

ODISHA POWER TRANSMISSION CORPORATION LIMITED



Technical Specification **For** **400 / 220/132/33KV Gas Insulated Switchgear (GIS)**

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400 / 220 / 132 KV GIS SUB-STATION SYSTEM

GENERAL DESCRIPTION OF GAS INSULATED SWITCHGEAR .

STANDARD SPECIFICATIONS

The switchgear conforms to the following IEC standards:

SWITCHGEAR, GENERAL:

IEC 62271-1 : High-voltage switchgear and control gear Part 1: Common specifications

IEC 62271-203 : High-voltage switchgear and control gear Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV Circuit-breakers:

IEC 62271-100 : High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers

IEC 62271-101 : High-voltage switchgear and control gear Part 101: Synthetic testing Disconnectors, earthing switches.

IEC 62271-102 : High-voltage switchgear and control gear Part 102: Alternating-current disconnectors and earthing switches Instrument transformers:

IEC 62271-303: High-voltage switchgear and control gear – Use and handling of sulphur hexafluoride (SF₆)

IEC 61000 Electromagnetic compatibility (EMC)

IEC 60060 High voltage test techniques

IEC 60071 Insulation co-ordination

IEC 60255 Electrical relays

IEC 60265 High voltage switches

IEC 60270 High-voltage test techniques - Partial discharge measurements

IEC 60376 Specification and acceptance of new sulphur hexafluoride

IEC 60480 Guide to checking of sulphur hexafluoride (SF₆)

IEC 60529 Degrees of protection provided by enclosures (IP Code)

IEC 60815 Guide for the selection of insulators in respect of polluted conditions

IEC 61869 Instrument transformers

IEC 60364 / 60479 / 60621 / IEEE std. 80 Standards for station grounding.

CENELEC/SVDB Pressure vessel codes

CABLE CONNECTIONS:

IEC 62271-209: High-voltage switchgear and control gear Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and dry- type cable-terminations

OUTDOOR BUSHINGS:

IEC 60137 : Insulated bushings for alternating voltages above 1000 V Transformer direct connection:

IEC 61639 : Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages of 72.5 kV and above.

SURGE ARRESTERS:

IEC 60099-4: Surge arresters Part 4: Metal-oxide surge arresters without gaps for A.C. Systems SF6-Gas:

IEC 60480: Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use

IEC/TR 62271-303: High-voltage switchgear and control gear Part 303: Use and handling of sulphur hexafluoride (SF6)

LOCAL CONTROL CUBICLES:

IEC 61439 -1: Low-voltage switchgear and control gear assemblies Part 1: General rules EMC.

IEC 62271-1: High-voltage switchgear and control gear Part 1: Common specifications The enclosures of the switchgear conform to the following EN standards:

ENCLOSURE

CENELEC standard mentioned above.

MODULAR DESIGN

Housings and expansion joints together form the pressure-resistant enclosure of the switchgear. The housings are made of cast or welded aluminium, the expansion joints of high-grade steel and the covers of steel or aluminium. The switchgear modules are single-phase or three-phase encapsulated.

The manufacturing and testing of the housings are state-of-the-art technology. Each, housing is subject to a pressure and gas tightness test and complies with the requirements of the relevant CENELEC standard.

SURFACE TREATMENT

Steel (covers):

Indoor structure: Hot galvanised or painted

Outdoor structure: Hot galvanised and painted

High-Grade Steel (expansion joints):

Indoor Pre-treatment: none

Paint work: none

Outdoor Pre-treatment: degrease

Paint work: same as housings of cast aluminium

CAST-ALUMINIUM:

Pre-treatment (indoor and outdoor): Sand-blast or degrease alkaline

Internal surfaces (cast-aluminium): Seevenax protective paint **RAL 7038** (grey)

Internal surfaces (aluminium wrought alloy): without surface treatment

External surfaces: material description: high-resistant 2-component polyurethane paint

Shade: RAL 9010 (white)

GAS

Gas compartments, monitoring of gas compartments:

- SF6 serves as insulation for the enclosure of several separately-sealed gas compartments

- static filters in all gas compartments – with single-phase encapsulation for each phase for single phase encapsulation design - absorb moisture and decomposition products; the filter material is placed in filter bags which are supplied in airtight cans
- all gas compartments are equipped with rupture diaphragms and, if necessary, with gas diverter nozzles; these nozzles are arranged in a way that, if the rupture diaphragm bursts, the gas flow is guided away in a direction not unnecessary hazardous to either personnel or equipment
- the modules of circuit-breakers, voltage transformers, cable connection module and surge arresters form separate gas compartments.
- the disconnecter gas compartment can contain other device earthing switch
- the switch operating shafts are supported and provided with lip seals against pressure and vacuum loss in such a way that during the evacuation process before commissioning no air can penetrate and no SF6 can escape during operation; **the leakage rate is less than 0.5 % SF6 per year and gas compartment.**
- the gas pressure is monitored by density monitors with indication; density monitors are installed directly at the gas compartment they monitor.

