.3.0 Circuit Breaker Performances:

5.3.1 Duty Cycle.

Open-0.3 seconds-Close-Open-3.0 minutes-Close-Open.

5.3.2 Interrupting time:

The maximum interrupting time at the minimum operating pressure of the mechanism shall be 3.0 cycles (60 m sec) as specified in Data Sheet-A1.

5.3.3 Total Break Time:

The total break time shall not be exceeded under any of the following duties:

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

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

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

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

5.3.4 Short Circuit Rating:

- a) VENDOR's shall tender proof of short circuit rating with transient voltage severity in accordance with latest revision of IEC-62271-100.
- b) All short circuit testing shall be carried out by direct tests or synthetic tests, in accordance with IEC-62271-100. Details of out of phase testing in accordance with latest versions of IEC- 62271-100 shall be provided with the bid.

5.3.5 Switching Surges:

The circuit breaker shall limit switching surges to 2.3 p.u. by the insertion of closing resistors, if necessary.

5.3.6 Short Line Faults:

Circuit breakers supplied to this specification shall be capable of interrupting short line faults on overhead transmission lines / cable when the available short circuit at the breaker terminals is equal to the interrupting rating of the breaker. If additional capacitance is required for TRV control, details must be submitted with the bid.

5.3.7 Thermal Rating of Resistors (If applicable):

- a) Closing and/or opening resistors shall have adequate thermal capacity for the following duty:

4CO-60 min-CO.

- b) An alternative price shall be submitted for breakers with closing and/or opening resistors with an adequate thermal capacity for the fourth CO operation of the above duty to be an out-of-phase switching operation.

5.3.8 Other Switching Duties:

It is required that the circuit breakers shall be re-strike free when de-energizing overhead lines and cables and shall be capable of switching unloaded transformer and shunt capacitor banks without exceeding specified over voltages.

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

5.4.0 Voltage withstand Vs Time Graph:

The BIDDER is required to provide a Voltage withstand Vs Time Graph in the range of 0.5 to 1000 micro sec., which shows the guaranteed insulation performance for the equipment offered. If capacitance is added to line or circuit side of breaker, these values of capacitance should be included in the studies.

5.5.0 Circuit Breaker Construction Features:

- 5.5.1 SF6 circuit breakers shall be of single pressure type and shall utilize puffer cylinder for arc interruption.
- 5.5.2 Each SF6 circuit breaker pole shall be provided with its own self-contained gas system.
- 5.5.3 The service connections for gas handling shall be located on each pole tank and easily accessible to facilitate servicing.
- 5.5.4 Unit type gas handling system shall be provided for above purpose.
- 5.5.5 The SF6 breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics, complete drying of container and breaker selection of 'O' ring etc. Materials such as activated alumina or molecular sieve shall be provided at appropriate locations as moisture absorbents. Also, suitable absorbents for removing SF6 arc products shall be employed.

5.6.0 Operating Mechanism:

- 5.6.1 Circuit breakers shall be power operated either by a motor charged spring operated mechanism or by hydraulic mechanism or combination of these. Main poles of the breakers shall be such that the design shall ensure a close pole spread with a maximum of 4 ms opening and 6 ms closing.
- 5.6.2 Circuit breakers shall feature high repeatability of absolute closing time over a wide range of parameters (ambient temperature, hydraulic/pneumatic pressure, control voltages etc).
- 5.6.3 Operating mechanism shall be suitable for high speed re-closing. It shall be non-pumping electrically and either mechanically or pneumatically under every method of closing (except during manual closing of a breaker for maintenance). A latch-checking switch shall be provided on mechanically trip free mechanisms to prevent re-closure before the breaker latches have reset.

- 5.6.4 Main poles shall operate simultaneously. There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong rigid, positive and fast in operation.
- 5.6.5 Trip coil shall be rated for not less than 500 W continuously.
- 5.6.6 Discrepancy circuit shall be provided which shall detect pole position discrepancy.
- 5.6.7 The design of the circuit breaker shall be such that contacts will not close automatically upon loss of gas/air/oil pressure.
- 5.6.8 A mechanical indicator shall be provided to indicate open and closed positions at a location from where it will be visible to a man standing on the ground. An operation counter shall also be provided.
- 5.6.9 A closing release shall operate correctly at all values of control voltage between 80% and 110% of the rated voltage. A shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of control supply voltage between 70% and 110% of rated voltage.
- 5.6.10 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 of adjustment with repeated operation of the breaker.
- 5.6.11 Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissives in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logics / scheme are to be employed DC supplies for all auxiliary circuit shall be monitored and for remote annunciation and operation lock out in case of DC failures.
- 5.6.12 Provision shall be made for attaching an operation analyzer to perform speed tests after installation of the breakers at site.
- 5.6.13 Spring Operated Mechanism:
- a) Spring operated mechanism shall be complete with motor, operating 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 one 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.
- h) The mechanism shall be such that the failure of any auxiliary, spring will not prevent tripping and will not cause trip or closing operation of power operating devices.

5.6.14 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 oil pressure controlling the oil pump and pressure in the high pressure reservoir shall be continuously monitored on the remote control board/SCADA. The necessary hardware to achieve this, including the loose pressure gauge instruments and interconnecting piping shall be included in BIDDER's scope of supply.
- c) The mechanism shall be suitable for at least two close-open operations after failure of AC supply to the motor.

5.6.15 Operating Mechanism Control:

- a) Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electrical control.
- b) A conveniently located manual tripping lever or break glass type push button shall also be provided for local tripping of the breaker and simultaneously opening the reclosing circuit. A

local manual closing device shall also be provided for maintenance purpose. Direction of motion of handle shall be clearly and indelibly marked.

5.6.16 Operating Mechanism and Accessories Housing:

- a) Operating mechanism, unit compressor, if offered and all accessories shall be enclosed in a weather-proof mechanism cabinet of hot dip galvanized sheet steel construction, the thickness of which shall not be less than 2 mm. Hinged doors giving access to the mechanism at the front and sides shall be provided. Suitable gaskets shall be provided to make the mechanism housing waterproof and dust-proof. Padlock and duplicate keys shall be included in the BIDDER's scope of supply.
- b) The operating mechanism control and all other controls shall be contained in a freestanding cabinet in the front of the system.
- c) Local control panel with necessary local closing/opening of switchgear and terminals for termination of control and protection cables shall be provided.
- d) Common marshalling box with necessary tubing and cables shall be provided. A light point with door switch and one 3 pin, 240 V, AC 15 A socket outlet shall be provided in the housing. Cable entry shall be from the bottom only.

5.7.0 Contacts:

- 5.7.1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise, which may cause pitting or welding. Contacts shall be easily replaceable and shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.
- 5.7.2 Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping.
- 5.7.3 Positive mechanism interconnection shall be provided between interrupting contacts, resistor switches (when used), blast valve mechanism, if any, to ensure maximum operating reliability or retention timing.

5.7.4 If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.

5.8.0 Auto Reclosing Equipment:

5.8.1 Wherever specified in Data Sheet, suitable high speed, single shot auto reclosing shall be provided. All relays, timers, controls and interlocks required for auto reclosing scheme shall be included in the offer. Selector switch, for single pole and three-pole auto reclosure and all the associated hardware shall be provided.

5.8.2 If breaker trips out after first shot, reclosing equipment shall lock out and no further closure will take place.

5.8.3 The duty cycle of the auto reclosing breakers shall be O-t-CO-t'- CO, where the dead time interval (t) shall be adjustable. The Bidder shall clearly state the minimum dead time interval (t) that can be used and the range of adjustment for the same. The value of t and t' shall be specified in Data Sheet-A1.

5.8.4 The auto reclose relays will be provided in the control & relay panel, which is specified in the respective specification. These relays shall be suitable for flush mounting.

5.8.5 Auto reclosing equipment shall be suitable for operation on the DC control voltage specified. Control circuitry shall be so arranged that the reclosing sequence shall not come into operation if the breaker is opened by hand (healthy trip) and also if the breaker is closed on to a short circuit.

5.9.0 Optional Devices:

Bidder shall quote as an optional item for following devices along with necessary cables, consoles etc., as a condition monitoring system.

5.9.1 Device (operation analyzer) for monitoring the operating time and speed of the breaker to be supplied as mandatory maintenance equipment.

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

This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc., shall be furnished as mandatory maintenance equipment.

5.9.2 A device for recording currents of trip and close coils of the breaker.

5.10.0 Additional data to be furnished along with offer:

- a) Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.
- b) Data on capabilities of circuit Breaker in terms of time and number of operation at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
- c) Curves supported by test data indicating the opening time under close open operation with combined variation of trip voltage and hydraulic pressure.

TESTS:

1. In accordance with the requirements stipulated under Section Data Sheet A1, the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100/203/200.

2. Routine Tests:

Routine tests as per IEC 62271-100/203/200 shall be performed on all circuit breakers.

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

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

6.0 DISCONNECT SWITCHES (ISOLATORS) AND EARTH SWITCHES:

General:

Disconnecter shall be of single/three pole, group operated type, installed in the switchgear to provide electrical isolation of the circuit breaker, the transformer, double bus and transmissionlines. The disconnector shall be operated by electric motor suitable for use on 220V DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current & short circuit.

6.1.0 Construction Features:

- 6.1.1 The Isolators, high-speed motor operated earth switches and hand-operated maintenance earth switches shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.
- 6.1.2 All similar parts shall be interchangeable.
- 6.1.3 The design shall be such that no lubrication of any part is required except at very infrequent intervals.
- 6.1.4 The isolator and earthing switch shall be provided with high current carrying contacts on the hinge and jaw ends and all contact surface shall be of silver faced copper.
- 6.1.5 Isolators shall be adequately rated to energize/de-energize the GIS bus bars.
- 6.1.6 Arrangement shall be provided to enable manual operation of Isolators and high-speed earth switches. Whenever the emergency manual handle is inserted into the drive mechanism, it shall not be possible to control the device electrically.
- 6.1.7 Each Isolator shall have an individual gas compartment. An associated earth switch may be arranged in the gas compartment of the isolator. It shall not affect the required maintenance and service aspect of GIS.

