

220KV GIS and Pothead yard of 240 MW Heo Hydro Electric Project, Arunachal Pradesh.		Technical Specification
		Volume II Section-I
		Sub Sec. 1 220kV GIS with GIB

Volume-II

Section I Sub-Section 1

Gas Insulated Switchgear with Gas Insulated Bus Duct

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220 kV GAS INSULATED SWITCHGEAR (GIS) with GAS INSULATED BUS DUCT (GIB)

1. Scope

This section covers the criteria for design, manufacture, supply and transportation up to site, handling and storage at site, erection, testing and commissioning of one (1) 220 kV Gas Insulated Switchgear (GIS) & required Gas Insulated Bus Duct (GIB), spare parts for five (5) years trouble free operation, special tools and tackles and as described in the specification. The 220 kV Gas Insulated Switchgear GIS & GIB will be installed in the powerhouse of the HEO HEP, the latter erected on the left bank of Yarjep (Shi) river located in District Shi Yomi, Arunachal Pradesh.

The layout shall be generally as shown on the drawings however, subject to the provisions of this specification and approval of the Engineer, these may be adjusted as necessary to suit the manufacturer's standard design.

The Gas Insulated Switchgear (GIS) will be the 220 kV Substation, installed in the GIS Hall (EL more than 1000m) located above transformer hall, in the GIS Building.

The Gas Insulated Switchgear (GIS) Bays shall be connected directly to respective generator transformers (GTs) and SST located in transformer hall and to respective SF6 to Air Bushings located in pot head yard, through Gas Insulated Bus (GIB).

The switchyard layout shall be designed to accommodate future extension, including space provision, for one 50 MVA reactor bay and two future outgoing feeder bays.

2. Reference Standards

2.1. General

The GIS shall be designed, manufactured, tested and erected in conformance with the latest applicable International, North American, and Indian Standards. Many standards may be similar or redundant from one organization to the other. The Contractor shall conform to International Standards at base. American Standards shall be used for items not covered by the International Standards. Indian Standards shall be considered for regional requirements and when legally binding.

The Contractor can use any other authoritative standard, which ensures equal or better quality than the Standards mentioned below, which may also be acceptable. However, where the equipment offered conforms to any other standards, the salient points of difference between standards adopted and provision of this specification and standards referred above shall be clearly brought out in the Bid. Copies of such standards in English language or fair English Translation shall be attached with the Bid.

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Compliance by the manufacturer with the standards of this specification does not relieve the manufacturer 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.

2.2. Standards

IEC:

IEC 68-3	Environmental Testing
IEC 71	Insulation coordination
IEC 267	Guide to testing of circuit breakers
IEC 506	Switching impulse test on HV insulators
IEC 1259	Requirement for switching of bus charging current by disconnectors
IEC 60044-1	Instrument transformers – Part 1: Current transformers
IEC 60044-6	Instrument Transformers - Part 6: Requirements for Protective Current Transformers for Transient Performance
IEC 60044-1	Instrument transformers - Part 2: Inductive voltage transformers
IEC 60060-1	High Voltage Test Techniques - Part 1: General Definitions and Test Requirements
IEC 60060-2	High Voltage Test Techniques - Part 2: Measuring Systems
IEC 60085	Electrical Insulation - Thermal Classification
IEC 60099-1 to 4	Non linear resistor type gapped surge arresters for AC systems
IEC 60137	Insulated Bushings for Alternating Voltages above 1000 V
IEC 60270	High Voltage Test Techniques Partial Discharge Measurements
IEC 60296	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear
IEC 60376	Specification of technical grade Sulfur hexafluoride (SF ₆) for use in electrical equipment
IEC 60439	Low Voltage Switchgear and Control Gear assemblies
IEC 60480	Guidelines for the checking and treatment of Sulfur hexafluoride (SF ₆) taken from electrical equipment for its re-use
IEC 60529	Degrees of Protection Provided by Enclosures
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment and for the Analysis of Free and Dissolved Gases
IEC 60694	Common specifications for high-voltage switchgear and control gear standards

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IEC 60859	Cable connections for gas insulated metal enclosed switchgear
IEC 61128	Alternating current disconnectors: Bus transfer current switching by disconnector
IEC 61129	AC earthing switches: Induced current switching
IEC 61181	Impregnated Insulation Materials - Application of Dissolved Gas Analysis (DGA) to Factory Tests on Electrical Equipment
IEC 61639	Direct Connection between Power Transformers and Gas-insulated Metal-enclosed Switchgear for Rated Voltages 72.5 kV and above
IEC 62271-100	High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers
IEC 62271-101	High-voltage switchgear and controlgear – Part 101: Synthetic testing
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: High-voltage alternating-current disconnectors and earthing switches
IEC 62271-203	High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 62271-305	Cable connection for gas insulated metal enclosed switchgear for rated voltages above 52KV
IEC 62271-306	Cable connection between power transformer & gas Insulated metal enclosed switchgear for rated voltages above 52KV

CENELEC:

EN 50052	Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear
EN 50064	Wrought aluminium and aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear
EN 50068	Wrought steel enclosures for gas-filled high-voltage switchgear and controlgear
EN 50069	Welded composite enclosures of cast and wrought aluminium alloys for gas-filled high-voltage switchgear and controlgear
EN 50089	Cast resin partitions for metal enclosed gas-filled high-voltage switchgear and controlgear

IS:

IS: 5	Colours for Ready Mixed Paints and Enamels
IS: 104	Ready Mixed Paint, Brushing, Zinc Chrome, Priming

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IS: 2705	Current transformers
IS: 2932	Enamel, Synthetic, Exterior: (a) Undercoating (b) Finishing Specification
IS 3156	Voltage transformers
IS: 14657	Gas insulated metal enclosed switchgear for rated voltages 72.5 kV and above – requirements for switching of bus-charging currents by disconnectors

OTHERS:

IEEE 80 (2000)	IEEE- Guide for safety in AC substation grounding
CIGRE 44	Earthing of GIS –an application guide (Elecra no: 151,Dec 93)
IEC 60267	Out of phase switching of Circuit Breaker
IEC 60129	Inductive current breaking
IEC 61128	Bus transfer capability of disconnecting switch
IEC 60859	Cable termination design

The components and devices which are not covered by the above standards shall conform to, and comply with, the applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Employer and the manufacturer shall list all such applicable standards, codes etc. The manufacturer shall supply those standards (soft copy) as and when required by NEEPCO without any extra cost borne to NEEPCO.

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

3. General Requirements

The Gas Insulated Switchgear (GIS) is a double bus bar arrangement and comprises sections of bus bar, dis-connectors, maintenance earthing switches, high speed earthing switches, circuit breakers, SF₆ / air terminations, surge arresters, current transformers, voltage transformers, gas monitoring detectors, local control cubicles, modular design with bolted flange connections, rigid/stiff floor slab “islands” without expansion and all required hardware, according to GIS manufacturer installation manual.

The Gas Insulated Switchgear (GIS) Bays shall be connected directly to respective generator transformers (GTs) located in transformer hall and to respective SF₆ to Air Bushings (for lines L-1 & L-2) located in pot head yard, through Gas Insulated Bus (GIB),

The number of switchgear bays and associated Gas Insulated Bus connections shall be as described below:

- Generator & Transformer Feeder -1 (Unit-1) Bay along with Gas Insulated Bus duct (GIB)

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GT-1);

- Generator & Transformer Feeder -2 (Unit-2) Bay along with Gas Insulated Bus duct (GIB GT-2);
- Generator & Transformer Feeder-3 (Unit-3) Bay along with Gas Insulated Bus duct (GIB GT-3);
- Outgoing Transmission Line-1 (O/G-1) Bay with Gas Insulated Bus duct (GIB L-1);
- Outgoing Transmission Line-2(O/G-2) with gas insulated bus duct (GIB L-2);
- Station Service Transformer bay with gas Insulated Bus duct.
- Bus Coupler (BC) Bay;
- Bus VTs & GIS Bus Bars (Bus-1 & Bus-2).

The above-mentioned bays are shown in tender drawings.

All control cabinets, marshalling kiosks, marshalling boxes, instruments, valves, pipes and flanges, supports and other required auxiliaries, as required are included in this Contract. The Contractor will be provided with the required 415 V AC and 220 V DC supplies.

The DC supply for the indicating devices and pilot equipment shall be 220 V DC. 110 V or 240 V AC supply shall be transformed by the Contractor from the 415 V AC with the use of control Transformers. Use of 415 V and 230 V AC for the control and indicating circuits shall not be acceptable but will be used for feeding auxiliaries.

The GIS and associated auxiliaries and equipment shall be designed to facilitate an easy operation, maintenance and repairs. All apparatus shall be so designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met with under operating conditions on the system, including those due to short circuit.

The GIS must provide a maximum degree of safety for the operators and others in the vicinity of the GIS Substation under all normal operating conditions and under fault conditions (short-circuit).

The GIS described in this specification is intended for continuous duty at the specified ratings and under the specified ambient conditions 24 hours a day, 365 days a year unless indicated otherwise. Further details can be clarified in negotiations between the Contractor and the Employer.

The initial gas filling of the GIS will be included in the offer.

The following requirements are derived from or are in addition to the technical data given:

- The bracing of all components subject to mechanical forces caused by short-circuit currents shall correspond to the values given in the data sheets; they must, however, withstand the effects of at least 2.5 times the rated symmetrical short time withstand current;

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- The thermal rating for all current carrying parts and insulating materials shall be a minimum of 3 second for the rated short time withstand current.

The layout shall sufficiently take in to consideration the thermal contraction of the assembly by the provision of expansion joints.

The arrangement of the GIS offered must provide adequate access for checking and maintenance. However, the space needed for the equipment shall be kept to a minimum, in order to optimally meet all space limitations.

4. Rating and Technical Data

Rating and Main Data of the GIS shall be as under:

Rated voltage, rms	245 kV
Nominal voltage class, kV rms	220 kV
Rated frequency	50 \pm 5% Hz
Number of phases	Three
Power-frequency voltage withstand current 1 min.- P to P and P to G	460 kV (RMS)
Power-frequency voltage withstand current 1 min.- across open contacts at minimum operating gas pressure	530 kV (RMS)
Rated impulse withstand voltage (peak value)	1050 kV
Rated current : feeder bay @ 40 °C	3150 A
Rated current : busbar @ 40 °C	3150 A
Short-circuit nominal duration	3 s
Short-time withstand current	50 kA
Rated peak withstand current (peak value)	135 kA
SF ₆ rated filling pressure (*)	0.65 MPa
Seismic level	0.24 g in horizontal and 0.16 g in vertical direction.
Installation	Indoor
Temperature	-10°C to +50°C
Design altitude	1100 m

Note: The adequate consideration for temperature rise, insulation level as per LOV study, clearances at higher altitude (greater than 1000 metres) and ambient temperature shall be taken care by the manufacturer.