1. GENERAL SPECIFICATION

The intent of this specification is to provide the work enumerated to be fully complete in every detail for the function designated. It is hereby required that the BIDDER, in accepting the contract, agrees to furnish all apparatus, appliances, material not herein specifically mentioned or included, but which may be found necessary to complete, perfect or test any portion of the apparatus or equipment herein specified in a substantial manner, and in compliance with the requirements implied in this specification and without extra cost to the PURCHASER/OWNER. The GIS manufacturer should have (1) prompt after sale service support having based in India (2) having HV testing kit & (3) provide supporting documents for the same.

NOTE: The Bus of the 400kV, 220 KV, 132kV & 33 KV GIS System shall be of **Aluminum** of adequate size and should be capable of withstanding the short circuit current level of 63kA, 50kA, 40 KA & 31.5 KA respectively for 3 sec. Care should be taken while designing the GIS system.

The tender work shall be carried out in accordance with the requirements of this specification and shall include design, manufacture, supply, testing at the factory, shipping to site, installation and testing at site and commissioning of the GIS and associated equipment.

Remarks: The type of exit termination shall be as defined in the Single Line Diagram.

EQUIPMENTS TO BE SUPPLIED BY THE BIDDER:

The apparatus shall include but not be limited to the following:

(A): To be used in GIS.

1. Circuit breakers
2. Dis connector switches (Bus / Line)
3. Maintenance earthing switches
4. Fast acting line earth switches
5. Bus Pts in 400/220 / 132/33kV side
6. SF6 Bus – duct
7. Current transformers
8. Surge arrester
9. Bus and elbow sections
10. Cable end enclosures.
11. SF6 to air bushings / cable terminations
12. Ground connection to the station ground grid
13. Auxiliary material to complete the GIS installation (like density switches,

- auxiliary power/control cable and bolts)
14. Support structures for the GIS
 15. Insulating SF6 gas
 16. Local Control Cubicle
 17. Special tools for installation, monitoring, testing & maintenance
 18. Commissioning spares
 19. Protection control and sub-station automation system with IEC 61850.

(B) Following equipment to be used in AIS: (as per site requirement & BPS)

1. Surge Arrester. (400 KV, 220KV & 33 KV side)
2. Line Capacitor Voltage Transformer: 400/220/132 KV side.
3. 33/0.43 KV, 250 KVA Station Transformers

(C) Following auxiliary system also to be supplied.

1. ACDB, DCDB, other Switch Boards to be installed in the Switch yard and in other areas etc.
2. Fire Fighting, smoke detection facilities as per requirement.
3. Station Batteries, PLCC Batteries, Battery Chargers.
4. Control & Power Cable as per requirement.
5. XLPE Power Cables for 33 KV Side (From Transformer to 33 KV side GIS & from 33 KV GIS to Station Transformers).

SERVICES TO BE SUPPLIED BY TENDERER:

1. All equipment and material shall be prefabricated, factory assembled, tested and shipped in the largest practical assemblies dependent on the mode of transport.
2. The Tenderer shall provide documentation as required in this specification.
3. The Tenderer shall provide the services of operation & maintenance for the purpose of installation, testing & commissioning and on-site training.
4. Construction of GIS Building for 420kV, 220 KV and 33 KV sides, Power Transformer foundations, Foundations for switch yard columns & equipment etc.
5. Construction of concrete & bitumen roads, drainage system, Site surfacing, Fencing etc.
6. Construction of Control room Building & Quarters.
7. Sub-station earthing & Illumination for switchyard and other buildings.

All additional apparatus and services, listed below, which are required to successfully complete the GIS installation shall be supplied by the purchaser.

1. All detailed engineering for civil works for foundations of equipment/ tower gantry, embedded steel, cable ducts. The erection of GIS & auxiliaries building shall be done by purchaser based on the detailed engineering done & civil drawings issued for erection by purchaser.
2. Sealing ends
3. High Voltage cable
4. Overhead line connection
5. Auxiliary voltage supply
6. Station earthing

2. ELECTRICAL RATINGS:

The GIS equipment shall be provided with one enclosure per phase for all gas compartments. The apparatus shall have the following basic electrical and design characteristics:

			420kV / 220 KV / 132kV
i)	Phase design		1-ph for (420kV & 220 kV) and 3-ph for (132 kV)
ii)	Rated voltage	KV	420 / 245 / 145

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	A	Rated lightning impulse withstand voltage (peak) phase to earth Across open contacts	KV KV	1425 / 1050 / 650 1425/ 1050/ 650
	B	Power frequency 1 minute (r.m.s.) phase to earth Across open contacts	KV KV	650 / 460 / 275 650 / 460 / 275
iii)	Rated frequency		Hz	50
iv)	Rated current (bus bars) [At 40°C]		A	4000A for 400kV & 3150A for 220kV & 132kV
v)	Rated short-time current (r.m.s) (3s)		KA	63 / 50 / 40
vi)	Rated making current (peak)		KA	170 / 135 / 108
vii)	Rated short circuit breaking current		KA	63 / 50 / 40
viii)	Partial discharge level, complete bay 1.5 x U//3		pC	< 5
ix)	SF6 gas pressure at 68 °F / 20 °C, for reference		kPa	*Shall be submitted by the manufacturer.
x)	Enclosure			*Aluminium alloy
xi)	Seismic level			"High" (as per clause no 4.2 of IEC-62271-207) for the area under the Zone-V as per IS-1893. "Medium" (as per clause no 4.2 of IEC-62271-207) for the area under other than the Zone-V as per IS-1893