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

The opening and closing of the disconnector shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.

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

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

Each disconnector shall be supplied with auxiliary switch having six normally open and six normally closed contacts for future use over and above those required for switchgear interlocking and automation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.

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

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

All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10A DC continuously.

The disconnectors and safety grounding switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.

The local control of the Isolator and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.

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

Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signal to the control room. The details of the inscription and colouring for the indicator are given us under

	<u>SIGN</u>	<u>COLOUR</u>
Open position	Open	Green
Closed position	Closed	Red

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

The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.

The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

6.2.0 **Accessories:**

6.2.1 Position Indicator:

A mechanical position-indicating device shall be provided for each isolator/earthing switch, which shall be clearly visible from ground. Viewing port shall be provided for visual verification of open/close position of the isolator/earthing switch.

6.2.2 Name Plate:

A weatherproof and corrosion-proof nameplate shall be provided on each isolator, earthing switch and operating devices, main bus etc. The nameplates shall conform to applicable standards.

6.3.0 **A. Safety Grounding Switches:**

1. Three-pole, group operated, safety grounding switches shall be operated by electric motor for use on 220V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.
2. Each safety grounding switch shall be electrically interlocked with its associated disconnecter and circuit breaker such that it can only be closed if both the current breaker and disconnecter are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnecter.
3. Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to control room.

4. The details of the inscription and colouring for the indicator are given a under:

	<u>SIGN</u>	<u>COLOUR</u>
Open position	Open	Green
Closed position	Closed	Red

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

6. Each ground switch shall be fitted with auxiliary switches having four normally open and four normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.

7. Provision shall be made for padlocking the ground switches in either the open or closed position.

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

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

10. The safety grounding switches shall conform to the requirements of IEC-62271-102 and shall have electrical endurance class:E0.

11. Mechanical position indication shall be provided locally at each switch and remotely at each bay module control cabinet/sub-station automation system.

B. HIGH SPEED MAKE PROOF GROUNDING SWITCHES:

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

Single/three phase switches shall be provided with operating mechanism suitable for operation from a 220V DC.

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

The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 100KA. The switches shall have inductive/capacitive currents switching capacity as per IEC-62271-102.

Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal control room.

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

	<u>SIGN</u>	<u>COLOUR</u>
OPEN POSITION	Open	Green
CLOSED POSITION	Closed	Red

High speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the control room in conjunction with opening of the associated disconnecter.

These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches cannot be closed if the circuit breakers and disconnectors are closed.

Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

Each high speed ground switch shall be fitted with auxiliary switches having four NO & four NC auxiliary contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

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

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

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

6.4.0 Interlocks:

6.4.1 Interlocking devices must provide absolute and positive protection against potentially harmful maloperations of the switchgear. The following functions shall be provided:

- 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.

6.4.2 Isolator and earthing switch shall be electrically interlocked such that it will not be possible to close the earthing switch when the isolator is closed or vice-versa.

6.4.3 Isolator shall be provided with electrical interlocking feature for manual operation of the isolator. This shall be in the form of bolt/shutter interlock comprising an interlock coil of latch-in type to lock the isolator-driving shaft and hence prevent isolator operation in the latch-in condition. To enable manual operation, the 'bolt'/'shutter' can be opened only when the equipment is free of interlocking signals from other equipments. When the 'bolt'/'shutter' is opened for manual operation, safety switch shall be automatically opened so that electrical operation is not possible during the manual operation. It shall be possible to release the latch by energizing the interlock coil when certain pre set conditions of interlocking scheme are fulfilled. For this purpose, the facilities shall be provided for wiring external interlocking contacts both in isolator opening and provided on the local control cabinet to facilitate emergency manual operation of isolator.

6.4.4 Electrical interlocking arrangement shall be fail-safe type.

6.4.5 The feeder grounding switches at remote end will be interlocked with the circuit breakers at the GIS and Vice Versa. Necessary provisions shall be made to achieve the interlocking.

6.5.0 Operating Mechanism and Controls:

6.5.1 Isolators shall be motor operated and controlled from the local control and from a remote point. Connections, interlocking requirements and auxiliary switches shall be in accordance with the PURCHASER's requirements.

6.5.2 The operating mechanism shall provide quick, simple and effective operation. Time of operation shall not exceed 12 seconds. One man shall be able to operate the isolator/earthing switch (when manually operated) without undue effort.

6.5.3 The operating mechanism shall be provided with sufficient adjustment to allow for final alignment of the isolator blades for simultaneous operation. Adjustable stops shall be provided to prevent over-travel in either direction.

6.5.4 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.

6.5.5 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. All holes in cracks, linkages, etc., having pins shall be drilled to accurate fit so as to maintain the minimum amount of slack and lost motion in the entire mechanism.

6.5.6 In addition to the limit switch contacts required for control of power operated isolators, the number of auxiliary contacts mentioned in Data Sheet-A1 shall be provided. These switch contacts shall be positive acting type and shall be directly driven from the isolator shaft through minimum linkages. The auxiliary contacts shall be of silver faced copper. When make before break contacts are specified, they shall be wiping type. The contacts (including limit switch contacts) shall be designed to carry 10A continuously without undue temperature rise. All contacts (including limit switch contacts) shall be suitable for breaking an inductive current of 3A and 2A at 110V DC & 220V DC respectively.

- 6.5.7 A local isolating switch fuse unit for disconnection of power supply, a local/remote selector switch and a set of open/close push buttons shall be provided in the associated local control panel for motor operated isolators.
- 6.5.8 The control shall be arranged such that the desired operation shall be completed when corresponding push button is pressed even momentarily. The control circuit shall be so designed that necessary interlocks with associated breakers and earthing switch shall be incorporated in it.
- 6.5.9 Arrangement shall be provided to permit manual operation of isolators. The arrangements shall be such that when manual operating handle is in the engaged position, the power operation shall be made inoperative.
- 6.5.10 For high speed earth switch, the operating mechanism design shall be such that during the operation of the isolator (especially manual operation), once the moving blades reach the sparking distance, springs shall take over to give a quick, snap action closing so that the isolator closing is independent of manual efforts. Similarly, the springs must assist during the opening operation to give quick breaking features. The bidder should offer type tested design operating mechanism.
- 6.5.11 The high speed motor operated earthing switch mechanisms shall be provided with a mechanism with stored energy to always assure completed operations.
- 6.5.12 If the power supply to Isolator/earthing switch is initially off and open/close command is given to isolator/earth switch which cannot be carried out due to non-availability of power at that moment, the operation of Isolator/Earth switch shall not take place when AC supply is restored subsequently.

6.6.0 Short Circuit Requirement:

- 6.6.1 The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:
- a) Mechanical damage to any part of the isolator or earthing switch.
 - b) Separation of the contacts or contact welding.
 - c) A temperature rise likely to damage insulation.

6.6.2 After the passage of these currents, the isolator shall be able to carry its rated current under specified conditions and the operation of the operating device shall not be impaired.

6.6.3 If earthing switch is combined with an isolator as a single unit, the rated peak short circuit current and the rated short time current of the earthing switch shall be at least equal to those specified for the isolator.

6.7.0 Other Requirements:

The requirements for heaters, control wiring and auxiliary switches for all earth switches shall be as detailed in Data Sheet-A1.

6.7.1 The disconnectors & earth switch shall conform to type tests and shall be subjected to routine tests in accordance with IEC 62271-100/102.

7.0 HIGH VOLTAGE CURRENT AND VOLTAGE TRANSFORMERS:

7.1.0 General Requirements:

7.1.1 Secondary terminals of each voltage and current transformers shall be brought out in a weather-proof terminal box. Facility shall be provided for short-circuiting and earthing the CT secondary at the terminal box. The star point whenever required shall be formed at the terminal box only.

7.1.2 Terminal and polarity marks shall be indelibly marked on each VT & CT on the associated terminals and these marks shall be in accordance with relevant standards.

7.1.3 Each VT & CT shall be provided with a rating plate showing the particulars as required by the relevant standard.

7.1.4 Each CT shall, when called for in specific requirements be equipped with an over voltage protective device to limit the voltage developed across the secondary terminals to a safe value not exceeding 3 kV. The protective device shall not require attention after it has operated and shall not interface with the proper operation of relays or instruments connected to the secondary circuits.

7.1.5 In the case of multi-core CTs, it shall be possible to adjust the tap settings on any core independent of the setting on the other cores for which purpose these tappings will have to be provided on the secondary windings.

7.1.6 In case of unearthed voltage transformers both the terminals of the primary winding shall be brought out through bushings rated for full line voltage. In case of earthed voltage transformer the end of

the primary winding intended to be earthed shall be brought out through a bushing and earthing connection shall be made outside. This is required to facilitate meggering of the primary winding for which the earth connection has to be removed. The neutral side bushings of the voltage transformers shall be rated for 1.1 kV class.

- 7.1.7 The secondary terminal box for the voltage transformers shall also include necessary HRC fuses/MCB's for protecting the secondary circuit. Further, for the purpose of fuse supervision on remote panel both terminals of fuse shall be brought out to the terminal box.
- 7.1.8 All CT cores in this specification shall be of low reactance type.
- 7.1.9 No turn's compensation shall be used in case of 'Class-PS' CTs.
- 7.1.10 Turns compensation, if any should be clearly brought out in the offer in guaranteed particulars.
- 7.1.11 In case of multi-ratio CTs, the minimum specified requirements in respect of VA, accuracy and knee point Voltage (KPV) and maximum secondary resistance specified shall be met at all taps.
- 7.1.12 Magnetising characteristics (extending well beyond KPV) and secondary impedance values shall be furnished in guaranteed particulars for all protection cores.
- 7.1.13 Voltage transformers shall be of electromagnetic type. Capacitor voltage transformers shall not be acceptable.
- 7.1.14 Voltage and current transformers shall be provided with the following accessories:
- a) Two earthing terminals for connecting the earthing conductor specified.
 - b) Rating and diagram plates shall be provided as per IEC standards.
- 7.1.15 Voltage and current transformers shall be given tropicalised treatment for satisfactory operation in hot and humid climate.
- 7.1.16 Voltage and current transformers shall be SF6 gas insulated.
- 7.1.17 **Tests:**
- Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC 61869-1, 2 & 3

7.2.0 Voltage Transformers:

General:

The voltage transformer shall conform to IEC 61869-1 & 3 and other relevant standards, except to the extent explicitly modifies in the specification.