(*) Gauge pressure at an ambient temperature of 20°C and an atmospheric pressure of 0.1013

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5. Design Requirements

- Workmanship shall be of the highest quality and shall conform to the best modern practices for the manufacture of high technology machinery and electrical switchgear;
- 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 full rated fault conditions, shall not lead to diminished performance or significantly shortened useful life of the switchgear. Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear;
- The switchgear shall be of the free-standing, self-supporting design, with all high-voltage equipment installed inside gas-insulated, metallic earthed enclosures, and suitably sub-divided into individual gas compartments, at least for:
 - busbar section;
 - busbar disconnectors;
 - circuit breaker;
 - line disconnectors;
 - line side Surge arrestor / Lightning arrestor / VT.
- Arrangement of the individual switchgear bays shall be such as to achieve optimum space-saving, neat and logical arrangement;
- The switchgear shall be operated either from the front or from the side;
- It shall be impossible to touch live parts of the switchgear unwillingly, i.e. without the use of tools or brute force, or to perform operations that lead to arcing faults;
- All interlocks that prevent potentially dangerous mal-operations, shall be constructed such that they cannot be defeated easily, i.e. the operator must use tools or brute force to over-ride them;
- Access to any component shall be reasonably possible and shall respect common sense rules. The actual position of disconnector and grounding switches shall be positively displayed by means of reliable optical indicators visible from the operating position;
- All components of the same rating and construction, which may need to be replaced, shall be interchangeable;
- Shipping sections which are tested in the factory shall be joined in the field by using bolted and sealed flange connections only. Field welding of enclosures is not acceptable;
- The size of the pre-assembled shipping sections shall be as big as practical for transportation

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(say a bay completely assembled at works);

- The maintenance-free period for any of its external components shall not be less than 5 years intervals. Internal components including refilling of gas shall not be less than 10 years. The Contractor shall propose the recommended period for schedule maintenance;
- Expansion joints provided to be locked in place after alignment is complete considering calculated maximum thermal expansion for all plug-in contacts. Pressure relief device shall be provided in each gas partition module along with moisture absorber located in a suitable place. 100 micro-meter or smaller sintered stainless-steel particle filtered disc shall be provided in gas filling port.
- Conductive particle traps shall be placed at support insulators (free from all voids), non-tracking type with sufficient mechanical and electrical strength. Single or double mitered elbows shall be used with bus duct depending on mechanical stress.
- Advanced integration with SCADA and bay-level control using IEC 61850 communication protocols.
- The enclosure and support structure shall be designed in such a way that a mechanic of 1800 mm in height and 80 kg in weight is able to climb on the equipment for maintenance.
- The Contractor shall furnish the following information/calculations for approval of the purchaser:
 - ✓ Details regarding the loosely distributed metallic particles within the GIS encapsulation and calculations of critical field strength for specific particles of defined mass and geometry.
 - ✓ Study report of VFTO generated for GIS installation.
 - ✓ The methodology and all the equipment for electrical partial discharge (PD) detection, including that mentioned in the specification else-where.
 - ✓ The calculations and documents in support of the average intensity of electromagnetic field on the surface of the enclosure above during detailed engineering.
 - ✓ The detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms
 - ✓ Calculations to show that there is no Ferro resonance due to capacitance of GIS for the voltage transformers
 - ✓ Design calculation for simulated parameters for Seismic level as applicable
 - ✓ Insulation Coordination studies including studies to recommend for additional surge arrestor
 - ✓ Calculation in support of touch & step voltages in all enclosures and earthing of complete GIS installation.

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- ✓ Measures to mitigate transient enclosure voltage by high frequency currents.
- ✓ Calculation for providing bus duct supports
- ✓ Calculation operating mechanism of breakers, disconnector and earthing switches.
- ✓ Data/calculations in regard of the load under severe short circuit conditions to be transferred to civil structure for designing of GIS hall

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6. Gas Enclosures

- The different sections or compartments constituting the gas enclosure shall be equipped with static filters. These filters shall be capable of absorbing any water vapor which may penetrate into the enclosure and shall be effective at least for the duration of time between major overhauls. Each compartment shall be fitted with a gas density monitor with indication;
- Due to safety requirement for working on the pressurized equipment, whenever the pressure of a gas compartment is reduced for maintenance, it should be ensured (through design) by the contractor that adjacent compartment would remain in service;
- The material and thickness of enclosures shall be such as to withstand an internal; flashover without burn through at rated fault current for a period as per IEC 62271-203. The material shall be such that it has no effect on environment as well as from the byproducts of SF₆ breakdown under arcing condition;
- SF₆ is completely sealed in and will not be consumed. Thus, with proper use there should be no environmental danger;
- Each gas compartment shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other gas compartment. To reduce the probability of leaks, connections with pipes between gas compartments is not acceptable;
- Each gas zone shall be furnished with a gas monitoring system consisting of a gas density continuous monitoring device;
- The gas-tight barriers and support 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 compartments or from the by-products of SF₆ breakdown under arcing conditions;
- Tests shall be carried out during the manufacturing of the switchgear to ensure that all insulators are free of partial discharge at a voltage which is at least 10% higher than the rated voltage.
- Each pressure filled enclosure shall be designed and fabricated to comply with the the design temperature and design pressures as defined in IEC 62271-203;
- Aluminium or aluminium alloy shall be exclusively used for the enclosures to resist external and internal corrosion without time limit, and without need of periodic cleaning and painting;
- The enclosures shall be designed to eliminate as much as possible all external effects of the flux created by normal and fault currents. The power losses in the system shall be kept to a minimum, and induced voltages on the enclosures shall not be allowed to exceed reasonable limits of safety for operating personnel;

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- The Contractor shall furnish supporting calculations in respect of induced voltage and losses guaranteed for the enclosure;
- Design calculations or proof test report to demonstrate strength of enclosure at design pressure and design temperature shall be furnished;
- 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 30°C at an ambient air temperature not exceeding 40°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 40°C;
- Manufacturers standard paint colour shall be used; a satin mat finish with a high scratch resistance is preferred.

7. SF₆ Gas

- The SF₆ gas required for first filling shall be furnished with the GIS, along with connecting hose and fittings. About 25% additional quantity of gas be supplied along with the gas required for first filling of equipment;
- SF₆ gas to be filled in GIS shall, in all respect, conform to the following values (in accordance with latest IEC publication):

Impurity Max allowable concentration (by weight)

Air	: 0.05%
CF ₄	: 0.05%
Moisture	: 15 ppm
Hydrolyzable fluorides expressed as HF	: 1.0 ppm

- During commissioning, the dew point of SF₆ gas shall be measured and documented;
- Components may be filled with N₂ for transportation and refilled with SF₆ on site.

8. Gas Sealing

- All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum;
- The permissible gas leakage shall be less than 0.5% per year for complete switchgear;
- All gas seals shall be located in double-groove for protecting the seals from dirt and corrosion and shall be of the self-centering type within the groove. Main seal shall be protected from dirt and corrosion by auxiliary seal.

9. Gas Density Monitoring Devices

- Temperature compensated gas density monitoring devices shall be provided for each gas

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compartment;

- Any pipe connection between the various gas compartments and a centralized measuring device is not acceptable;
- The devices shall provide continuous and automatic monitoring of the density of the gas and also provide online monitoring (Display at SAS) of the density of the gas.
- The SF₆ gas monitoring system shall have two alarm settings:
 - ✓ Early warning, when the gas density is approaching a low level;
 - ✓ Alarm stage, when the gas density is reaching the low insulation level and initiating the blocking of the circuit-breaker trip and close coils.

10. Pressure Relief Device

- Automatic pressure relief devices shall be incorporated in the basic design as a precaution against bursting of enclosure;
- Pressure relief shall be by means of bursting disc or pressure relief system with a preset opening pressure;
- Devices shall be positioned to ensure that personnel will not be endangered in case of sudden relief of gas.
- Automatic external pressure relief devices shall be incorporated in the basic design as a precaution against bursting of enclosure. Internal pressure relief devices shall not be acceptable. The bursting pressure of the relief device shall be effectively coordinated with the rated gas pressure and the pressure rise due to arcing to avoid any mal-operation in normal operating conditions. Deflection devices shall be installed to ensure that personnel will not be endangered. Pressure relief shall be by means of a metallic bursting disc system with a preset opening pressure. For better gas tightness, bursting discs made of graphite or non-metallic material shall be avoided.
- If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided.

11. Busbars

- The conductors of the busbars shall be fabricated of aluminum alloy sections of cross-sectional area suitable to meet the current rating requirements;
- The main busbars shall be housed in three phase enclosure while the GIB (Gas Insulated Bus) shall be housed in single phase enclosure. The tubular bus compartment shall be housed in corrosion resistant aluminum enclosures, filled with pressurized SF₆ gas;
- The conductors shall be supported from the enclosures by homogeneous epoxy resin

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insulators shaped to ensure uniform electrical field distribution and zero corona at rated voltage. Adequate provisions shall be made for absorption of the thermal expansions between the conductors and the enclosures. The metal bellow type compensators for adjusting tension shall be provided where ever required.

- Optimization of outdoor GIB length using overhead AIS connection with Bus Post Insulator of respective voltage class is generally acceptable subject to meeting the electrical clearances as stipulated.
- For the maintenance of GIB of one circuit, only that circuit shall be isolated. Adequate clearance between bus ducts of two circuit shall be ensured by the contractor during layout finalization.

12. Expansion Joints and Flexible Connections

- Adequate provision shall be made for absorption of thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. Metal bellow type compensators with adjustable tensioners shall be provided, where required;
- The continuity of service during thermal expansion / contraction and vibrations shall be ensured;
- Expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected.
- Bellows or Compensating Units: - Adequate provision shall be made to allow for the thermal expansion of the conductors & enclosures and for differential thermal expansion between the conductors and the enclosures. The bellows metallic (preferably stainless steel) with suitable provision for permitting the movement during expansion and contraction maybe provided and shall be of following types:
 - Lateral / Vertical mounting units: These shall be inserted, as required, between sections of busbars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.
 - Axial compensators: These shall be provided to accommodate changes in length of busbars due to temperature variations.
 - Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.
 - Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.
 - Vibration compensators: These bellow compensators shall be provided for absorbing

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vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

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

13. Support Structures, Ladders and Walkways

- All supporting structures necessary for the support of the GIS equipment including associated parts as anchor bolts, beams, wall / floors, etc. shall be supplied;
- Access has to be considered in the design of the structures to all equipment of the GIS;
- It shall be possible to access to all the filling valves with the gas cart at reasonable distance;
- All steel structure members shall be hot-dip galvanized after fabrication. All field assembly joints shall be bolted. Field welding shall not be acceptable;
- Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work;
- All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation.

14. Earthing of the GIS

- The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences
- The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The contractor shall supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The contractor is also required to supply all the earthing conductors and associated hardware material for connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure, GIS surge arrestor etc. to the ground bus of GIS.
- 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, current transformers, voltage transformers, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected either internally or externally with Copper bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main

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grounding bus of the GIS.

- The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS. The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus. The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents due to by lightning strikes, operation of surge arrestor, phase to earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The manufacturer shall provide suitable barrier of non-linear resistor/counter discontinued SF6/Air termination SF6/HV cable bushing etc. to mitigate transient enclosure voltage.
- The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values. The enclosures of the GIS shall be grounded at several points and connected to ground bus such that there shall be a grounded cage around all live parts;
- The three (3) enclosures of the single-phase GIS shall be bonded to each other at the ends of the GIB to ensure and localize flow of circulating currents;
- Substantial earthing terminals / pads suitable for connecting 75 x 8 mm mild steel flat capable of carrying the maximum possible earth-fault current shall be provided at positions to be determined by the GIS manufacturer. The terminals shall be designed to carry this current without damage for a duration at least equal to the short circuit period of the main busbars. These grounding terminals shall be suitable for bolted connection;
- The Contractor shall provide the material and labor to bond each earthing terminal to the main grounding grid located within the GIS hall and GIB in Transformer enclosures / hall. Earthing conductors shall be capable of withstanding 50 kA for 1 second;
- Where operating mechanism cabinets are mounted on the GIB enclosures, the grounding shall be made by separate conductor. Local control cabinets and marshalling boxes shall be grounded through a separate conductor;
- All conduits and control cable sheaths shall be connected to the control cabinet or marshalling box grounding bus. All steel structures shall be grounded. All wirings of GIS shall be shielded and grounded. Sub-assembly to sub-assembly ground conductors should be provided to ensure safe voltage gradients;

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- Provisions of IEC 62271-203 and IEC 60694 regarding safeguards in earthing of connected cables, testing during maintenance and other safety measures shall be ensured.