7.2.1 (a) Voltage transformers shall be of the metal enclosed, gas-insulated inductive type, mounted directly on the high voltage enclosure with plug in contacts that allow easy removal. This applicable for line VT.

(b) The voltage transformer shall be in a separate bay module on the bus and will be connected to phase to ground and shall be used for protection, metering and synchronization.

7.2.2 The voltage transformers shall be of inductive type, nonresonant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The supplier shall prove by calculations and guarantee that there is no risk of Ferroresonance due to the capacitance of the GIS. The voltage transformers shall have three secondary windings.

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

7.2.4 (a) Minimum accuracy, burden and transient response characteristics shall be in accordance with the Data Sheet-A1 of this specification.

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

(c) The accuracy of 0.2 metering core should be maintained throughout the entire specified burden on all three winding without any adjustment during operation.

7.2.5 (a) Secondary terminals must be located in accessible grounded terminal boxes on the PT enclosure itself. The secondary connections must be wired to the terminal strip in the respective bay marshalling cubicle.

(b) Voltage transformer secondaries shall be protected by HRC cartridge type fuses/MCB for all the windings. The secondary terminals of the VTs shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via fuse/MCB.

7.2.6 BIDDER shall provide the VT selection scheme for outgoing feeders ie., potential supply to protection system shall be switched to bus VT depending on position of bus side disconnect switch (power supply to the feeder and VT potential supply for protection shall be from the same bus).

7.2.7 The VTs on cable incomers shall be capable of discharging the 220 kV/66 kV cables (capacitance up to 0.425 micro farad per phase per KM), charged to a peak voltage of 245 kV/72.5 kV. Discharge time shall be less than 30 seconds.

7.2.8 The diagram for the interconnection of VTs shall be provided inside the marshalling box.

7.3.0 Current Transformers:

General:

The current transformer and accessories shall conform to IEC 61869-1 & 2 and other relevant standard except to the extent explicitly modified in the specification.

7.3.1 Number and Location of CTs:

- i. The CTs shall be provided as per Data Sheet-A1 of this specification. The particulars of the various cores may be change within reasonable limits as per the requirement of the protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores.
- ii. Bus bar protection CT cores shall be located at outermost side away from breaker.
- iii. The physical relative location of CT cores should be such as to ensure overlapping of protective zones.

7.3.2 Rating of Relaying Cores:

The rating of relaying cores shall be as per Data Sheet-A of this specification.

7.3.3 Minimum Accuracy for Relaying Cores:

5P20 class & Class-PS shall be as per Data Sheet-A1 of this specification. The relaying cores shall be of low remanence design. Gaps in the core shall not be larger than necessary to limit remanence. The core remanence shall not exceed 10% of the saturation flux that is created by the application of 10 DC ampere turns per inch length of core around the magnetic path.

7.3.4 Rating of metering core shall be same as for relaying cores but low reactance design is not required.

7.3.5 Accuracy class for Metering Cores on all ratios shall be as specified in Data Sheet. Current transformer guaranteed burden and accuracy class are to be intended as simultaneously for all cores.

7.3.6 Other CT Requirements.

i. For each type of CT, application data shall be supplied in accordance with IEC 60869-1&2.

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

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

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

iii. In addition to the information requested, short time rating factors for 5, 15, 30 and 60 minutes shall also be provided.

iv. The rated extended primary current shall be 150% at all ratios and 200% at ratio other than highest ratio.

v. Provision shall be made for primary injection testing either within CT or outside.

vi. Electromagnetic shield to be provided against high frequency transients typically 1 - 30MHz.

7.3.7 Current transformers must have secondary terminals outside the high voltage enclosure, mounted in suitable accessible terminal boxes. All secondary leads of all CTs must be wired to shorting type terminals on the terminal strip in the local control panel of each breaker bay.

7.4.0 OUTDOOR BUSHINGS:

A) General

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

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

Bushing shall be in accordance with the requirements of IEC publication 60137 as applicable.

B) Insulation levels and creepage distances

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

The creepage distance over the external surface of outdoor bushings shall not be less than 25 mm/KV.

C) Bushing types and fitting

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

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

D) Mechanical forces on bushing terminals

Outdoor bushings must be capable of withstanding cantilever forces due to weight of busduct and short circuit forces. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.

E) The gas to air bushing shall confirm to type tests & shall be subjected to routine test in accordance with IEC including the following routine tests

- i. Measurement of the dielectric losses (dissipation factor, $\tan \delta$) and capacitance at ambient temperature.
- ii. Dry power-frequency voltage withstand test (1 min. at minimum rated SF6 pressure).
- iii. Partial discharge measurement at 150% rated maximum voltage/min. SF6 pressure).
- iv. Resistance measurement.

8.0 HIGH VOLTAGE LIGHTNING ARRESTERS:

8.1.0 Insulation co-ordination and selection of surge arrester:

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

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

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

8.1.1 Duty Requirements:

- a) The surge arrester shall be of heavy-duty station class and gapless (Metal oxide) type without any series or shunt gaps.
- b) The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers overhead lines and cables.
- c) 245KV, 110kV, 72.5 & 33kV KV class arrester shall be capable of discharging energy equivalent to class-3 of IEC for 245KV, 110kV, 72.5kV & 33kV system on two successive operations.
- d) The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- e) The surge arresters are being provided to protect the following whose insulation levels are indicated in the table given below:

Equipment to be protected	Lightning impulse (kVp) for 245 KV system	Lightning impulse (kVp) for 110 KV system	Lightning impulse (kVp) for 72.5 KV system	Lightning impulse (kVp) for 33 KV system

Power Transformer	± 950	± 550	± 325	± 170
Instrument Transformer	± 1050	± 550	± 325	± 170
CB/Isolator phase to ground	± 1050	± 550	± 325	± 170
Across open contacts	± 1200	± 550	± 325	± 170

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

The arrester enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the manufacturer and shall be fitted with a discharge counter located in an easily accessible position.

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

8.2.0 Constructional Features:

- a) Lightning arresters shall be of the hermetically sealed, Gapless (Metal Oxide) type of self supporting construction, suitable for use with gas insulated switchgear. They shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The lightning 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.
- b) Outer enclosure shall be metal clad having adequate mechanical strength and rigidity, for satisfactory operation under climatic conditions, which prevail at site.
- c) All metal parts shall be of non-rusting and non-corroding metal. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities. All similar parts, particularly removable ones, shall be interchangeable.

8.3.0 Accessories:

8.3.1 Discharge Counter:

- a) Self contained discharge counter, requiring no auxiliary or battery supply shall be provided for each single pole unit when specified in specific requirements. The discharge counter shall be visible through an inspection window. The counter terminals

shall be robust and shall be so located that incoming and outgoing connections are made with minimum possible bends. Suitably sized bypass shunts of copper to facilitate bypassing the discharge counter shall be furnished. The design of the terminal connectors shall permit the connection of these shunts.

- b) The connecting conductor from lightning arrester earth terminal to the discharge counter incoming terminal shall be insulated for a minimum of 4 kV and this insulated conductor shall be supplied along with the arrester by the BIDDER. This insulating conductor shall be of the type, which does not require sealing ends or plumbed joints at its either end for terminations.
- c) A leakage current detector as an integral part of the discharge counter shall be supplied. The counter along with the detector shall be so arranged that it will be possible to read the leakage current values from outside the cubicle. The value of leakage current beyond which the operation is abnormal shall be clearly marked in red colour on the detector.

8.3.2 Shield:

Shield shall be provided on each complete arrester unit for proper stress distribution as dictated by the voltage class of the arresters.

8.4.0 Tests:

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

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

Test on Surge Monitors:

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

8.5.0 Drawings:

- 8.5.1 Drawing incorporating the following particulars shall be submitted with the bid:

- a) Description of arrestor offered giving performance, salient features, ratings, features to make the arrester explosion-proof, etc.
- b) Volt/time characteristic of the arrester.

9.0 GENERAL SPECIFICATIONS FOR MECHANISM CABINETS AND LOCAL CONTROL PANELS:

9.1.0 Mechanism Cabinets:

9.1.1 The accessories and auxiliary equipment required for the correct functioning of each circuit element shall be installed in conveniently located mechanism cabinet (s).

9.1.2 General Requirements:

- a) All mechanism cabinets shall be totally enclosed rigid sheet steel structures. Doors shall be provided with concealed or semi-concealed hinges, three point latching devices and handles shall be gasketed using Neoprene gaskets.
- b) Terminal blocks for terminating all control, indication and monitoring wiring from the associated circuit element shall be installed in each mechanism cabinet. All terminal blocks shall be identified with marking strips. The conductor size range, which the terminals can accommodate, shall be clearly shown on the drawings. The terminal blocks used for cable connections shall be disconnecting type.
- c) A ground bar for terminating the ground wires of shielded control cables shall be located near the cable entrance location.
- d) Two sets of adequately rated, thermostat controlled heaters, shall be provided in each cabinet. Provision for monitoring of heater failure is required for all heaters.
- e) A receptacle rated 415V, AC, 3 phase, 4 wire shall be installed in each cabinet in addition to a light point with door switch and one 6 pin, 240V, AC, 5/15A socket outlet.
- f) Adequate safety precautions shall be taken to avoid accidental contact with 415V potential. The following precautions shall be observed:
 - i) All live parts shall be completely shielded using a halogen free fire retardant insulating material.
 - ii) 600V terminal blocks shall have removable covers and wiring shall be separated from other potentials.
 - iii) A clear and legible warning notice carrying wording "DANGER-415V" shall be located on the enclosure door.
- g) Control equipment shall not be mounted on the hinged doors. All control equipment shall be suitable for operating in an ambient temperature varying between +5°C & +45°C.

- h) Mechanism cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.
- i) Auxiliary Switches:
 - i) Directly operated, electrically separate, auxiliary switches shall be provided on breakers, disconnect switches and ground switches to satisfy the PURCHASER's requirements.
 - ii) Each contact shall be capable of carrying 10A continuously and interrupting 3.0 A inductive 110V DC and 2.0A inductive at 220V DC. Operating time for auxiliary switches required for breaker failure protection shall be one cycle or less. The BIDDER shall indicate the operating time of all auxiliary switches on the appropriate drawings. The limit switch contacts shall be capable of carrying 10A continuously. These switches shall be capable of making & breaking inductive current of at least 3A & 2A at 110V DC & 220V DC respectively.
 - iii) Auxiliary switches which are not utilized in the control circuit shall be connected to the terminal blocks for PURCHASER's use. This is in addition to the PURCHASER's requirement as per Data Sheet-A1.
- j) All alarm and trip contacts from operating mechanism shall be wired to the local control panels.

9.1.3 Circuit Breaker Cabinet:

The circuit breaker mechanism cabinet shall include the following:

- a) One (1) position indicator, which shall be in line with Clause 4.16.1 above.
- b) One (1) operation counter electrically operated.
- c) Facility for electrical or mechanical timing of contacts and resistor insertion.

9.1.4 Isolator Cabinet:

The isolator mechanism cabinet shall include a position indicator, which shall be in line with Clause 4.16.1 above.

9.1.5 Earth Switch Cabinet:

The earth switch mechanism cabinet shall include a position indicator, which shall be in line with Clause 4.16.1 above.

9.1.6 Voltage Transformer Cabinet:

VT secondaries (where applicable) shall be terminated in a cabinet, which contains the following:

- a) Two (2) Nos. secondary isolating switches 3 PST, rated 250V, 30A and associated terminals.
- b) HRC fuses for protection.

9.1.7 Current Transformer Cabinet:

CT secondaries shall be terminated in a conveniently located cabinet (s) containing terminals in accordance with the requirements of all clauses under 7.0 above.

9.2.0 Local Control Panel & Substation Automation System:

- a) Individual local control panels for each circuit shall be supplied as a part of this contract to facilitate local control of circuit breakers, isolators and earth switches. These panels shall also house the various contactors, timers, etc., to realize various interlocks as per PURCHASER's requirement among circuit breakers, isolators and earth switches. The contacts, signals and conditions originating from/going to the gas insulated switchgear, associated auxiliary and monitoring equipment shall be wired up to the local control panel for further use.
- b) VOID.
- c) Completely separate and isolated circuit shall be used for switchgear control, tripping, alarms and auxiliary devices. CLOSE and TRIP circuits shall be kept isolated to their final mechanical or electrical actuators. Trip circuits shall be individually and permanently monitored for continuity.
- d) Each auxiliary control circuit – but no trip circuit – shall be protected by a two pole miniature circuit breaker with auxiliary contacts.

9.2.1 Constructional Features:

- i. Local control panel shall be sheet steel enclosed and shall be dust, weather and vermin proof providing a degree of protection of IP-54. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling.
- ii. Local control panel shall be provided with hinged door (s) with padlocking arrangement and shall be floor standing type.

- iii. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCCBs without danger of contact with live metal.
- iv. All live parts shall be provided with at least phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively.
- v. Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands including cable gland for cables from control room to GIS shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from bottom only.
- vi. Two earthing terminals shall be provided to suit the earthing conductor.
- vii. All sheet steel work shall be degreased, pickled, phosphated and then applied two coats of zinc chromate primer and two coats of finishing synthetic enamel paint, both inside and outside. The interior shall be painted glossy white and exterior paint shade shall be 693 as per IS-5 and subject to approval. For chemical/corrosive areas, epoxy paint shall be used whenever specified in Data Sheet-A1.
- viii. All the hardware required for fixing the panel shall be in BIDDER's scope.
- ix. Disconnecting type terminal links shall be provided for current transformer circuits.
- x. Terminal wiring shall be accessible from the front side of the panel.

9.2.2 Switches/MCBs/MCCBs:

- a) Switches/MCBs/MCCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable IEC standards.
- b) It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs with the downstream MCCBs/MCBs/fuses to provide satisfactory discrimination.
- c) MCCB for complete isolation of the DC control circuits shall be provided.

9.2.3 Fuses:

- a) Fuses generally shall be of HRC cartridge line type, mounted on plug-in type of fuse bases having a rupturing capacity of 80KA. Fuses up to 63A may be of HRC cartridge screw-cap, D-type, having a rupturing capacity of not less than 46KA at 440 V AC and 16KA at 110V / 220V DC.
- b) Fuses shall be provided with visible operation indicators to show that they have been operated.

9.2.4 Control & Auxiliary Power Supply:

- a) All control equipment shall be suitable for operation on 220 V DC system.
- b) DC & AC power supply shall be done in a manner, which will enable isolation of individual equipment. Common supply bus will be formed in the cubicle and then power supply shall be distributed into individual equipment through MCCBs.
- c) Separate circuits with switches, fuses etc., of adequate rating shall be provided for control of space heater, lighting and power receptacle etc. These shall be on 240 V, S-phase, AC supply.

9.2.5 Relays (If applicable):

- i. Relays for various controls, monitoring and blocking functions of a particular circuit element shall be installed in associated local control panel. Protective relays shall be subject to transient test and shall be approved by the PURCHASER. All relays shall have dust covers.
- ii. Necessary auxiliary relays for alarm, time-delay relays voltage relays as required for control and protection shall be mounted inside the local control panel. Voltage relays shall have sufficient thermal capacity for continuous energisation, using external resistors, if necessary.
- iii. Auxiliary relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage.
- iv. Each relay shall be provided with at least 4 NO and 4 NC potential free contacts for the PURCHASER's use.
- v. Coils of all the relays shall be adequately rated to avoid spurious operation of relays on DC system ground or induced surges. Minimum pick up current of relay coil shall be 100 milli amps.
- vi. All relays shall be tropicalised and suitable for maximum ambient temperature of 45°C.

- vii. Make and type of relay shall be subject to the PURCHASER's approval.

9.2.6 Control and Selector Switches:

Control and selector switches shall be of the rotary type provided with properly designated escutcheon plates clearly marked to show the operating positions. Control switches shall have momentary contacts, spring return to centre, with pistol grip handle. Selector switches shall have stay put contacts with oval handles. The number of contacts and their operation in each switch shall be as per the requirements of the connected circuit. The switches shall be rated for minimum 10A at 240V AC and 2A inductive break at 220V DC. Control switches shall be discrepancy type. The local/remote selector switch shall be lockable in both positions.

9.2.7 Push Buttons:

All push buttons shall be of push to actuate type having 2 NO and 2 NC self-reset contacts. They shall be provided with integral escutcheon plates, engraved with their functions. Push buttons contacts shall be rated for 10A at 240V AC and 2A inductive breaking at 220V DC.

9.2.8 Indicating Lamps:

Indicating lamps shall be of the LED type and low watt consumption. Lamps shall be provided with series resistors.

9.2.9 Space Heater:

Strip type space heaters of adequate capacity shall be provided inside each cabinet. Heaters shall be complete with rotary type ON-OFF switch, HRC fuse on phase or a single-pole MCB with overload and short circuit protection, link on the neutral and a thermostat to cut off the heaters at 45°C. The heaters shall be suitable for connecting to 240V, 1 phase, 50 Hz supply.

9.2.10 Interior Lighting and Receptacle:

Control cabinet shall be provided with a 240V, 1 phase, 50 Hz, 40 W preferably fluorescent lighting fixture for interior illumination controlled by an ON-OFF switch and 240 V, 1 Phase, 5/15 Amp, 6 pin receptacle. Power source for interior lighting and receptacles shall be completely independent of control power source.

9.2.11 Cabinet Internal Wiring:

- a) Local control panels shall be supplied completely wired, ready for the external connections at the terminal blocks. All wiring shall be carried out with wires of 600 V grade, 120°C rated, stranded copper conductors. The insulation shall be fire retardant low smoke type, approved and tested in accordance with PURCHASER's requirement. Power circuits shall be wired with stranded tinned copper conductors of adequate sizes to suit the rated current. Alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.5 Sq.mm and shall be shielded type. CT circuits shall be wired with stranded copper conductor of size not smaller than 2.5 Sq.mm. CT secondary connections should be terminated on disconnecting type links by means of insulated round (eye) type lugs.
- b) Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminal shall be adequately rated for the circuit current, the minimum rating shall be 20A. Control wiring shall be protected against mechanical damage and shall be colour coded in accordance with PURCHASER's requirement. Colour sleeving may be used in lieu of continuous colouring. Physical separation between various colour wiring shall be maintained as much as possible.
- c) The wire terminations shall be made with solderless crimping type of tinned copper lugs, which firmly grip insulation and conduction.
- d) Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant plastic wiring channels/troughs with strap on covers shall be used for this purpose.

9.2.12 Mimic Diagrams:

Mimic diagrams shall be provided on local control panels. The mimic strips shall be screwed on to the panel and shall be made of anodized aluminium. Colours of the various voltages of the mimic bus shall be subject to the PURCHASER's approval. The width of mimic strip shall not be less than 7 mm.

9.2.13 Local Alarm/Annunciation:

- i. Window type alarm annunciation shall be provided on local control panels of each bay for various abnormal conditions.

The alarm windows should have provisions for detecting cleared and uncleared faults and flashing for new faults.

- ii. The following abnormal conditions (In addition to conditions indicated elsewhere in the specifications) shall be annunciated.
 - a) Low gas pressure for each gas compartment of the bay.
 - b) Very-Low gas pressure for each gas compartment of the bay.
 - c) High gas pressure for each gas compartment of the bay.
 - d) Hydraulic motor excessive start.
 - e) Hydraulic motor run excessive.
 - f) Hydraulic motor overload.
 - g) Hydraulic motor circuit trouble.
 - h) Hydraulic first level (low hydraulic pressure).
 - i) Hydraulic second level (Very-Low Hydraulic pressure) – Close block.
 - j) Very-Low Hydraulic pressure trip.
 - k) Low hydraulic oil level alarm.
 - l) Breaker pole discrepancy.
 - m) Isolator open/close incomplete.
 - n) Isolator motor overload, one for each bay.
 - o) DC control supply failure.
 - p) Alarm circuit DC healthy (continuously ‘ON’).
 - q) Selector switch local.
 - r) Four spare windows.