EQUIPOTENTIAL EARTH MAT: (BELOW THE GIS)

- When a fault current flows through the earthing connections into the soil, the enclosures, linked to the earthing circuits, are carried at the same potential as the earthing mat conductors but this potential is generally different from that on the soil surface.
- In order to ensure the security of personnel, it is necessary to install an equipotential mat linked to the general earthing mat in the zones where metal enclosures and fixed accessories are accessible from the floor.
- It is also necessary to provide an equipotential earthing mat in the zones where an emergency mechanical operation or a locking system is accessible from the floor. It is therefore possible to extend the equipotential mat to allow the operator to carry out his manoeuvres.
- In order to ensure a good equipotential surface, each element of the equipotential mat must be connected to the general earthing network by the manufacturer.
- This mat will be placed on the floor, all around the switch gears. It is not required in front of the control cubicles. If it is an oxidizing material, it should be hot dip galvanized.
- The manufacturer must provide and specify this equipotential earthing mat. The location of the equipotential mat should be defined by the supplier for all the GIS and at places where:
 - The enclosures are accessible for the floor.
 - Manual operation of apparatus or locking system is located.
- Three copies of final equipotential earth mat drawings along with design calculations may be submitted for approval by the successful Tenderer.

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15. Local Control Equipment and LV Cables

- Each switchgear bay module shall be supplied with a main control cabinet either installed on the floor or mounted onto the switchgear. The cabinet shall have full height, hinged, gasketed and lockable doors;
- The cabinet shall provide the following functions and devices:
 - Mimic diagram;
 - Switchgear control functions;
 - Local / Remote operating mode.
- Local visualisation and control:
 - Position indication;
 - SF₆ alarms;
 - Integrated bay interlocking;
 - AC and DC power supply;
 - All necessary incoming and outgoing terminal blocks;
 - Space heaters when necessary.
- All control wiring and terminations internal to the switchgear, and connecting the switchgear to the bay module control cabinets, shall be provided by manufacturer;
- All control cables shall be shielded. Cable shields shall be grounded at both ends. Grounding connections shall be as short and direct as possible and shall terminate at the point of entry to cabinets or terminal boxes;
- All control cables shall be installed and terminated in such a manner as to limit the effects of transient electromagnetic voltages on the control conductors to an acceptable level.
- Closing of the circuit- breaker from the local control unit shall only be available when the breaker is isolated for maintenance purposes. Circuit-breaker control position selector, operating control switch and electrical emergency trip push button shall be installed in the Local Control Cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only. The emergency trip push buttons shall be properly shrouded.
- If Disconnect or earth switch is not in the fully open or closed position a "Control Circuit Faulty" alarm shall be initiated, and electrical operation shall be blocked.
- 20% spare terminals shall be provided in each LCC apart from terminals provided for the termination and interconnection of all cabling associated with remote and supervisory control, alarms, indications, protection and main power supply etc .

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- Where plugs and sockets connect control cabling between the local control cubicle and the switchgear these shall not be interchanged. In plug in connector type cable arrangement, min 2 cores of the cable with connected condition on both side up to the TB to be left unused as spare.
- Hydraulic/pneumatic and SF6 auxiliary equipment necessary for the correct functioning of the circuit breaker, isolators and earth switches shall be located in a separate cubicle compartment.
- LCC shall be suitable for remote operation from substation automation system (SAS). Each gas tight compartment shall be monitored individually per phase basis through SAS
- Constructional Features
- Local Control cubicle shall be free standing, floor mounting type (Standalone). Bay mounted LCCs are not accepted. It shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation. Alternatively folded sheet panels of adequate thickness and strength is also acceptable. Minimum degree of protection of enclosure of LCC shall be IP55
- Access to all compartments shall be provided by doors. All fastenings shall be integral with the panel or door and provision made for locking. Cubicles shall be well ventilated through vermin-proof louvers (if required) having anti insect screen. All doors shall be gasketed all around with suitably profiled Neoprene/EPDM gaskets conforming to the provision of IS 11149.
- For LCC panel of each feeder bay (i.e. line, transformer, etc.), Bus Coupler bay, separate AC/DC supply for power circuit of GIS switchgear shall be provided, fed directly from ACDB/DCDB. The control DC supply (for control, interlocking, signaling) shall be tapped from respective relay & protection panel. For LCC panel illumination and heating purpose Loop in Loop out AC Supply can be provided.
- Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses/MCBs. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier bases shall have imprints of the fuse 'rating' and 'voltage'.
- Each LCC Panel shall be provided with the following

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- 1. Plug Point: 240V, Single phase 50Hz, AC socket with switch suitable to accept 5/15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.
- Interior Lighting: Each panel shall be provided with a door-operated LED lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.
- Space Heater: Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.
- Operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations, and other ancillary equipment shall be accommodated in sheet steel vermin proof IP-65 cubicles.
- The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of associated apparatus. All the control switches shall be internal i.e. installed behind a lockable glass door, that allows a complete view of the annunciator and mimic diagram when the LCC door is closed. Necessary protection shall be provided to avoid inadvertent operation of control switches.
- An interlocking scheme shall be provided that takes into account the following basic requirements.
- To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
- prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.
- Electrical bolt interlocks shall be energized only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocked/handle lock, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.
- Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.
- Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except that where double bus bar arrangements are specified, on-load transfer of feeder circuits from one bus bar to another shall be made possible by interlocks which ensure that the associated bus coupler and its isolators are closed.

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- Bus coupler circuit breaker shall be Electrically interlocked so that it shall not be possible to open a bus coupler circuit breaker while on load change over is in progress.
- All isolating devices shall be interlocked with associated circuit-breakers and isolators in the same station so that it shall not be possible to make or break current on an isolating device unless a parallel circuit in that station is already closed.
- Separate DC supply with changeover facility shall be provided in the LCC for control and power requirement of the GIS bay components and local alarm/indication.

16. Low Voltage Equipment

- All control circuits shall be manufacturer's standard for the application on hand, but shall be approved by the Employer. Special functions shall be included if indicated in the single line diagram, or if shown in special control specifications accompanying this enquiry;
- All local control functions such as:
 - Switchgear interlocking functions;
 - Over current protection means for low voltage equipment;
 - Local operation of the switchgear;
 - Indicating and measuring equipment.

Must be located either at the bay or in the local control cubicle. The cubicle shall have degree of protection IP33 at least.

- All switching devices shall be interlocked by means of electrical or electronic equipment. These interlocking facilities shall be located in the local control cabinet of each bay. These must provide absolute and reliable protection against any potentially harmful maloperation of the switchgear. The following functions shall be provided:
 - The operator must be forced into the only safe and logical sequence to actuate circuit-breakers, switches, disconnectors and earthing switches;
 - The actual, completely closed or completely opened position of all switching devices must be checked before and after each move;
 - Implementation of logic checks and issuing the resulting signals ENABLE or BLOCKED for the switching device;
 - Manual local operation and automatic remote operation for all essential functions;
 - Local emergency unlocking equipment via safety key switch under full responsibility of the operator.
- The gas monitoring and indication of each bay shall be carried out for all three phases

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separately. The density monitors shall be located directly at the gas compartment monitored.

The gas monitoring shall have suitable fittings and valves to fulfill the following functions:

- For circuit-breaker compartments: monitoring of the gas density with alarm for drop in density, lock out of the circuit-breaker in case of a further drop and an indication;
 - For switchgear gas compartments: monitoring of the gas density in two stages and an indication;
 - Access for evacuating, filling and topping via gas service cart.
- Finely-stranded copper wire of at least 1.5 mm² cross-sections shall be used within the control cabinet for all control wiring. Manufacturer's standard crimp-type terminations and screw line-up terminals suitable for a cross-section of at least 2.5 mm² proofed against creepage currents shall be used. All interconnecting wiring must be suitably protected against mechanical damage, e.g. by routing them in protective channels or pipes;
 - The core insulation and outer sheath of cable shall be of halogen-free special polymer.
 - The cable shall be flame-retardant, flexible, abrasion-and wear-resistant
 - Prefabricated cables with sufficient spare cores with heavy duty multi-point plug-in connections on GIS end shall be provided.
 - All instrument transformer connections shall be hard wired to terminal block via ring type connection.
 - Each control circuit shall be protected by suitable over current protection means which provide an alarm signal when operated;
 - Anti-condensation heaters shall be provided in the control cabinets, in the operating mechanism housings of disconnectors, earthing switches, circuit-breakers, current and voltage transformers.

17. Circuit Breakers

The circuit breakers switches are represented on the single line diagram as 52.

General: SF₆ gas insulated metal enclosed circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification

- The circuit breakers shall comprise one or two interrupting chambers puffer type. It shall be designed for installation in SF₆ gas-insulated metal clad switchgear, and shall use SF₆ gas for both insulation and arc quenching;
- The breaker operating mechanism shall be of the Motor-spring charge mechanism with stored energy for multiple operations. Pneumatic or hydraulic mechanisms are not acceptable. It

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shall be suitable for single and triple pole automatic reclosure;

- The circuit breakers shall be suitable for following switching duties:
 - ✓ Terminal faults;
 - ✓ Short line faults;
 - ✓ Out of phase switching;
 - ✓ Interruption of line charging currents.
- The operating mechanism shall be capable of performing a complete O- 0.3s – CO – 3 min - CO sequence. On failure of the motor drive or breakdown of the auxiliary voltages, an O-CO operation shall still be possible;
- The circuit breaker shall be capable of: Interrupting the steady and transient magnetizing current shall be as follows:
 - a) Interrupting line/cable charging/capacitive current as per IEC without re-strikes and without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4
 - b) Clearing terminal fault (100%) & short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
 - c) Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.
 - d) The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization of shunt reactor and/or series capacitor compensated lines with trapped charges.
- All control and monitoring equipment for the circuit-breaker and its accessories shall be installed in a drive control cubicle. The related control wiring shall be wired to plug-in connectors. The cabinet shall have degree of protection IP33 at least;
- The circuit breaker control system shall prevent closing of the circuit breaker when there is insufficient stored energy in the operating mechanism storage system and insufficient SF₆ gas density / dielectric strength. It shall lockout the breaker when the SF₆ gas density drops below a minimum permissible level. The state of the breaker arc-quenching and insulating gas shall be monitored by a temperature-compensated pressure switch or density switch with two alarm levels. The first stage alarm shall be set well before any dangerous condition is reached; the second stage shall initiate breaker lockout. In addition, the actual gas pressure shall be shown on a local control cubicle / SCADA;
- The insulation strength across the open contacts of the circuit breaker for lightning impulse, switching surges and power frequency withstand voltages shall be as per IEC60694 / 62271-