- iii.
 - a) Two (2) potential free electrical contacts shall be exclusively provided for remote alarm/indication with each and every alarm/trip condition. These contacts shall be in addition to those required for local indication and trip. These are to be wired to the cable termination blocks in the local control panels to give remote alarm/indication in Control & Relay panels/SCADA.

 - b) Provision shall be made for tripping of Breaker & remote end Breaker whenever the gas pressure in Breaker compartment & other gas compartments towards line reaches tripping pressure. Similarly provision shall be made for isolation of bus bar wherever the gas

pressure in Breaker compartment & other gas compartment towards the bus reaches tripping pressure.

9.2.14 Labels and Diagram Plate:

- i. Every equipment mounted in the cabinet shall be provided with individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front with a non-rusting label engraved with the designation of the cabinet.
- ii. Inside the door, a circuit diagram engraved on non-rusting metal shall be fixed for reference.

9.2.15 Heater Circuits:

- a) All heaters shall be thermostat controlled and shall be suitable for connecting to a 415 V, 3 phase, 50 Hz supply.
- b) The BIDDER shall provide heaters as may be required for the correct functioning of the equipment.

9.2.16 Cabling Scope:

- i. The cable supply and cabling to achieve following interconnections shall be included in BIDDER's scope.
 - a) Entire cabling among mechanism cabinets of various circuit breakers, isolators and earth switches to local control panel.
 - b) Cabling between current transformer, voltage transformer cabinets to local control panel.
 - c) Cabling among various mechanism cabinets and local control panels for realising interlocks.
 - d) Cabling from various monitoring, control and instrumentation equipment being supplied under this contract up to local control panel and to remote Control & Relay panel.
- ii. BIDDER shall include all the hardware required for cabling in his scope of supply.

9.2.17 Cables:

- a) Outer and inner sheathing material of power and control cables supplied by VENDOR shall be fire retardant low smoke type and shall meet the following requirements:

- i) The critical oxygen index value shall be minimum 21 at 250°C when tested for temperature index test as per ASTM- D-2863-77.
 - ii) The maximum acid gas generation shall be less than 15% by weight, the total acid content being determined by titration. The test set up.
 - iii) The smoke generation under fire shall pass the light transmission of minimum 40% when tested as per ASTM-D-2843-77.
 - iv) The finished cable shall pass the flammability test as per IEC-332.1. In addition to this, the finished cable shall pass flammability test as per Swedish Svensk Standard SS-424-14-75 (1978-05-26) POWER CABLES – FLAMMABILITY TESTING.
- b) The power cables shall be stranded copper conductor. Outer sheath shall be resistant to termite, fungus and rodent attack.
 - c) The control cables shall be stranded, tinned, annealed, high conductivity copper and shielded type. Outer sheath shall be resistant to termite, fungus and rodent attack. The individual cores shall be numbered by serial imprinting. The height of lettering used shall be 3 mm and the numbers shall be black in colour and printed at a spacing of 200 mm.
 - d) The cables shall conform to latest versions of IEC standards in addition to meeting the requirements of this specification.
 - e) Silicon rubber, treated glass braid nickel wire leads shall be provided to connect the circuit wiring to the heater terminals.
 - f) Any special cables required shall be included in BIDDER's scope of supply.
 - g) The insulation of wires used for all panel wiring shall conform to items (a) of this clause.

9.2.18 Drawings and Data:

- a) As part of the proposal, the BIDDER shall furnish the following drawings and data for scrutiny.
 - 1) Local control panel arrangement drawing showing dimensional views, cable entry location and mounting details.

- 2) Schematic and panel wiring diagrams of the local control panel.
- 3) Bill of material listing equipment designation, make type, ratings etc., of the various equipment mounted on local control panel.

9.2.19 Test and Test Reports:

- i. The Type test reports shall be submitted with the bid.
- ii. Acceptance and routine tests for all supply equipment's/components parts shall be carried out as per the relevant standards for the respective equipment. These test reports shall be submitted to the PURCHASER before despatch of the equipment.
- iii. Local control panel shall be subjected to the following tests:
 - a) High Voltage test (2000V for 1 minute).
 - b) Megger test.
 - c) Electrical control, interlock and sequential operation tests.

10.0 SEISMIC DESIGN CRITERIA:

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration, which may be assumed to act non-concurrently. Seismic level Zone-**II** as per new IS-1893, Year2002, 60068-3-3, IEEE 693-2005 has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from he forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. If the equipment has not been type tested earlier, design calculations of simulated parameters should be furnished along with the offer.

To prevent the movement of GIS sub-assemblies i.e., various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over

stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the purchase's approval.

11.0 INDUCTION MOTORS:

11.1 Scope:

This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's works, delivery to site and performance testing of three phase squirrel cage induction motors for general purpose.

11.2 Performance and Characteristics:

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply condition.

Supply condition

Variation of supply voltage from rated motor voltage	<u>±</u> 10%
Variation in supply frequency from rated frequency	<u>±</u> 5%
Combined voltage and frequency variation	<u>±</u> 10%

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range of 85% of the rated motor voltage to maximum permissible voltage.

The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified.

Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment.

Except as mentioned herein, the guaranteed performance of the motor shall be met with tolerances specified in applicable standard.

11.3 Insulation:

Any joints in the motor insulation such as at coil connections or between slot and end winding sections shall have strength equivalent to that of the slot sections of the coil.

The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, chemical humid and tropical climate. The tropicalising treatment shall be as per the applicable standard.

11.4 Temperature Rise:

The temperature rise shall not exceed the values given in Table-I for a reference ambient of 40°C.

Table-I

Temperature measurement by	Insulation Class	Maximum temperature rise for all types of enclosures
Thermometer method	E	65°C
	B	70°C
Winding resistance method	E	75°C
	B	80°C
	F	100°C
	H	125°C

For motors specified for outdoor installation account shall be taken for heating due to direct exposure to solar radiation.

11.5 Constructional Features:

The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repairs.

Motors weighing more than 15 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

The rotor bars shall not be insulated in the slot portion between the iron core laminations and the bars.

Except as noted, horizontal motors shall be foot-mounted type and vertical motors shall be flange-mounted type.

When the motor is supplied with driven equipment including a common base (bedplate, channels, etc.), the VENDOR shall ensure that such bedplate is adequately braced to keep vibrations and misalignment within satisfactory limits.

11.6 Bearings:

Greased ball bearings or greased roller bearings shall be of reputed make subject to the PURCHASER's approval. The life of the expectancy of the bearings shall be stated.

The bearings shall be so constructed that the loss of lubricating fluid is kept to a minimum and greasing shall be possible without any dismantling operation.

The bearings shall prevent dirt and water from getting into the motor. Bearing lubricant shall not find access to motor windings.

The bearings shall permit running of the motor in either direction of rotation.

Lubricants shall be selected for prolonged storage and normal use of the motors in tropical climate and shall contain corrosion and oxidation inhibitors. Grease shall have suitable bleeding characteristics to minimize settings.

Sleeve bearings for use with motors having flexible couplings with limited end play, shall have adequate axial end play to permit assembly so as to prevent transmitting or thrust from driven equipment to motor bearings.

11.7 Terminal Box:

Terminal boxes shall be of weatherproof construction designed for outdoor service to eliminate entry of dust and water. Gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.

The terminal box shall be suitable for top and bottom entry of cables.

Unless otherwise approved, the terminal box shall be capable of being turned through 360° in steps of 90°.

The terminal shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances.

Suitable cable glands and cable lugs shall be supplied by the motor VENDOR to match cables being employed.

11.8 Paint and finish:

Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting, and corrosion. The equipment shall be thoroughly greased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

The motor fan shall also be painted to withstand corrosion.

11.9 Heating during Idle Periods:

For motors rated below 30 KW, during idle periods, the stator winding will be connected to a 24 V single phase, 50 Hz, AC supply for heating and elimination of moisture. The supply will be connected between any two terminals for a delta connected motor and between one terminal and other two shorted terminals for a star connected motor. The VENDOR shall clearly bring out in his offer if there is any objection to the above method of heating, stating reasons thereof.

11.10 Accessories:

Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of the PURCHASER's earthing conductors. These earthing points shall be in addition to earthing stud provided in the terminal box.

Except when otherwise specified, the motors shall be provided with a bare shaft extension having a key slot and a key at the driving end.

12.0 Tests

12.1 All the factory routine test and site test done as per applicable IEC

13.0 TRANSPORT OF EQUIPMENT TO SITE:

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz circuit breakers, disconnectors, earth switches, surge arrestors and bus sections exceeding 3 metres length shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted

by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer-in-charge. Further, within three weeks the contractor shall communicate the interpretation of the data.

14.0 PACKING, STORAGE AND UNPACKING:

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

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

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

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

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

All blanking plates, caps, seals etc. necessary for sealing the gas sections during shipments to site shall be provided. If considered

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

Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site. For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected.

The contractor will be able to use the available storage areas at site.

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

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

HIGH VOLTAGE GIS AND BUS DUCTS
DATA SHEET - A1

a) 245kV, 123kV, 72.5kV & 36kV HIGH VOLTAGE CIRCUIT BREAKERS:

Sl. No.	Particulars	245 KV	123kV	72.5 KV	36kV
1.1	Application	For lines, bus coupler and transformers	For lines, bus coupler and Transformers	For lines & Transformers and Bus Coupler	For lines, bus coupler and transformers
1.2	Quantity				
1.3	Type of circuit breaker	SF6 insulated, metal enclosure Class C2-very low probability of restriking during capacitive current breaking as per IEC-62271-100 Class M2-10,000 operations as per IEC-62271-100	SF6 insulated, metal enclosure Class C2-very low probability of restriking during capacitive current breaking as per IEC-62271-100 Class M2-10,000 operations as per IEC-62271-100	SF6 insulated, metal enclosure Class C2-very low probability of restriking during capacitive current breaking as per IEC-62271-100 Class M2-10,000 operations as per IEC-62271-100	SF6 insulated, metal enclosure / VCB
1.4	Number of poles	3	3	3	3
1.5	Type of operation	Individually operated single pole	Three single poles gang operation	Three single poles gang operated	Three single poles gang operation
1.6	Rating				
	i. Voltage				
	a) Nominal system voltage	220 kV	110 kV	66 kV	33 kV
	b) Highest system voltage	245 kV	123 kV	72.5 kV	36 kV
	ii. Normal current:				
	a) Incoming/Outgoing line breaker	2000 A	1600 A	1600 A	800 A
	b) Transformer breakers	2000 A	1600 A	2000A/1600A (Refer SLD for details)	800 A
	c) Bus coupler breaker	2000 A	1600 A	2000 A	800 A
	iii. Short circuit breaking current:				
	a) RMS AC component	50/40 kA	40 kA	40 kA	31.5 kA
	b) % DC component	As per IEC-62271	As per IEC-62271	As per IEC-62271	As per IEC-62271
	iv. Short time current and duration				
	a) Current kA	50/40 kA	40 kA	40 kA	31.5 kA
	b) Duration Sec.	3 Sec	3 Sec	3 Sec	3 Sec
	v. Making capacity kA	125 kA (peak)	100 kA (peak)	100 kA (peak)	78.75 kA (peak)

	vi. Operating duty	0-t-CO-t'-CO t:0.3 seconds t':3.0 minutes	0-t-CO-t'-CO t:0.3 seconds t':3.0 minutes	0-t-CO-t'-CO t:0.3 seconds t':3.0 minutes	0-t-CO-t'-CO t:0.3 seconds t':3.0 minutes
	vii. Total break time, Cycles Milli Seconds	3 (maximum) 60	3 (maximum) 60	3 (maximum) 60	4 (maximum) 80
	viii. Make time,	5 (maximum)	5 (maximum)	5 (maximum)	5 (maximum)
	ix. Cumulative switching capacity without requiring maintenance	2 million Amp.	2 million Amp.	2 million Amp.	2 million Amp.
1.7	System grounding	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed
1.8	Auto reclosing type	Single phase & 3-Phase	3-Phase	3-Phase	3-Phase
1.9	Terminal Faults				
	a) First pole to clear factor	1.3	1.5	1.5	1.5
	b) Method of representation of Wave	BY BIDDER	BY BIDDER	BY BIDDER	BY BIDDER
1.10	Short line faults				
	a) Method of representation of wave	BY BIDDER	BY BIDDER	BY BIDDER	BY BIDDER
1.11	Additional breaking current ratings:				
	a) Out-of-phase breaking	As per IEC-62271-100	As per IEC-62271-100	As per IEC-62271-100	As per IEC-62271-100
	b) Breaking current with over voltage factor 2.3 PU.				
	i) Line charging breaking current	125 A	31.5 A	10 A	10 A
	ii) Cable charging breaking current	250A	140A	125 A	50A
	iii) Small inductive breaking current	0.5 to 10 A			
	c) Capacitor bank breaking current	400A	400A	400A	400A

	d) Temperature (i) Reference ambient temperature (ii) Max. permissible temperature rise	45°C As per IEC-62271-100 depending on class of insulation	45°C As per IEC-62271-100 depending on class of insulation	45°C As per IEC-62271-100 depending on class of insulation	45°C As per IEC-62271-100 depending on class of insulation
1.12	a) 1.2/50 μs impulse + ve & - ve b) 1 minute power frequency dry & wet	1050 KV (peak) 460 KV RMS	550 KV (peak) 230 KV RMS	325 KV (peak) 140 KV RMS	170 KV (peak) 70 KV RMS
1.13	Operating mechanism				
	a) Electro-pneumatic b) Hydraulic c) Motor compressed spring d) Fixed trip/tripfree Compressed air system	BIDDER to indicate BIDDER to indicate BIDDER to indicate Trip free BIDDER to indicate. If required for breaker operation, BIDDER shall quote for entire system	BIDDER to indicate BIDDER to indicate BIDDER to indicate Trip free BIDDER to indicate. If required for breaker operation, BIDDER shall quote for entire system	BIDDER to indicate BIDDER to indicate BIDDER to indicate Trip free BIDDER to indicate. If required for breaker operation, BIDDER shall quote for entire system	BIDDER to indicate BIDDER to indicate BIDDER to indicate Trip free BIDDER to indicate. If required for breaker operation, BIDDER shall quote for entire system
1.14	Miscellaneous				
	a) No. of potential free auxiliary contacts for exclusively PURCHASER's use (Rating: 220 V, DC, 10A) a. NO b. NC c. Make before break	10 10 3	10 10 3	10 10 3	2 2 3
	b) Earthing conductor: a. Material b. Size	Copper To suit circuit current and duration.			
	c) No. of trip coils	Two (2)/Pole	Two (2)/Pole	Two (2)/Pole	Two (2)/Pole
1.15	Mechanical & Electrical endurance class	M2-C2	M2-C2	M2-C2	M1-C1

2.0	245 KV, 110kV, 72.5 KV & 33kV ISOLATORS & EARTH SWITCHES				
2.1	Quantity	245 KV	110 KV	72.5 KV	33 KV
	a) Isolators				
	b) Motor operated high speed earth switches: - On line side				
	c) Hand operated maintenance earth switches				
	i. Earthing of main buses				
	ii On either side of breakers				
	iii. On transformer side isolators				
2.2	Voltage	245 KV	123 KV	72.5 KV	36kV
2.3	Frequency	50 Hz	50 Hz	50 Hz	50 Hz
2.4	No. of phases	Three (3)	Three (3)	Three (3)	Three (3)
2.5	Rated continuous current of isolators at 45°C ambient temperature				
	a) Incoming / outgoing lines	1600A	1250A	1250A	800A
	b) Transformer	1600A	1250A	1600A/1250A (Refer SLD for details)	800A
	c) Bus coupler	1600A	1250A	1600A	800A
2.6	Interrupting capacity of Isolators: As per IEC-62271-102				
	a) Magnetizing current	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate
	b) Line charging current	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate
	c) Max. length of GIS bus that can be discharged by opening the isolator	BIDDER to indicate	BIDDER to Indicate	BIDDER to indicate	BIDDER to indicate

2.7	Rated switching capacity of Isolators				
	a) Rating b) Line charging current c) Rated making current d) Capability to switch power transformer e) Making capacity f) Maximum length of GIS bus that can be charged by the isolator	As per 2.5 BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate	As per 2.5 BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate	As per 2.5 BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate	As per 2.5 BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate BIDDER to indicate
2.8	Operating time:				
	a) Opening time b) Total opening time c) Closing time	BIDDER to indicate BIDDER to indicate BIDDER to indicate			
2.9	Short time current:				
	a) Rating b) Duration	50/40 KA (rms) 3 seconds	40 KA (rms) 3 seconds	40 KA (rms) 3 seconds	31.5 KA (rms) 3 seconds
2.10	Rated peak short circuit current	125 KA (peak)	100 KA (peak)	100 KA (peak)	78.75 KA (peak)
2.11	Design requirements:				
	a) Ambient temperature b) Seismic coefficient acceleration	45°C 0.04 g	45°C 0.04 g	45°C 0.04 g	45°C 0.04 g
	c) Insulation levels (1.2/50 micro sec. Wave) a. Impulse withstand voltage each pole to earth and between poles b. Impulse withstand voltage across isolating distance	1050 KV (peak) 1200 KV (peak)	550 KV (peak) 550 KV (peak)	325 KV (peak) 375 KV (peak)	170 KV (peak) 170 KV (peak)
	d) One minute power frequency withstand: a. Each pole to ground and between poles b. Across isolating distance	460 KV (rms) 530 KV (rms)	230 KV (rms) 230 KV (rms)	140 KV (rms) 160 KV (rms)	70 KV (rms) 70 KV (rms)
	e) Operating mechanism for Isolators	Motor driven (emergency manual)			
	f) Potential free auxiliary contacts exclusively for PURCHASER's use: a. NO b. NC c. Make before break	6 6 3	6 6 3	6 6 3	6 6 3

	g) Minimum strength of the insulator: a. Torsional kg.m b. Cantilever kg	BIDDER to indicate BIDDER to indicate			
	h) Auxiliary power supply a. For control & interlock b. For motor drive	220 V ungrounded DC [415 V, 3 Ph, 4 wire, AC]	220 V ungrounded DC [415 V, 3 Ph, 4 wire, AC]	220 V ungrounded DC [415 V, 3 Ph, 4 wire, AC]	220 V ungrounded DC 415 V, 3 Ph, 4 wire, AC
	i) Interlocks with circuit breaker: a. Type b. Scope c. Quantity	Electrical BY BIDDER For all isolators & earth switches			
2.12	Operating mechanism of earth switches:				
	a) Cable/feeder incomer side earth switches	High speed motor driven (emergency manual)	High speed motor driven (emergency manual)	High speed motor driven (emergency manual)	motor driven (emergency manual)
	b) Bus bar and other maintenance earth switches	Motor driven (emergency manual)			
2.13	A. Mechanical endurance class of disconnectors. B. Electrical endurance class of earthing switches. i. High speed earthing switch with short circuit making capability. ii. Maintenance earthing switch	M1 (2000) E1/E2 E0	M1 (2000) E1/E2 E0	M1 (2000) E1/E2 E0	M1 (2000) - E0