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100;

- The circuit breaker and bus insulation shall be coordinated so that due to lightning impulse, switching surge and power frequency voltage, no flashover shall take place. In case flashover takes place, the same shall be confined in the bus rather than in the circuit breakers in either open or closed position;
- The circuit-breakers shall be provided with at least two trip coils and two closing coils. Provisions for manual emergency operation must be made. All circuit-breakers shall be suitable for remote control. Main contact position of all three poles must be indicated by directly activated auxiliary position switches with at least 12 NO and 12 NC contacts wired to a plug connector in the local control panel for customer's use;
- The circuit breaker shall be able to operate locally or from a remote point. Local operation shall be by means of an open / close control switch located in the bay module control cabinet. Remote control via a remote / local control transfer switch will be from the power house control room. The protection devices will remain operational in either remote or local control mode. When in the maintenance mode, all remote trip or close control signals will be blocked. The breaker controls shall operate from the two independent 220 V DC systems with both the trip coils connected;
- The circuit breaker as well as local control cubicle shall be provided with red and green local indicating lamps which shall be connected through one normally open and one normally closed contact of auxiliary switch for each pole. The circuit breaker shall further be provided with amber lamp to indicate healthy trip conditions. i.e trip circuit supervision;
- A mechanical indicator shall display the position of the main contacts;
- The circuit breakers shall be interlocked electrically with their associated disconnectors such that the disconnector cannot be opened unless the associated circuit breakers are opened. The interlocking shall prevent any incorrect switching sequence and enable the breakers to be operated without risk, either from the local bay module control cabinet or from remote control room;
- The circuit-breaker mechanisms shall be provided with anti pumping devices to prevent pumping when the closing circuit remains energised and should the CB either fail to latch, or be tripped by a protection device during closing;
- The specified system studies shall be carried out to determine the location and characteristics of the surge arrester and to define the necessary switching devices. The switching devices shall of the "POINT ON WAVE" type employing state of the art technology
- Operating counters shall be provided for each pole of the circuit breaker;
- The Contractor shall demonstrate by calculus if the circuit breakers require pre-insertion

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resistors in order to manage switching transients over a switching event.

17.1. Constructional Features:

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

- a) If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.
- b) Contacts: All making and breaking contacts shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.
- c) Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.
- d) Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.
- e) The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 p.u. power frequency voltage across the breaker continuously)
- f) In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products
- g) Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site. The contractor shall supply three set of transducers for each substation covered under the scope.
- h) Circuit Breaker shall be supplied with auxiliary switch having additional 10 NO (normally open) and 10 NC (normally closed) contacts for future use over and above those required for switchgear interlocking and other control and protection function. These spare NO and NC

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contacts shall be wired upto the local control cubicle.

- i) The CO (Close-open) operation and its timing shall be such as to ensure complete travel/insertion of the contact during closing operation and then follow the opening operation.
- j) The bidder has to verify whether the offered insulation level of the line end breakers is adequate for the respective transmission lines or not.

17.2. Operating mechanism

General Requirements:

- a) Circuit breaker shall be operated by spring charged mechanism.
- b) The mechanism shall be housed in a dust proof cabinet and shall have IP: 55 degree of protection.
- c) The operating mechanism box shall be strong, rigid, rebound free and shall be readily accessible for maintenance.
- d) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.
- e) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker.
- f) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. A non-resettable operation counter shall also be provided.
- g) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
- h) The contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.
- i) The duty cycle for the CB shall be O-0.3s-CO-3 min-CO.

17.3. Control :

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- a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.
- b) Each breaker pole shall be provided with two (2) independent tripping circuits and trip coils which may be connected to a different set of protective relays.
- c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose, a local/remote selector switch and close and trip control switch shall be provided in the breaker control cabinet.
- d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.
- e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.
- f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies shall be monitored for remote annunciations and operation lockout in case of dc failures.
- g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

17.4. Spring operated mechanism (spring-spring)

- a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
- b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
- c) After failure of power supply to the motor one O-CO operation shall be possible with the energy stored in the operating mechanism.
- d) Breaker operation shall be independent of the motor which shall be used solely for

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compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 90 seconds for full charging of the closing spring.

- e) Closing action of circuit breaker shall compress the opening spring ready for tripping.
- f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local control cabinet & SAS .
- g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.
- h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.
- i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
- j) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-3 minutes.
- k) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.
- l) An overload relay shall be provided for protection of the spring charging motor.

17.5. Technical Parameters

Rated voltage	245 kV	
Rated current	3150 A	
Short-circuit rated current	50 kA	
Peak current (peak value)	135 kA	
Rated One minute Power insulation level	Phase to Earth	460 kV (rms)
	Open contact	530 kV (rms)
Rated Switching impulse withstand voltage (kV peak)	Phase to Earth	1050 kV
	Across open contacts	1200 kV
Performance during capacitive current switching	Class C2 as per IEC 62271-100	

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Frequency of mechanical operation	Class M2 as per IEC 62271-100
Operating mechanism	Spring type
Number of auxiliary contacts	12 NO and 12 NC on each pole wired to terminal blocks in control cabinet
Number of trip coils	2 per pole
Number of closing coils	2 per pole
SF ₆ gas characteristics for SF ₆ circuit breaker	As per IEC-60376
Breaking time	40 ms
Closing time	60 ms
Rated braking time	40ms
Noise level	140dB at 50m distance from the base of circuit breaker
Rated supply voltage of closing and opening devices and auxiliary circuit	220 V dc, 240 V ac, 50Hz / 415 V ac, 50 Hz, 3-phase.
SF ₆ filling pressure (*)	0.70 MPa

(*) Gauge pressure at an ambient temperature of 20°C and an atmospheric pressure of 0.1013 MPa

TESTS:

- The circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.
- The type test report of Electromagnetic Compatibility Test (EMC) of CSD shall be submitted for approval

ROUTINE TESTS

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

- 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 control voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be arranged by the contractor at his

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own cost. After completion of site pre-commissioning test, 03 nos. travel transducer shall be handed over to purchaser.

- During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test.
- Routine tests on Circuit breakers with Controlled switching device as per IEC/TR 62271-302.

18. Disconnectors

Disconnectors are used in order to assure a dielectric safe gap between both contacts for secure isolation of system areas with different potential, e.g. busbar disconnectors isolating a circuit breaker, transformer, reactor, and transmission lines from the busbar.

The disconnectors typically are represented on the single line diagrams attached as 29. The disconnectors shall be of single pole encapsulated type. They shall be three-phase linkage-operated by a maintenance-free self-contained electric motor, installed in the switchgear, in locations as shown on the single-line diagram;

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

- The disconnectors shall be equipped with a manual operating mechanism. Whenever it shall be impossible to operate the device electrically during the manual operation;
- The disconnectors on the bus side shall have the following breaking capabilities:
 - Closed loop current breaking capability in case of transfer of one operating bus to the other;
 - Breaking capability of capacitive charging current of GIS busbars.

Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when the above currents are interrupted.

- The disconnecting switch operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All bearings shall be permanently lubricated or shall be such that no lubrication or maintenance is

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required;

- The disconnecter enclosures shall be provided with inspection windows in order to know the status of the main contacts;
- Opening and closing of the disconnectors shall be either by local or remote control;
- Remote control through the Remote / Local transfer switch shall be from the control room;
- The disconnecting switch operation shall be interlocked electrically with the associated circuit breakers such that the disconnecting switch control is inoperative if the circuit breaker is closed. Actuation of the emergency manual operating device shall also disable the electrical control;
- Disconnectors and adjacent maintenance earthing switches shall have electrical interlocks to prevent closure of the earthing switches when the disconnectors are in the closed position and to prevent closure of the disconnecting switch when the earthing switch is in the closed position;
- The disconnecting switch shall be pad lockable in the close, open or electrical position;
- Each disconnecting switch shall have a clearly identifiable local, positively driven mechanical position indicator, together with remote position indicator on the bay module control cabinet;
- Disconnectors having adjacent high-speed earthing switches shall be interlocked such that the high-speed switches close first to discharge the line charging currents before the respective disconnectors may be opened;
- Signaling of the closed position shall not take place unless it is certain that the movable contacts has reached a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely;
- Each disconnecting switch shall be supplied with 12 NO and 12 NC auxiliary switches mechanically coupled to, for use by others, over and above those required for switchgear interlocking purposes.
- The mechanical endurance class shall be M2 as per IEC for 400kV, 220 kV and 132kV disconnectors. Electrical endurance class shall be E2.
- Disconnect switch shall be capable of switching inductive currents as per IEC 60129 and bus transfer as per IEC 61128

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18.1. Technical Parameters

Rated voltage	245 kV
Rated current	3150 A
Short-circuit rated current	50 kA
Peak current (peak value)	135 kA
Rated One minute Power insulation level	Phase to Earth 460 kV (rms)
	Open contact 530 kV (rms)
Rated Switching impulse withstand voltage (kV peak)	Phase to Earth 1050 kV
	Across open contacts 1200 kV
Operating mechanism	Electric motor
Number of auxiliary contacts	12 NO and 12 NC on each pole wired to terminal blocks in control cabinet
SF ₆ gas characteristics for SF ₆ disconnectors	As per IEC-60376
Total operating time of disconnector along with its operating mechanism	Less than 8 seconds
Interruption of loop current	2000 A @ 20 V
Rated capacitive current make and break capacity	0.5 A.
Rated supply voltage of devices and auxiliary circuit	220 V dc, 240 V ac, 50Hz / 415 V ac, 50 Hz, 3-phase.
SF ₆ filling pressure (*)	0.70 MPa

19. Maintenance Earthing Switches

Maintenance earthing switches are used for properly connecting de-energized live parts of the high-voltage system to the ground and to protect personal during maintenance works.

- The maintenance earthing switches shall be of the single pole encapsulated type. They shall be three-phase linkage-operated by a self-contained electric motor;
- In order to provide test facilities, the maintenance earthing switches shall be insulated from the enclosures and have easily removable ground connections;
- Each earthing switch maintenance shall be electrically interlocked with its associated disconnecting switch and circuit breaker such that it can only be closed if both the circuit

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breaker and disconnecting switch are open. Once closed it shall be secured against re-opening;

- The maintenance earthing switches enclosures shall be provided with inspection windows in order to know the status of the main contacts;
- Maintenance earthing switch shall be made operable remotely or locally from the bay module control cabinet;
- Each maintenance earthing switch shall have a clearly identifiable local, positively driven mechanical position indicator, together with remote position indicator on the bay module control cabinet;
- Interlocks shall be provided such that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits;
- Each maintenance earthing switch shall be supplied with 12 NO and 12 NC auxiliary switches mechanically coupled to, for use by others, over and above those required for switchgear interlocking purposes;
- Provision shall be made for padlocking the maintenance earthing switches in either the open or close position.;
- Provisions for manual operation shall be made. Whenever it shall be impossible to operate the device electrically during the manual operation.
- The safety grounding switches shall conform to the requirements of IEC- 62271- 102 and shall have electrical endurance class: E2 & shall have mechanical endurance class M2 for 220 kV voltage level.
- The grounding switch shall be provided with test provision (insulated link) to permit test voltage up to 10 kV and up to 200 A to be applied to the main conductor without removing SF6 gas from the enclosure and without disassembling the enclosure except for ground shunt leads.
- The degree of protection of the Drive Mechanism box of maintenance earth switch shall be IP55
- Termination point grounding switch shall be able to make short circuit current and capable of breaking the induced capacitive and inductive current as per IEC 61129 (Class-B duty) considering the transient recovery switching duty imposed on grounding switch.
- Mechanical position indication shall be provided locally at each switch and Electrical indication at each Local Control Cabinet (LCC) / SAS.