3.0 245 KV, 110kV 72.5 KV & 33kV VOLTAGE TRANSFORMER					
		245 KV	110kV	72.5 KV	33kV
3.1	a) Quantity	Two sets of 3 single phase VT's (One set on each main bus bar)	Two sets of 3 single phase VT's (One set on each main bus bar)	Two sets of 3 single phase / one three phase VT's (One set on each main bus bar)	Two sets of 3 single phase VT's (One set on each main bus bar)
	b) Type	Magnetic	Magnetic	Magnetic	Magnetic
3.2	Nominal system voltage	220 KV	110kV	66 KV	33kV
3.3	Highest system voltage	245 KV	123kV	72.5 KV	36kV
3.4	Frequency	50 Hz	50 Hz	50 Hz	50 Hz
3.5	System Neutral Earthing: a) Type b) Co-efficient of earthing	Effectively earthed 0.8	Effectively earthed 0.8	Effectively earthed 0.8	Effectively earthed 0.8
3.6	Standard insulation withstand characteristics (Table III-C of IEC Publication-186):				
	a) One minute power frequency withstand	460 KV (rms)	230kV (rms)	140 KV (rms)	70kV (rms)
	b) Impulse withstand voltage	1050 KV (peak)	550 KV (peak)	325 KV (peak)	170 KV (peak)
c) Secondary winding withstand voltage (min)	2 KV (rms)	2 KV (rms)	2 KV (rms)	2 KV (rms)	
3.7	Design requirements:	220 KV	110kV	66 KV	33kV
	a) Quantity	One Main Busbar One No. each of S-Phase VTs	One Main Busbar One No. each of S-Phase VTs	One Main Busbar One No. each of S-Phase VTs	One Main Busbar One No. each of S-Phase VTs
	b) Rated primary voltage	220/ $\sqrt{3}$ KV	110/ $\sqrt{3}$ KV	66/ $\sqrt{3}$ KV	33/ $\sqrt{3}$ KV
	c) Rated secondary voltage				
	a. S1	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V
	b. S2	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V	110/ $\sqrt{3}$ V
	c. S3	-	-	110/ $\sqrt{3}$ V	-
	d) Method of connection				
	a. Primary winding	Star	Star	Star	Star
	b. S1	Star	Star	Star	Star
c. S2	Star	Star	Star	Star	
d. S3	-	-	Open delta	-	
e) Application:					
a. S1	Metering	Metering	Metering	Metering	
b. S2	Protection	Protection	Protection	Protection	
c. S3	-	-	Open delta	-	

	f) Rated Burden a. S1 b. S2 c. S3 g) Rated power factor for all secondary windings: h) Accuracy class a. S1 b. S2 c. S3	150 VA } bidder 150 VA } shall - } furnish - } sizing - } calculation	100 VA } bidder 100 VA } shall - } furnish - } sizing - } calculation	200 VA } bidder 150 VA } shall 50VA } furnish - } sizing - } calculation	25 VA } bidder 25 VA } shall - } furnish - } sizing - } calculation
	i) Rated voltage factor j) Class of winding insulation k) Max. winding temperature at 110% excitation & rated burden l) Secondary cable size m) Earthing conductor: a. Material b. Size n) Seismic acceleration	1.2 Cont, 1.5 for 30 sec. Bidder to indicate As per Table 5 of IEC-61869-1&3 4 Core, 6 Sq. mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g.	1.2 Cont, 1.5 for 30 sec. Bidder to indicate As per Table 5 of IEC-61869-1 &3 4 Core, 6 Sq. mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g.	1.2 Cont, 1.5 for 30 sec. Bidder to indicate As per Table 5 of IEC-61869-1&3 4 Core, 6 Sq. mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g.	1.2 Cont, 1.5 for 30 sec. Bidder to indicate As per Table 5 of IEC-61869-1&3 4 Core, 6 Sq. mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g.
4.0	Current Transformer Data:	220kV	110kV	66kV	33kV
4.1	Quantity	-		-	
4.2	Nominal system voltage and frequency	220 KV, 50 Hz	110 KV, 50 Hz	66 KV, 50 Hz	33 KV, 50 Hz
4.3	Highest system voltage	245 KV	123 KV	72.5 KV	36KV
4.4	System neutral earthing a) Type b) Co-eff. Of earthing	Effectively earthed 0.8	Effectively earthed 0.8	Effectively earthed 0.8	Effectively earthed 0.8
4.5	Number of cores as per clause	Refer Technical parameters	Refer Technical parameters	Refer Technical parameters	Refer Technical parameters
4.6	Primary current rating:	Refer Technical parameters	Refer Technical parameters	Refer Technical parameters	Refer Technical parameters
4.7	Short time thermal rating: a) Current b) Duration	50/40KA 3 Sec.	40KA 3 Sec.	40 KA 3 Sec.	31.5KA 3 Sec.

4.8	Dynamic rating	125 KA (Peak)	100 KA (Peak)	100 KA (Peak)	78.75 KA (Peak)
4.9	Insulation a) Class of insulation b) Maximum temperature rise of winding: a. Ambient b. Temperature rise	BIDDER to indicate 45°C As per table-5 of IEC-61869-1			
4.10	1.2/50 micro sec impulse withstand positive and negative	1050 KV (peak)	550 KV (peak)	325 KV (peak)	170 KV (peak)
4.11	One minute power frequency withstand	460 KV (rms)	140 KV (rms)	140 KV (rms)	70 KV (rms)
4.12	Miscellaneous:				
	a) Secondary cable size b) Grounding conductor c. Material d. Size c) Design seismic co-efficient d) Whether over voltage protective device across secondary required?	4 Core, 6 Sq.mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g Bidder to indicate	4 Core, 6 Sq.mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g Bidder to indicate	4 Core, 6 Sq.mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g Bidder to indicate	4 Core, 6 Sq.mm stranded copper conductor Copper To suit short circuit current and duration 0.04 g Bidder to indicate

Items	Quantity	Core No.	Application	Current ratio Amps	Rated external burden VA	Accuracy Class	Accuracy limit factor	Min. Knee Point Volt (V)	Max. CT secondary winding resistance Ohms	Max. existing current at half the knee point voltage (V)
1	2	3	4	5	6	7	8	9	10	11
1	220 KV LINES / Bus Coupler :									
		1	Main-1 protn.	1200-600/1A	--	Class PS	--	--	--	--
		2	Main-2 protection/ Back-up protection	1200-600/1A	--	Class PS	--	--	--	--
		3	Metering	1200-600/1A	10	0.2S	--	--	--	--
		4	Bus bar protection	1200/1A	--	Class PS	--	--	--	--
		5	Bus bar protection	1200/1A	--	Class PS	--	--	--	--
2	150 MVA, 220/66 KV TRANSFORMER (220kV SIDE):									
		1	Main protn.	600-300/1A	--	Class PS	--	--	--	--
		2	Back up protection	600-300/1A	--	Class PS	---	---	---	---
		3	Metering	600-300/1A	10	0.2S	--	--	--	--
		4	Bus bar protection	1200/1A	--	Class PS	--	--	--	--
		5	Bus bar protection	1200/1A	--	Class PS	---	--	--	--

3	66 KV SIDE OF 150 MVA TRANSFORMER / Bus Coupler:									
		1	Main protn.	1600-1000/1A	--	Class PS	--	--	--	--
		2	Metering	1600-1000/1A	10	0.2S	--	--	--	--
		3	Back up protection	1600-1000/1A	30	--	5P20	--	--	--
4	31.5 MVA, 66/ 11 KV TRANSFORMER (66kV SIDE):									
		1	Main protn.	400-200/1A	--	Class PS	--	--	--	--
		2	Metering	400-200/1A	10	0.2S	--	--	--	--
		3	Back up protection	400-200/1A	30	--	5P20	--	--	--
5	66 KV LINE: (For lines with Drake ACSR)									
		1	Main protn.	800-400/1A	--	Class PS	--	--	--	--
		2	Metering	800-400/1A	10	0.2S	--	--	--	--
		3	Back up protection	800-400/1A	30	--	5P20	--	--	--
6	66 KV LINE: (For 1000 Sq.mm UG cables)									
		1	Main Protn.	1200-800/1-1A	--	Class PS	--	--	--	--
		2	Metering	1200-800/1-1A	10	0.2S	--	--	--	--
		3	Back up protection	1200-800/1-1A	30	--	5P20	--	--	--

7	66 KV LINE: (For 630 Sq.mm UG cables)									
		1	Main Protn.	800-400/1A	--	Class PS	--	--	--	--
		2	Metering	800-400/1A	10	0.2S	--	--	--	--
		3	Back up protection	800-400/1A	30	--	5P20	--	--	--
8	110/33 KV TRANSFORMER:									
		1	Main protn.	400-200/1A	--	Class PS	--	--	--	--
		2	Metering	400-200/1A	10	0.2S	--	--	--	--
		3	Back up protection	400-200/1A	30	--	5P20	--	--	--
9	110/11 KV TRANSFORMER:									
		1	Main protn.	200-100/1A	--	Class PS	--	--	--	--
		2	Metering	200-100/1A	10	0.2S	--	--	--	--
		3	Back up protection	200-100/1A	30	--	5P20	--	--	--

Note : **For class PS core, of all KV class CT's the minimum kneepoint volt and RCT (secondary) shall be furnished by the bidder. The same should be suitable for reliable operation of the distance /differential relays which may be obtained from the manufacturer of the offered relay.**