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19.1. Technical Parameters

Rated voltage	245 kV
Short-circuit rated current	50 kA
Peak current (peak value)	135 kA
Rated One minute Power insulation level	Phase to Earth 460 kV (rms) Open contact 530 kV (rms)
Rated Switching impulse withstand voltage (kV peak)	Phase to Earth 1050 kV Across open contacts 1200 kV
Operating mechanism	Electric motor
Number of auxiliary contacts	12 NO and 12 NC on each pole wired to terminal blocks in control cabinet
SF ₆ gas characteristics for SF ₆ disconnectors	As per IEC-60376
Total operating time of earthing switch along with its operating mechanism	Less than 8 seconds
Rated capacitive current make and break capacity	0.5 A
Rated supply voltage of devices and auxiliary circuit	220 V dc, 240 V ac, 50Hz / 415 V ac, 50 Hz, 3-phase
SF ₆ filling pressure	0.70 MPa

20. High Speed Earthing Switches

Earthing switches located at the entrance of the transmission line circuits and on busbars shall be of the high-speed type and shall be used to discharge the respective charging currents, in addition to their safety grounding function.

- The high earthing switches shall be capable of interrupting the inductive and capacitive currents of the equipment to be discharged;
- The high-speed earthing switches shall be of the single pole encapsulated type. They shall be three-phase linkage-operated by a self-contained electric motor;
- Closing and opening switching shall be fast action type to provide switching capability;
- The short-circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating;
- High speed earthing switch operation shall be done locally from the bay module control

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cabinet, or remotely from the control room in conjunction with opening of the associated disconnecting switch;

- These earthing switches shall be electrically interlocked with their associated circuit breakers such that the earthing switches cannot be closed if the circuit breakers are closed. The earthing switches shall be required to close before the disconnectors are opened in order to dissipate the trapped charges, when the lines are taken out of service for maintenance, etc.;
- Each high-speed earthing switch shall have a clearly identifiable local, positively driven mechanical position indicator, together with remote position indicator on the bay module control cabinet;
- The high-speed earthing switches enclosures shall be provided with inspection windows in order to know the status of the main contacts;
- Interlocks shall be provided such that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits;
- Each high-speed earthing switch shall be supplied with 12 NO and 12 NC auxiliary switches mechanically coupled to, for use by others, over and above those required for switchgear interlocking purposes;
- Provision shall be made for padlocking the high-speed earthing switches in either the open or close position.
- High speed ground switch operation should be possible locally from Local Control Cabinet (LCC) as well as from SAS.
- The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 3 sec. and shall be equipped with a silver-plated contact and to be connected to copper flat riser outside the earthing switch module.

20.1. Technical parameters

Rated voltage	245 kV	
Making capacity	135 kA	
Short-circuit rated current	50 kA	
Peak current (peak value)	135 kA	
Rated One minute Power insulation level	Phase to Earth	460 kV (rms)
	Open contact	530 kV (rms)
Rated Switching impulse withstand voltage	Phase to Earth	1050 kV

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(kV peak)	Across open contacts 1200 kV
Operating mechanism for contact opening	Electric motor
Operating mechanism for contact closing	Spring
Number of auxiliary contacts	12 NO and 12 NC on each pole wired to terminal blocks in control cabinet
SF ₆ gas characteristics for SF ₆ disconnectors	As per IEC-60376
Total operating time of earthing switch along with its operating mechanism	Less than 3 seconds
Rated capacitive current make and break capacity	18 A.
Rated supply voltage of devices and auxiliary circuit	220 V dc, 240 V ac, 50Hz / 415 V ac, 50 Hz, 3-phase.
SF ₆ filling pressure	0.70 MPa

21. Voltage Transformers (IVT)

The voltage transformers are represented on the single line diagram as IVT.

- The voltage transformers shall be located as required on the single line diagram and shall be used for protection, metering and synchronizing;
- Ratings shall be as stated in attached technical schedule;
- The voltage transformers shall be of the inductive type with SF₆ gas insulation and shall be effectively shielded against high frequency electromagnetic transients;
- The voltage transformers shall be of single-phase transformer with three secondaries type, but forming with another two voltage transformers an assembly for Y connexion with their neutrals connected to earth;
- The voltage transformers shall conform to the IEC 60044-2 and other relevant standards except to the extent explicitly mentioned in the specification;
- Provision for short circuit and overload protection for voltage transformers against external short circuit shall be made;
- The rating and diagram plate shall be provided complying with the requirement of IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, and connection diagram etc.;
- The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of SF₆ switchgear;

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

21.1. Technical Parameters

Ratings for each voltage transformer shall be as stated below:

A. Voltage Transformes : Transformer feeder

Parameter	Winding-III	Winding-II	Winding-I
Rated secondary voltage, V	110 / $\sqrt{3}$	110 / $\sqrt{3}$	110 / $\sqrt{3}$
Rated secondary burden, VA	30	30	30
Accuracy	0.2	3P	3P
Utilisation	Metering (Synchronization)*	Protection	Protection
Transformation ratio for all windings	$\frac{220 \text{ kV}}{\sqrt{3}} - \frac{110 \text{ V}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}}$		

Note *: Only one phase is required for synchronization

B. Voltage Transformers : Bus Mounted (IVT-A & IVT-B)

Parameter	Winding-III	Winding-II	Winding-I
Rated secondary voltage, V	110 / $\sqrt{3}$	110 / $\sqrt{3}$	110 / $\sqrt{3}$
Rated secondary burden, VA	30	30	30
Accuracy	0.2	0.2	3P
Utilisation	Metering (Synchronization)*	Protection	Protection
Transformation ratio for all windings	$\frac{220 \text{ kV}}{\sqrt{3}} - \frac{110 \text{ V}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}}$		

(*) Note: Only one single phase transformer is required

C. Voltage Transformes : Feeder IVTs (Gen-1,2,3, SST)

Parameter	Winding-I	Winding-II
Rated secondary voltage, V	110 / $\sqrt{3}$	110 / $\sqrt{3}$
Rated secondary burden, VA	30	30
Accuracy	0.2	0.2
Utilisation	Metering	Metering

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Transformation ratio for all windings	$\frac{220 \text{ kV} - 110 \text{ V}}{\sqrt{3}} / \frac{110 \text{ V}}{\sqrt{3}}$
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22. Current Transformers

The current transformers are represented on the single line diagram as CT.

- The current transformers shall be of the metal-enclosed, gas-insulated inductive type and shall be used for protective relaying and metering, fitted externally to the supporting enclosure. The CTs shall have multicores and their secondary leads shall be brought out into the secondary shorting-type terminal box;
- All current transformers shall have effective electromagnetic shields to protect against high frequency transients;
- Current transformers cores located inside the Circuit breaker compartment shall not be acceptable;
- Current transformers shall conform to IEC 60044-1, IEC 60044-6, IS 2705 and other relevant standards except to the extent explicitly mentioned in the specification;
- Suitable provision shall be made for primary current injection testing of current transformer circuits.

22.1. Technical Parameters

Ratings for each current transformer shall be as stated below:

Current Transformers : CT-52T1, CT-52T2 & CT-52T3	
Rated voltage	245 kV
CT Ratio	400-1 / 1 / 1 / 1 / 1 / 1 A
No. of CT's per phase	1
Number of cores for protection	4
Class	5P20 or PS class for Protection
Knee Point Voltage	>700 V
I _{exc.} At 0.5 knee	≤ 30 mA
R _{ct} Max (75 °C)	3.3 Ohm
Number of cores for metering	2
Class	0.2s
Burden	30
Current Transformers: CT-AB	
Rated voltage	245 kV

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CT Ratio	2200 -1 / 1 / 1 / 1 / 1 / 1 A
No. of CT's per phase	1
Number of cores for protection	4
Class	5P20 or PS class for Protection
Knee Point Voltage	>900 V
I _{exc.} At 0.5 knee	≤ 40 mA
R _{ct} Max (75 °C)	13.3 Ohm
Number of cores for metering	2
Class	0.2s
Burden	30
Current Transformers: CT-L1, CT-L2	
Rated voltage	245 kV
CT Ratio	2200-1 / 1 / 1 / 1 / 1 / 1 A
No. of CT's per phase	1
Number of cores for protection	4
Class	5P20 or PS class for Protection
Knee Point Voltage	>900 V
I _{exc.} At 0.5 knee	≤ 40 mA
R _{ct} Max (75 °C)	13.3 Ohm
Number of cores for metering	2
Class	0.2s
Burden	30

Note: The knee point voltage, the maximum exciting current at knee point voltage, the burdens, ratios, and accuracy class of the current transformers will be validated by the contractor as per Dimensioning of Current Transformers for Protection Application and may undergo change during detailed engineering.

23. Surge Arresters

The surge arresters also known as lightning arresters, are represented on the single line diagram as LA.

Each surge arrester shall conform to IEC-60099-4 for Gapless Arrester wherever applicable and shall meet the specifications indicated below:

- The surge arrester shall be of heavy-duty station class and gapless (metal oxide) type without any series or shut gaps;

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- The surge arresters (LAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers and long lines;
- The reference current of LAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. Values and calculations shall be furnished with offer;
- The LAs shall be fully stabilized thermally to give a life expectancy of one hundred (100) years under site conditions and take care of effect of direct solar radiation;
- The LAs shall be suitable for circuit breaker duty cycle in the given system;
- The LAs shall protect power transformers, circuit breakers, disconnecting switches, instrument transformers, etc with insulation levels specified in this specification;
- The LAs shall be capable of withstanding meteorological and short circuit forces under site conditions;
- The surge arresters are provided to protect the following equipment whose insulation levels are indicated in the table given below.

Equipment to be Protected	Rated Lightning Impulse (kVp) for 245 kV System
Power Transformers	1050
Instrument Transformer	1050
Circuit Breakers and Disconnectors (Across open contacts)	1050
Circuit Breakers and Disconnectors (Across open contacts)	1200

The Contractor shall carry out the insulation coordination studies as per applicable IEC. The location of surge arrestors shown on the single line diagrams is indicative only. If the Contractor feels that surge arrestors at some more locations are required to be provided, the cost for the same should also be included in the offer.