5.0	198 KV, 96kV, 60 KV & 30kV LIGHTNING ARRESTER DATA:				
5.1	Applicable standard	IEC60099-4	IEC60099-4	IEC60099-4	IEC60099-4
5.2	Quantity	---	---	---	---
5.3	Rating:				
	a) Type	Gapless (Metal Oxide)	Gapless (Metal Oxide)	Gapless (Metal Oxide)	Gapless (Metal Oxide)
	b) Rated arrester voltage	198 KV (rms)	96 KV (rms)	60 KV (rms)	30 KV (rms)
	c) Rated frequency	50 Hz	50 Hz	50 Hz	50 Hz
	d) Nominal discharge current of 8/20 micro second wave shape	10 KA	10 KA	10 KA	10 KA
5.4	<u>Performance Data:</u>				
	i. Maximum switching surge residual voltage (1kA)	500KV _P	272KV _P	175KV _P	85KV _P
	ii. Maximum residual voltage at rated nominal discharge current	600 KV (peak)	600 KV (peak)	195 KV (peak)	600 KV (peak)
	iii. Impulse current withstand	125 KA	100 KA	100 KA	78.75 KA
	a. High current short duration test value (4/10 S wave)	As applicable to Class-3			
	b. Low current long duration test value	2000 μ sec.	-	-	-
	c. Virtual duration of rectangular wave	168 KV (rms)	81 KV (rms)	50 KV (rms)	20 KV (rms)
	iv. Maximum continuous operating voltage				
5.5	<u>Design Data:</u>				
	a) Long duration Discharge class	3	3	3	3
	b) Minimum discharge capability of arrester	5 kJ/kV	5 kJ/kV	5 kJ/kV	5 kJ/kV
	c) Withstand voltage for 10 cycles KV (rms)	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate
	d) Seismic Acceleration	0.03 g	0.03 g	0.03 g	0.03 g
5.6	<u>Arrester Housing:</u>				
	Withstand test voltages:				
	a. One minute power	460 kV (rms)	230 kV (rms)	140 kV (rms)	70 kV (rms)

	frequency dry & wet. b. 1/50 μ S impulse	1050 kV (peak)	550 kV (peak)	325 kV (peak)	170 kV (peak)
5.7	<u>Additional requirements:</u>				
	a) Minimum cantilever strength of arrester assembly	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate	BIDDER to indicate
	b) Minimum prospective symmetrical fault current, pressure relief device to be rated for	50/40 kA rms	40 kA rms	40 kA rms	31.5 kA rms
5.8	<u>Accessories required:</u>				
	5 Surge counter	One per pole	One per pole	One per pole	One per pole
	6 Leakage current monitor	One per pole	One per pole	One per pole	One per pole
5.9	Explosion proof/non-explosion proof	Explosion proof	Explosion proof	Explosion proof	Explosion proof
6.0	<u>245KV, 110kV, 66KV & 33kV BUS DUCTS:</u>	245 KV	123kV	72.5 KV	36kV
6.1	Type of main GIS bus	Isolated/Three phase type	Isolated/Three phase type	Isolated/Three phase type	Isolated/Three phase type
6.2	Type of exit bus duct for interconnection with Transformers/Lines	Isolated/Three phase type	Isolated/Three phase type	Isolated/Three phase type	Isolated/Three phase type
6.3	Type of cooling	Natural air cooled	Natural air cooled	Natural air cooled	Natural air cooled
6.4	Installation:				
	a. GIS	Indoor	Indoor	Indoor	Indoor
	b. Bus duct connection to transformer	Partly Indoor & partly outdoor			
6.5	Insulation	SF6 gas conforming to IEC-60376, 60376A & 60480	SF6 gas conforming to IEC-60376, 60376A & 60480	SF6 gas conforming to IEC-60376, 60376A & 60480	SF6 gas conforming to IEC-60376, 60376A & 60480
6.6	Nominal service voltage	220 KV	110kV	66 KV	33kV
6.7	Maximum system voltage	245 KV	123kV	72.5 KV	36kV
6.8	Continuous current rating of bus ducts under site condns:				
	a. Transformer bus / line bus (Aux bus)	1600 A	1600 A	1600 A/1250 A	1600 A
	b. GIS main buses	2500 A	2500 A	2500 A	2500 A

6.9	Basic impulse insulation level (1.2/50 μ sec wave) i. For single phase type of main bus bars ii. For three phase type of main bus bars	1050 KV (peak) 1.5 x 1050 KV (peak)	550 KV (peak) 1.5 x 550 KV (peak)	325kV (peak) 1.5 x 325kV (peak)	170 KV (peak) 1.5 x 170 KV (peak)
6.10	One minute power frequency dry withstand voltage	460 KV	230kV	140 KV	70kV
6.11	Momentary current rating	125 kA (peak)	100 kA (peak)	100 kA (peak)	78.75 kA (peak)
6.12	Short time current rating for three seconds	50/40 kA (rms)	40 kA (rms)	40 kA (rms)	31.5 kA (rms)
6.13	a. Maximum temperature (hot spot) of bus bars at rated current b. Maximum temperature of bus bars when rated short circuit current is carried for three seconds when fault occurs at maximum operating temperature	85°C 250°C	85°C 250°C	85°C 250°C	85°C 250°C
6.14	Maximum temperature (hot spot) of enclosure at rated current and ambient temperature of 45°C	70°C	70°C	70°C	70°C
6.15	Bus bar material	Copper/Aluminium	Copper/Aluminium	Copper/Aluminium	Copper/Aluminium
6.16	Bus enclosure material	Aluminium/Steel 1 BIDDER to furnish details	Aluminium/Steel BIDDER to furnish details	Aluminium/Steel 1 BIDDER to furnish details	Aluminium/Steel 1 BIDDER to furnish details
6.17	Degree of protection for enclosure	Water and gas tight	Water and gas tight	Water and gas tight	Water and gas tight
6.18	Type of joints between adjacent sections	Bolted/welded	Bolted/welded	Bolted/welded	Bolted/welded
6.19	Insulators: a. Rated voltage b. One minute power frequency dry withstand voltage	245 kV 460 kV (rms)	123 kV 230 kV (rms)	72.5 kV 140 kV (rms)	36 kV 70 kV (rms)

	c. Impulse withstand voltage (1.2/50 μ S wave)	1050 kv (peak)	550kv (peak)	325 kv (peak)	170kv (peak)
	d. Material of insulation	Non-hygroscopic cast-resin/Porcelain	Non-hygroscopic cast-resin/Porcelain	Non-hygroscopic cast-resin/Porcelain	Non-hygroscopic cast-resin/Porcelain

7.0	245kV, 123kV, 72.5kV & 36kV BUS DUCT LENGTHS:									
7.1	Bidder shall indicate the quantity of exist bus duct lengths and accessories with reference to typical layout drawing enclosed with the bid.									
		245kV, 220/66kV Transformer		110kV, 110/33kV Transformer		72.5kV, 66/11kV Transformer		33kV, 33/11kV Transformer		
		220kV side	66kV side	110kV side	33kV side	66kV side	11kV side	33kV side	11kV side	
	a. Straight length b. Bellows c. Bends d. Interface with transformer bay SF-6 gas to Air bushing	Bidder to indicate the quantity with reference to typical drawing enclosed with the Bid.								

8.0	245kV, 123kV, 72.5kV & 36kV SF6 GAS TO AIR BUSHINGS:									
8.1	Quantity	---		---		---		---		
8.2	Normal voltage system and frequency	220 kV, 50 Hz		110 kV, 50 Hz		66kV, 50 Hz		33 kV, 50 Hz		
8.3	Highest voltage system	245 kV		123 kV		72.5 kV		36 kV		
8.4	System neutral earthing									
8.4.1	Type	Effectively earthed		Effectively earthed		Effectively earthed		Effectively earthed		
8.4.2	Co-efficient of earthing	0.8		0.8		0.8		0.8		
8.5	Current rating	1600 A		1600 A		1600 A/1250A		-		
8.6	Short time thermal rating									
8.6.1	Current	50/40 kA		40 kA		40 kA		31.5 kA		
8.6.2	Duration	3 Sec		3 Sec		3 Sec		3 Sec		
8.7	Dynamic rating	125 kA (peak)		100 kA (peak)		100 kA (peak)		78.75 kA (peak)		
8.8	Insulation									
8.8.1	Class of insulation	BIDDER to indicate								
8.8.2	Maximum temperature rise a. Ambient b. Temperature rise	45°C As per IEC								

8.9	1.2/50 micro seconds impulse withstand positive and negative	1050 kV (rms)	550 kV (rms)	325 kV (rms)	170 kV (rms)
8.10	One minute pf withstand	460 kV (rms)	230 kV (rms)	140 kV (rms)	70 kV (rms)
8.11	Material of primary conductor	Copper	Copper	Copper	Copper
8.12	Test facility	Test tap shall be provided for testing of bushing at site	Test tap shall be provided for testing of bushing at site	Test tap shall be provided for testing of bushing at site	Test tap shall be provided for testing of bushing at site
8.13	Cantilever test load, 90° to bushing axis on both ends one after another (at inside pressure 1.9 bar) 1 min.	N 2000	N 2000	N 2000	N 2000
8.14	Permissible cantilever moment at bushing flange a) Static b) Dynamic	Nm 10000 Nm 13500	Nm 10000 Nm 13500	Nm 10000 Nm 13500	Nm 10000 Nm 13500

9.0	INDUCTION MOTORS:	
9.1	Application	Gas insulated switchgear
9.2	Number of units	As required
9.3	Type of motor	Squirrel cage
9.4	Supply system fault level	42 kA
9.5	Supply Neutral	Effectively earthed
9.6	Rated voltage	415 V
9.7	Number of phases & frequency	3 Ph, 50 Hz
9.8	Type of duty	Continuous
9.9	Duty designation	S1
9.10	Method of starting	DOL
9.11	Class of insulation	B
9.12	Reference ambient temperature	45°C
9.13	Temperature rise by thermometer/winding resistance	75°C
9.14	Location	Indoor
9.15	Hazardous area division	Non-hazardous
9.16	Atmosphere	Chemical/Dusty
9.17	Type of cooling	Totally enclosed fan cooled
9.18	Designation for degree of protection	IP 55
9.19	External cable details 10.0 Type 11.0 No. of cores 12.0 Size	Aluminium/Copper conductor, PVC/XLPE Armoured cable 3 BY BIDDER
9.20	Space heaters for motors required	Yes, for motors rated 30 kW and above
9.21	24V, 1 Phase, AC, winding & heating for motors required	Yes, for motors rated 30 kW and above
10.0	<u>SF-6 Gas maintenance plant:</u>	
10.1	Minimum Vacuum capability of the vacuum pump	5 x 10 ⁻² milli bar
10.2	Minimum capacity of the vacuum pump	32 M ³ per hour
10.3	Minimum capacity of SF6 gas storage receiver	Quantity of gas in the largest compartment of the GIS + 10% spare