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

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The contractor shall perform all necessary studies and the report shall detail the limits of all equipment parameters which could affect the insulation co-ordination. The report shall also detail the characteristics of the surge arrester and shall demonstrate that the selected arrester's 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 purchaser's approval

23.1. Technical Parameters

Maximum continuous operating voltage (MCOV)	168 kV
Nominal System Voltage (U_n)	220 kV
Highest System Voltage (U_m)	245 kV
Frequency	50 Hz
Rated voltage (U_r)	216 kV
Lightning impulse withstand voltage for external insulation	1050 kVp
Power frequency withstand voltage for external insulation	460 kV
Creepage distance	To be determined by the Contractor
RIV (Radio Interference Voltage) at 156 kV	Less than 500 micro volts
Energy Capability	10.8 kJ / kV of U_r .
Short-circuit / Pressure relief capability	50 kA symmetrical
Nominal discharge current	20 KA of 8/20 microsec. wave
Discharge current at which insulation coordination is done	20 KA of 8/20 microsec. wave
Long duration discharge class	4
Service Conditions:	
Ambient temperature :	-10°C to +40°C
Design Altitude	1000 m
System neutral earthing	Effectively earthed

23.2. Constructional features:

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- The nonlinear blocks shall be of sintered/infered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.
- The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.
- The main grounding connection from the surge arrestor to the earth shall be provided by the contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

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

24. 245 kV generator transformer connection and outgoing line connection (SF₆ to Air bushing connection) modules

The Gas Insulated Switchgear (GIS) bays will be connected directly to the respective transformers (GTs & SST) located in transformer hall and to respective SF₆ to Air Bushings (for lines 1 & 2) located in pot head yard, through single phase Gas Insulated Bus (GIB).

- AIS equipment terminals of Lines L-1 & L-2 shall be connected to gas-insulated switchgear through SF₆ to Air bushings and GIB. AIS equipment has been covered under separate section of the document while GIB along with main circuit end terminal, SF₆ to Air bushings, connection interfaces, bends, hardware (screws, washers and nuts), seal and SF₆ gas forms part of scope under GIS.
- SF₆ to air Bushing shall be of Polymer/composite type or better and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition, substation layout. The electrical and mechanical characteristics of bushings shall be in

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accordance with IEC:60137. All details of the bushing shall be submitted for approval and design review.

- Polymer composite insulator shall be seamless sheath of a silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of the IEC publications IEC 61462 and the relevant parts of IEC 62217. The design of the composite insulators shall be tested and verified according to IEC 61462.
- Mechanical forces on bushing terminals: Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct (GIB) on one side & AIS conductor/AI tube on the other side and short circuit forces. Type test reports shall be submitted as per applicable IEC.
- Including radio interference voltage (RIV) test shall be submitted in line with the requirement as specified in Transformer package for approval.
- GTs (single phase) of generating units and SST shall be directly connected to gas-insulated switchgear through SF₆ / Oil bushings on transformers (supplied by transformer supplier). The scope under GIS shall include single phase enclosures (tubes) for the transformer Oil / SF₆ bushings, main circuit end terminal, connection interfaces, bends, hardware (screws, washers and nuts), seal and SF₆ gas;
- Enclosure adapters may be required to connect the SF₆ bus directly to the SF₆ to oil transformer bushing, bolting directly to a flange on the bushing, and totally enclosing the insulator and live parts in the SF₆ environment;
- The adapter shall have a removable cover and removable bus link to permit disconnecting the transformer from the bus, testing of the bus or transformer separately, and easy removal of the transformer (if required);
- The bus connecting the transformer to the GIS shall contain a bellows assembly and flexible conductor connection to minimize vibration transfer from the transformer;
- The limit of supply for high voltage connection on transformer is to comply with IEC standards;
- Coordination shall be established between the GIS supplier and transformer supplier through the Contractor in order to perform the required steps over the engineering, installation and testing stages;
- The Contractor shall be responsible for coordination and shall supervise and approve all steps relating to the connection between the GIS tube and the HV bushing of the transformer. The Contractor shall be responsible for the sealing, SF₆ filling and pressure

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testing of the connection. Testing of the connections shall be done jointly with the GIS supplier according to IEC standards 60270, 60137 and 62271-203.

24.1. Technical Parameters

Rated voltage	245 kV
Rated power frequency withstand voltage	460 kV
BIL (1.2/50 μ s) Rated lightning impulse withstand voltage	1050 kVP
SIL (250/2500 μ s) Rated switching impulse withstand voltage	
Rated normal current (minimum)	2500 A
Rated short-time withstand current (3s)	50 kA
Rated peak withstands current	135 kA
Rated frequency	50 Hz
SF₆ pressure gauge:	
-Filling pressure (at 20 °C)	0.65 MPA
-Min. service pressure range (Dielectric test pressure) at 20°C	0.58 MPA
-Design pressure of the adapter housing	0.92 MPA
-Test pressure of the adapter housing	1.84 MPA
-Rupture diaphragm bursting pressure	1.1 \pm 5% MPA
-Bursting pressure of the adapter housing	\geq 4.7 MPA
Loss of gas (per year and compartment)	<0.5%
Temperature rise of enclosures at rated current:	
- which have to be touched during normal operation	MAX 20°C
- which need not be touched during normal operation	MAX 30°C
- which are not accessible to the operator	MAX 60
Ambient temperature range:	
- indoor	-10°C TO 40°C
- outdoor	-10°C TO 40°C

25. Online Portable Monitoring System for Partial Discharge Detection

- The GIS shall be provided with a continuous monitoring system for partial discharge measurement using Ultra High Frequency (UHF) method. For the purpose adequate numbers of UHF sensors (on each phase) at strategic locations covering the entire installation shall be provided. The Portable Partial Discharge Monitoring system shall be used to monitor any kind of partial discharges occurring inside the insulation of EHV equipment. The system should be usable during the HV testing (whilst installation and commissioning) as well as during

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maintenance of GIS (and transformers).

- The system shall be self-sufficient to sense, acquire and analyse the UHF signals emitted by partial discharge in GIS. It should be able to identify and classify even the smallest of partial discharge. The system should be able to take inputs from internal and external couplers and optimise the number of inspections required to cover the full GIS. It should be easy to carry in between bays and designed to withstand under difficult environmental condition allowing PD recording of 1 hour to 12 months.
- The analysis system should be a Windows based software platform that allows easy configuration of substation and locations. It should allow importing / exporting and storing the configurations and easily retrieving them later. System should also provide facility to connect remotely using remote client.
- System should be able to take inputs from any UHF coupler fitted in the GIS. A sampling resolution of 256 samples per cycle shall be provided to ensure accurate PD detection. The sensitivity of the offered system shall be in accordance with CIGRE document for UHF detection TF 15 / 33.03.05 that will be verified as part of site sensitivity tests. System should eliminate all external noise automatically. It should also distinguish between noise and coincidence of PD event among different phases. System should be able to identify and analyse the PD quickly in real time similar to the online PD monitoring system. The contractor / bidder shall furnish the details of offered system with the bid for information / review of employer. Megger make PD monitoring system preferred.
- The system shall capture high frequency transient phenomenon, generated by partial discharges, characterized by measuring signals in the UHF range (Ultra High Frequency, 100MHz-2000 MHz).
- The online PDMS shall be tested according to the following standards.
- EN55011:11/2009 – IEC61326-1:5/2006, IEC61000-3-2:9/2005, IEC61000-3-3:9/2008, IEC61000-4-3:5/2006 – IEC61326-1:5/2006, IEC61000-4-4:12/2004 – IEC61326-1:5/2006, IEC61000-4-5:11/2006 – IEC61326-1:5/2006, IEC61000-4-6:5/2003 – IEC61326-1:5/2006, IEC61000-4-11:8/2004 – IEC61326-1:5/2006, IEC61000-4-2:03/2009 – IEC61326-1:5/2006, IEC60255-5, IEC61180, IEC61000-4-8, IEC61000-4-9, IEC61000-4-10, IEC60068-2-1/2, IEC60068-2-6, IEC60068-2-27, IEC60529
- The Monitoring of the PDMS system must be Continuous and real time via simultaneous channels. No Multiplexer device or system shall be allowed.
- The PDMS System should be display partial discharge amplitudes in dB μ V and dBm and the user should have the access to select the amplitude as per the requirements.
- The PDMS system should be capable to measure and store the data of time period of

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measurement is minimum of 5 years.

- The PDMS shall be extendable up to minimum of 1000 measurement channels and the data acquisition unit should have minimum 60 numbers of channels in 1 rack to avoid multiple devices and further handling.
- Also the PDMS system should have 2 different types of data monitoring system for indoor IP54 and for outdoor it should be IP65 rated.
- All the PD sensors should have protection or PDMS system OEM should provide the protection device to avoid electrification to avoid damage to the equipment as well as humans.
- The UHF PD signals should convert to lower frequencies (<2MHz) directly at the output of the UHF Sensor and transmitted from UHF sensor to Acquisition unit to avoid external interference in the measurement and it can transmit the PD signal up to 80-meter distance.
- Each Racks must be equipped with built in UPS system for backup during supply interruption the backup time is a minimum of 20 minutes duration.
- Control Cabinet of the PDMS is installed with:
 - Latest version of Industrial type PC (IPC) with MS Windows 10 or Newer.
 - The server must have Two RAID controlled hard disk for redundancy.
 - IPC is installed with optional CD drive, a Keyboard & Mouse drawer.
 - The system must have 21” touch screen display for easy operation (Normal monitor display not allowed)
 - The system should have leaser colour printer for reporting.
 - The system should be capable for LAN interface for Time synchronisation via NTP and shall be configured for establishing a Windows Remote Access Connection
 - The Cabinet Must be lockable type to avoid unauthorized access.
 - The cabinets should have dedicated UPS.
- PDMS Control Software:
 - The software should have Measurement data's as PRPD (Phase Resolved Partial Discharge) Pulse diagram, Trend measurement, PDIV & PDEV etc.
 - Overview of the GIS (Gas Schematic Diagram or Single Line Diagram) with the indication of Position and Labelling of each sensor.
 - Trending of Upp and Upavg for each sensor
 - Provide 3D view (Time, Phase Angle & Amplitude)
 - Live scope view of measurement
 - Monitored by Watchdog to ensure that the software runs all time
 - PDMS control software shall provide analysis panel for analysing the historic and the life measurement data for multiple sensors in parallel

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- Control Panel shall provide Upp and Upavg trending for an adjustable time period
- The Time Period shall be adjustable though start and end or selecting hourly/daily/weekly/monthly plot
- Possible to view the historical data over the lifetime of the system
- Measurements of different phases of one sensor position shall be beneath each other to ease the comparison of signals.
- PDMS control software can be switchable to a manual operation mode for investigative measurements, commissioning, and for HV Test modes.
- During the Manual operation mode operator can display the live (Update period below 0.5s) scope view of up to 24 sensors in parallel to get instant feedback about PD activity in the GIS.
- Manually start the recording of PRPD s for further analysis
- Measurements gain is adjustable
- Dedicated HV mode will record all measurements during the HV test along the HV voltage values to check the PD inception & extinction voltage and the same will be replayed later.
- Control software has dedicated Maintenance mode to Supress/Pause the event and alarm generation in case the owner wants to perform any maintenance activities in the system.
- Control software provides a dedicated mode for the sensitivity verification procedure according to CIGRE TBA654 (former CIGRE 15/33.03.05).
- Dedicated mode should guide the user through the verification procedure, store the measurement data and provide a detailed report in MS Word or PDF format.
- PDMS control software shall generate logs:
 - High level PD Events & Low-level PD Events
 - System Fault Events
 - Maintenance Request Events
 - Switching Operations
 - Communication Errors
 - PD events shall be indicated to ease the review of significant data
- Alarm Criteria:
 - Allows to set thresholds along a count rate that need to exceed this threshold in an adjustable period of time.
 - Shall be adjustable to avoid short term interruptions from external disturbances
 - Shall be adjustable for individual sensor or group of sensors
- PRPD Measurement & Synchronization condition:
 - To guarantee a phase resolved PD measurement, the PDMS shall be synchronized to the HV supply of the GIS through AC signals from the VT's

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- There should be a minimum of 4 sync-inputs to connect VT signals from each section of each busbar, for the proper synchronization at all time
- PDMS shall provide a facility to automatically select one active synchronization signal

• PDMS Features:

- PDMS shall provide an extensive self-monitoring facility
- System shall monitor the status of MCBs, overvoltage protections, the redundant fiber optic ring network, the connection to each acquisition unit, the connection to each frequency converter unit and the status of heating and cooling devices.
- Each change of the status of the monitored equipment shall lead to event that logged in the control software event list
- PDMS use gating antennas to pick up the external noise signals and eliminate.

• IEC61850 Integration:

- Integration to the Substation SCADA/SAS shall be through an IEC61850 interface
- The current Measurement data and PD alarm indication for each sensor shall be available
- The system shall communicate any system fault or maintenance requests over IEC61850
- Alternatively, potential free contacts should be available to forwards events and alarm situations via hardware

• Calibration:

- UHF couplers must be first calibrated as per CIGRE procedure TBA654 as part of factory acceptance tests to guarantee detection sensitivity of 5pC
- GIS of same design shall be used as test specimen during the coupler calibration. The Pulse injection level determined through above the factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of the PDMS system. The data sheet/ frequency response characteristics shall be submitted for reference.
- Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

• PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance Diagnostic Software:

To interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patterns as library pictures to train the user.

One portable monitoring system must be stored as a spare part in accordance with the specifications, and Megger-made PD monitoring systems are preferred.

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● Portable Partial Discharge Measurement system with Monitoring facility for 220 kV GIS

The principle of operation shall be based on UHF principle of detection. The equipment is capable for measuring Partial Discharge in Noisy and charged GIS environment.

- The measurement bandwidth of equipment shall be in order of 100 MHz – 2000 MHz with possibility to select a wide range of intermediate bandwidths for best measurement results.
- The equipment should have minimum 8 nos. of Partial Discharge Measurement channels, 1 Sync channel and 1 gate input channel. Partial Discharge activities on all 8 channels can measured in parallel on same display on software.
- The measurement data of all UHF probes shall be measured real time parallel with a resolution of 256 measurement values per sine wave to ensure that no PD pulses are missed. No multiplexing shall be allowed. Recording of only samples or peak values is not acceptable.
- To transmit the measurement signals from the UHF probe to an acquisition unit, the UHF signal shall be converted to lower frequencies (below 2 MHz) directly at the output of the UHF probes. The amplitude shall be converted on a logarithmic scale to ensure a wide coverage of the measurement.
- A dedicated HV test mode shall record all measurements during the HV test along the HV voltage values to check the PD inception & extinction voltage. The same shall be replay-able after the HV test.
- A dedicated Sensitivity test mode to guide the user through the sensitivity verification procedure according to CIGRE TBA654, record the measurement results and generate a report.
- Software should have dedicated live Monitoring tap which included Live analysis of All 8 channel simultaneously and show live trending of dBμV or dbm against time. The trend of each channel measurement have different colour code to differentiate channels results in the Graphs
- The external or internal synchronization signal determines the phase position of every Partial Discharge pulse.
- The instrument shall be with the gating channel other than Partial Discharge measuring channels, to eliminate disturbance signals from the measurement. The instrument can be connected to the disturbance antenna that provides a gating signal.
- For results analysis the Software should have options to check historic analysis of all 8 channels simultaneously and it options put limits for pd warning and general events. It should mention date and time , channel details, PRPD pattern and maximum limit when it creates any alarm events in software.
- The instrument should operate as a stand-alone system without operator presence for days,

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weeks or month. During such an operation, the system should automatically record a trending of the PD activity. In case configurable thresholds are exceeded, the instrument should store the current measurement as a PRPD with a date and time stamp, the sensor/channel on which it occurred and allow the operator to review the PD activity in an alarm event list.

- The kit should be capable to measure PD with the length between the kit to UHF sensors of a minimum of 60 Meters distance.
- The Instrument can be connected to PC/Laptop through USB or LAN Connections.
- It should record PD value, PRPD patterns and raise alarms when exceeded values.
- It should offer remote access via mobile communication interface.
- The kit should be capable to measure PD with the length between the kit to UHF sensors of a minimum of 60 Meters distance.
- The Instrument should be in portable housings, lightweight, shock resistance and watertight outdoor cases, with cables, disturbance antenna and suitable calibrator/impulse generator.

- **Qualifying Criteria**

- The bidder shall provide a reference list of PD monitoring system, which is supplied by them and in successful operation worldwide in a power utility.
- The bidder/OEM should have supplied system in 400kV GIS for minimum 300 PD sensor for single customer.
- The bidder/OEM of PDMS should be in the business of supply of PDMS for Generator for at least 10 years. Please submit customer reference list.
- OEM of equipment should have manufacturing facility and service centre in India to support the product throughout its life cycle and documentary evidence should be submitted along with bid.
- Class-I local suppliers are eligible for purchase preference in procurements, meaning they are given preference over Class-II local suppliers and non-local suppliers, provided their quoted rate falls within a certain margin of the highest quoted bidder considered for award.
- The "local content" requirement to categorize a supplier as "Class-I local supplier" is a minimum of 50%.

26. Gas Recovery System

Due to leakage of the SF₆ gas estimated at 1% (per year) of the volume of the GIS switchgear and Gas Insulated Bus (GIB) plus the volume of the of the largest component of the GIS and GIB, a Gas Recovery System is required under the Kyoto Protocol.

The Contractor shall provide and install (if considered necessary):

- SF₆ detectors with their control panels, details and locations;

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- Demonstrate through calculations, the volume of leakage from the volume of the GIS switchgear and Gas Insulated Bus bar (GIB);
- Recommend if any other arrangement is required / recommended for recovery of SF₆.
- Clear instructions shall be provided by the Contractor for the handling, recycling and treatment of new and used SF₆ gas.

27. SF6 Measuring Device (DILO)

The Contractor shall provide an SF₆ gas measuring device. This device shall be capable of volume percentage measuring for indication of the SF₆-concentration in SF₆ / N₂ or SF₆ / air-gas mixture. The device shall also be capable of measuring moisture content and other contaminants.

28. SF6 Handling Device (DILO)

The Contractor shall supply an SF₆ gas handling device mounted on a wheel-cart. The device shall be suitable to handle the SF₆ gas of the GIS Switchgear and / or GIB. The device shall perform the following functions: gas recovery, evacuation, purifying, storage and filling. The device shall be supplied complete with:

- Automatic and manual process control;
- Simple trouble-free gas handling;
- Liquid and gaseous storage;
- Pressure storage tank for gaseous and liquid SF₆ gas of sufficient size to store the equivalent of three SF₆ terminations;
- Recovery of SF₆ gas down to 1mbar entirely without oil;
- 30 m cord and plug set. Cord shall be oil and abrasion resistant. Plug shall be heavy duty lock-on type with IS standard plug configuration.

29. GIS Testing

The 220 kV Gas Insulated Switchgear (GIS) shall be completely assembled and tested at the factory and at site. Tests shall be performed in the presence of Employer's representative. Tests shall be performed in compliance with latest edition of IEC 62271-203 and IEC 60137.

No material shall be shipped until the test reports are duly approved by the Employer or his representative. The Contractor shall furnish the type test certificates for approval of the Employer.

30. Testing

30.1. Factory Tests

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The manufacturer shall be fully equipped to perform all the required tests as specified. Bidder shall confirm the capabilities of the proposed manufacturing plant in this regard when submitting the Bid. Any limitation shall be clearly stated. The Contractor shall bear all additional costs related to tests which are not possible to carry out at his own works. The Contractor shall submit a quality assurance and test plan for approval. A typical test plan is indicated below. This is not intended to form a comprehensive program. It is Contractor's responsibility to draw up and carry out such a program in the form of detailed quality plan duly approved by Employer for necessary implementation.

Test Plant Typical (GIS)			
Item	Test category	First unit	Balance units
Continuous current carrying and temperature rise test	Routine	✓	✓
Current path resistance measurement	Routine	✓	✓
Short-duration power-frequency high voltage test	Routine	✓	✓
Enclosure pressure tests	Routine	✓	✓
Measurement of insulation resistance	Routine	✓	✓
Measurement of insulation power factor and capacitance between main conductor and earth.	Routine	✓	✓
Appearance, construction and dimension check	Routine	✓	✓
Knee point voltage measurement of CT's	Routine	✓	✓
Current transformer (CT's) ratio and polarity	Routine	✓	✓
Voltage transformer (VT's) ratio and polarity	Routine	✓	✓
Contact resistance of circuit breaker	Routine	✓	✓
Contact resistance of disconnecter	Routine	✓	✓
Contact resistance of earthing switch	Routine	✓	✓
Operation of interlocks	Routine	✓	✓
Density switch tests	Routine	✓	✓
Any other test deemed necessary	Routine	✓	✓

30.2. Acceptance Tests

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- If acceptance tests in the Employer or their representative presence are requested, then they are integrated into the routine testing programme;
- The programme, test dates and tolerance criteria must be defined by an agreement between the manufacturer and the Employer. Production constraints linked to the size of transport units must be taken into consideration when preparing these programme;
- Two types of participation are offered to the Employer or their representatives:
 - The Employer is present throughout testing which takes place according to the Manufacturer schedule;
 - The Employer is only present for the repetition of certain tests.

The manufacturer shall do at least the following test:

- Routine test program complies with the IEC 62271-203 standard;
- Voltage tests on main circuits;
- Dielectric tests as per IEC 62271-203;
- Measurement of main circuit resistances;
- Measurement of partial discharges as per IEC 62271-203 (except for transformers and surge arrester);
- Enclosures pressure tests;
- Gas tightness tests;
- Mechanical operation tests for circuit breaker;
- Tests of auxiliary electrical;
- Verification of correct wiring as per IEC 62155;
- SF₆ bushing tests as per IEC 62271-203;
- Current transformer tests as per IEC 6044-1;
- Voltage transformer tests as per IEC 6044-2;
- Surge arrester tests as per IEC 6099-4.

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

30.3. DESCRIPTION OF THE TYPE TEST FOR GIS

1. Tests to verify the insulation level of the equipment and dielectric test on auxiliary circuits
2. Tests to prove the temperature rise of any and measurement of the resistance of the main circuit part of the equipment.
3. Tests to prove the ability of the main and earthing circuits to carry the rated peak and

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rated short time withstand current

4. Tests to verify the making and breaking capacity of the included switching Devices
5. Tests to prove the satisfactory operation of the included switching devices
6. Tests to prove the strength of the enclosures
7. Gas tightness tests
8. Tests on partitions
9. Tests to prove the satisfactory operation at limit temperatures
10. Tests to assess the effects of arcing due to internal fault
11. Verification of the degree of protection of the enclosure
12. Additional tests on auxiliary and control circuits
13. Reactor current switching test For Reactive Current switching capability
14. Test to demonstrate the Power frequency withstand capability of breaker in open condition at lock out pressure.
15. Electromagnetic compatibility tests (if applicable)
16. Radio inference voltage tests
17. Test report for 10Kv Insulation earth switch,
18. Test report of operating mechanisms for all the duties.

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

30.4. TESTS REPORTS

After the tests indicated above have been conducted, three (3) certified copies of complete test report shall be submitted to Employer after proper scrutiny and signing on each page by the Test Engineer and/or Contractor.

31. PACKING AND SHIPPING

The type of packing to be used must be suitable for all commonly used means of transportation from manufacturer's location to the installation site. If not indicated otherwise in the contract, the GIS shall be thoroughly prepared for export and packed for shipment via ocean-freight. Methods of shipment and packing to be employed are subject to Employer's approval.

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Export packing methods used shall also be suitable for extended storage at the site under covered shed, and under the environmental conditions, prevailing at site. A sufficient amount of drying agent inside the GIS packing material shall absorb possible condensations.

Care shall be taken to seal off the connecting flanges of the individual GIS compartments for shipment, to prevent damages and the ingress of contamination into the gas compartments. Machined sealing surfaces shall be suitably protected against physical or corrosion damage. Sealing surfaces which are exposed to the atmosphere during transport must be protected by a protective coating (such as Tectyl) which will be peeled and / or washed off during installation.

The static filters provided for the inside of GIS compartments shall not be installed before transportation but separately packed in airtight sealed tin cans and marked suitably.

The SF₆ gas for the initial filling of the entire switchboard shall be shipped separately in approved steel cylinders, marked according to international regulations or Indian Standards. Extra gas shall be included for compensation of possible losses during installation and the first filling.

Marking of shipping containers is subject to purchaser's approval, and guidelines for special marking must be followed meticulously to ensure positive identification at the job-site.

A packing list must be provided for each individual packing unit to enable the Employer's personnel to identify the unit clearly at site

Packing lists in English and Indian language for each individual packing-unit must show each and every item that is actually shipped. The description must enable purchaser's personnel to identify each item.

All parts shall be adequately marked to facilitate field erection. Boxes and crates shall be marked with the contract number and shall have a packing list enclosed, showing the parts contained therein.

The GIS is shipped in fully assembled Transport Units (TU).

- The dimensions of the TU have been optimized by taking into account the most frequently stipulated transport limitations and handling facilities;
- The fully assembled TU are sealed with desiccators in a protective cover;
- The TU are placed in a rigidly framed plywood case suited for overseas transport;
- To prevent ingress of dust and moisture in the gas compartments all the transport units which can be sealed are pressurised with SF₆ gas or dry nitrogen at a pressure of 0.03 MPa;
- No equipment or material shall be dispatched to the site prior to its inspection at manufacturer's works by the Employer or his authorized representative. The Employer's representative shall have access and facilities for unrestricted inspection of manufacturer's

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works.

32. MISCELLANEOUS REQUIREMENTS FOR GIS

32.1. STORAGE

Transport unit packaging will be designed to prevent any damage to the equipment during transport and the storage period of 6 months from ex work shipment to beginning of erection on site. The transport units must be stored on site in a ventilated building, free from dirt and dust and not subject to flooding.

If the planned storage exceeds 6 months or if the conditions are particularly severe it will be necessary to install periodic inspection and maintenance works during the storage period.

32.2. MOUNTING

- Installation and pre-commissioning will be performed either the technical responsibility of manufacturer;
- The manufacturer performs all the necessary operations by its own staff or supervises and technically manages the customer's workers.

32.3. ERECTION AREA REQUIREMENTS

GIS mounting requires a clean and dust free environment. Civil works should be finished before mounting starts. The floor should have a firm surface and be easy to keep free from dust using a floor cloth or vacuum cleaner.

The floor should be clean and unencumbered by tools or equipment not required for mounting the GIS. Walls and ceiling should be of such quality that they do not peel. If necessary, a coat of suitable "anti-dust" paint should be applied on all these surfaces. Suitable crane, lifting devices and scaffolding should be provided. Adequate interior lighting should be provided during the erection period.

32.4. SITE SECURITY

Access to the site should be restricted to those people required for mounting the GIS;

Hand tools, special tools and certain spare parts should be stored in locked premises under supervision.

32.5. ELECTRICAL POWER SUPPLY TO THE SITE

Electrical power supply should be made available during the entire mounting period;

The specifications for the electrical power supply at the site shall be as stipulated in GCC / SCC or in this section.

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The electrical power supply should be able to meet the requirements of the gas processing plant, the vacuum cleaner, hand tools and lifting equipment.

32.6. PREPARING MOUNTING

The order in which bays are mounted is determined by mutual agreement between the employer and GIS supplier / contactor. The order depends on the environment of the GIS, ease of access and lifting means.

33. DRAWINGS, DATA, MANUALS AND GUARANTEED PARTICULARS

A. Drawings, data and guaranteed particulars shall be furnished with the Bid.

The following drawings and test reports for each item shall be supplied as part of the contract along with the Bid Document:

- Layout drawings (with relevant compartments, housing size, weight per meter, material description and structural support locations);
- Filled data sheet (Technical particulars);
- Technical Specification;
- Descriptive brochures for all auxiliary equipment;
- Temperature rise calculation for conductor and enclosure;
- A complete Bill of Material for the devices, components, accessories and parts. The Bill of Material can be integrated to the drawings for convenience;
- Type tests and special test reports conducted on similar rating;
- Quality Assurance Program;
- Detailed arrangement drawings and specifications of GIS.

The Bidder shall submit the dimension and clearance drawings in a floppy or CD-ROM also.

Any bid lacking complete information in this respect is likely to be rejected.

B. Drawings, data manuals, etc. and documentation to be furnished by the bidder after award of contract.

After award of contract, the Bidder shall supply five (5) copies of the following drawings; for approval as per agreed time schedule and shall subsequently provide six (6) complete sets of final as-built drawings, one of which shall be electronics file as CD suitable for reproduction

- Technical particulars for GIS and associated accessories;
- Civil assignment drawing of GIS;
- Layout drawing of GIS;
- Details of Seal off Bushing;

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- Details of Wall Frame assembly;
- Typical support arrangement details;
- Design calculations for sizing of bus duct including short-circuit withstand capability, temperature rise and losses;
- Erection, Testing, Commissioning Manual for GIS;
- Operation and maintenance manual for GIS;
- Earthing layout drawing for GIS;
- Erection key diagram;
- Spare parts list;
- Packing, loading, Transportation and Unloading Manual;
- List of CT's and PT's indicating the location, quantity, acc. Class etc.

C. Operation, Maintenance and Erection Manuals four (4) copies and one (1) of electronics copy shall be supplied by the Contractor for review approval. The manuals shall contain all the drawings and information required for erection, operation and maintenance of the GIS.

Descriptive literature and data on GIS, CT's, VT's, circuit breakers, disconnectors, surge arrestor, 245 kV transformer connection modules, gas monitoring equipment and other accessories, etc., shall also be supplied by the manufacturer along with the instruction manuals.

After approvals, and incorporating the Employer's comments, the Contractor shall submit twelve (12) sets of final O&M Manuals and one (1) set of electronic files on a CD.

33.1. QUALITY ASSURANCE PROGRAM

A quality assurance program detailing specific control procedure proposed to be adopted for controlling the quality characteristics relevant to each item of GIS will be furnished. This shall include, but not be limited to the following to ensure conformance of equipment specification and relevant Codes / Standards:

- a. Inspection of incoming raw materials;
- b. Tests to Verify chemical and physical properties of all materials including test certificates of bought-out items as per relevant Indian Standards;
- c. Tests during manufacture / assembly of GIS, its fittings and accessories including customer hold points, etc.

Others test as part of manufacturer's standard quality assurance plan. The Contractor shall submit the Quality Assurance Plan for the approval of the Employer.

33.2. O&M PERSONNEL TRAINING

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The Contractor shall arrange training sessions for O&M personnel of the Employer at site using the O&M Manuals supplied.

34. NAME PLATE & LABELS

All the GIS System shall be provided with a nameplate. It shall be mounted in a position that it shall be visible in the position of normal service and installation. The nameplate shall conform to the requirements of relevant IEC / IS and as per stipulations of General Technical Requirements and shall incorporate the following information:

- Manufacturer's Name or trade Mark;
 - Type Designation or Serial Number;
 - Applicable Rated values;
 - Relevant Standard.
- All name plates shall be of non-rusting metal or three (3) ply laminated with white engraved lettering on black back ground, inscription and lettering sizes shall be subjected to Employer's approval.

Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end

35. SPARE PARTS AND SPECIAL TOOLS

The spare parts mentioned hereunder are meant for use by the Employer for 5 years trouble-free operation & shall not be used as erection / commissioning spares required during installation. All the spare parts shall be interchangeable & shall be of the same material and workman ship as corresponding parts of the main equipment.

If any additional spare parts required for a 5 years trouble-free operation period are recommended by Contractor, these shall be listed and the unit price shall be quoted in the price schedule. The Employer reserves the right to order any or all of such spares.

All spare parts shall be protected against corrosion and shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Works Identification System.

All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage. Material that is subjected to long term storage shall be stored in a dry, ventilated room with low humidity.

Acceptance of any spare parts will not take place before the Contractor has submitted the complete final list of all spare parts and tools. They shall be replaceable without cutting or

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destruction of adjacent components. Before issue of the Completion Certificate, the spare parts shall be checked at the Site by the Contractor in presence of the Engineer / Employer.

35.1. MANDATORY SPARES LIST

Item No	Description	Qty.
1	Circuit breaker	
	Fully assembled circuit breaker (3 poles)	1 No
	Tripping Coil	6 Nos
	Closing Coil	3 Nos
	Motor for operating mechanism	1 No
	Hand crank for manual operation	2 Nos
	Auxiliary contacts block	1 No
2	Disconnecter	
	Set of crank	1 No
	Motor for operating mechanism	1 No
	Hand crank for manual operation	2 No
	Auxiliary contacts block	1 No
3	Earth Switch / High speed Earth switch	
	Motor / solenoid for operating mechanism	1 No each type
	Hand crank for manual operation	2 No
	Auxiliary contacts block	1 No
4	Surge Arrester	3 set
5	Density switch	12 Nos
6	Molecular filter for SF ₆ gas	1 set
7	Typical section of main run of GIS bus duct, including conductors, junctions and theirs supports	1 set
8	Insulators	2 set
9	Pressure relief device	3 No
10	Gas density monitoring device	3 No
11	Gas seals	3 set
12	SF ₆ Gas bottle (40 kg)	2 No
13	Kit of safety disc for compartments	1 set
14	Temperature compensated density switch TRAFAG	1 No

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15	Grease for gaskets - Molykote 111 (cartridge of 437.5 gr.)	1 No
16	Portable PD meter for on line PD monitoring system	2 Sets

If any additional spare-parts required for trouble free operation are recommended by bidder, these shall be listed and the unit price shall be quoted in the price schedule. The Employer reserves the right to order any or all of such spares.

35.2. TOOLS AND APPLIANCES

Item No	Description	Qty.
1	Spanners including D ring and box type of all sizes	3 set
2	Set of all types and sizes of eye bolts	3 Lot
3	Torque wrenches of each size	3 set
4	Racks for storage of Tools and Tackles	3 set
5	SF ₆ Measuring and Handling Devices	1 set
6	SF ₆ filling valve	3 No
7	SF ₆ Leak detector	1 No
8	Handling station for filling, recuperation and vacuum SF ₆ gas	1 No
9	Direct reading Dew Point Meter with digital indication and corresponding pressure indicator	1 No
10	Static contact resistance meter	1 No
11	Dynamic contact resistance meter with attachments	1 No

Any additional tools / special devices specifically required for assembly / erection, dismantling and maintenance of the GIS shall be listed and included in offer by the Contractor.