***Aluminum alloy: All external enclosure shall be of Aluminium alloy.**

3. EQUIPMENT SPECIFICATION

It is understood that each manufacturer has their own particular GIS design concept and it is not the purpose of this specification to impose any unreasonable restrictions. However, in the interest of safety, reliability and maintainability, the switchgear offered shall meet the following minimum requirements stipulated herein.

3.1 General

The GIS shall be made of tubular Aluminum alloy and filled with SF6 gas for insulation. Enclosures shall be of single phase for 400kV & 220 kv and 3- phase encapsulation for 145kV for both the bus bars and the feeder section bays.

The switchgear shall be modular in design. Future extensions shall be easily accomplished by adding extra feeders without dismantling any major parts of the equipment. As much as possible the parts shall be of standard manufacture with similar parts and assemblies being interchangeable.

The tenderer is encouraged to offer an optimized physical layout regarding minimized space requirements and maintainability.

Shipping sections which are tested in the factory shall be jointed in the field by using bolted and sealed flange connections only. Field welding of enclosures is not acceptable. The size of the per-assembled shipping sections shall be as big as practical for transportation. Complete station assembly in the factory for testing purpose and dis assembly for shipping is not preferred.

The flanged connections shall have gas seals between the flange surfaces. For outdoor application, suitable means shall be used to protect the gas seal from the external environment. Connections including bolts and nuts shall be adequately protected from corrosion and easy accessible with the proper tools.

Tenderer shall confirm the nominal rating of GIS components at **50°C**

Bus Potential Transformer (PT) shall be provided with additional disconnector as shown in the Single Line diagram.

3.1.1 SECTIONALIZATION

The switchgear must be sectionalized, with gas tight barriers between sections or compartments. The sections shall be designed

- i) To minimize operational shut down when the gas pressure is reduced due to Leakage or for maintenance purposes.
- ii) To minimize the quantity of gas that has to be evacuated and recharged before and after maintaining any item of equipment.

Continuous bus lengths without gas segregation shall not be acceptable. The length of the bus bar compartments shall be such that the gas handling / quantity in an individual BUSBAR COMPARTMENT shall be limited to 100 kg.

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

The gas system proposed shall be submitted with the proposal. External fixtures shall be of non-corrosive material and be capped wherever required.

For the purpose of gas monitoring and maintenance, the GIS shall be provided with gas density monitoring device along with temperature compensated gas density switch having two stage contacts in each gas compartment.

Pressure relief devices shall be used where ever required.

3.1.2 CONDUCTOR TYPE AND CONTACTS

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

3.1.3 SUPPORT INSULATORS AND SECTION BARRIERS

Support insulators shall be used to maintain the conductors and enclosure in proper relation. Barrier insulators which are employed to isolate gas compartments as well as support insulators shall be manufactured from high quality epoxy resin, free of all voids and be designed to reduce the electrical stress on the insulators to a minimum. The support insulator shall have holes on both sides for proper flow of gas.

The mechanical strength must be sufficient to ensure the conductor's space requirements and clearances when short circuit faults occur. In addition, the gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum gas pressure differential under normal operating condition and maximum pressure differential with one of the adjacent enclosures at three times operating gas pressure and the other at atmospheric pressure for five minutes. Its safety factor shall be no less than 4.5 **or as per relevant IEC standard (latest).**

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 **or as per relevant IEC standard (latest).**

3.1.4 GAS SYSTEM

The GIS shall be furnished with sufficient sulfur hexa-fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. During commissioning the dew point of SF6 gas shall be measured and documented. Maximum water content of SF6 -gas in GIS, within guarantee period:

CB ≤ 150 PPM (volume) or as per relevant IEC standard (latest).

Others ≤ 500 PPM (volume) or as per relevant IEC standard (latest)

The Gas loss of the switchgear shall be in no case higher than 0.5% per year (as per IEC62271-203).

3.1.5 GAS SEALS

All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O-ring type. The material and method of sealing used shall be stated in the tender.

3.1.6 GAS FILTERS / TREATMENT

Each gas compartment shall be fitted with gas filters, driers or desiccants for the absorption of moisture and the gaseous products of switching. The filter shall be effective for the duration of time between major overhaul. It shall be possible to replace the active material of the filter without extensive dismantling. The absorbent shall be located in an easy accessible location. The tenderer shall indicate the detail and type of filters used in the various gas sections

3.1.7 SF6 GAS QUALITY

The GIS shall be designed for use with SF6. All SF6 gas supplied as part of the tender shall comply with the requirements of IEC 60376 at a minimum.

3.1.8 GAS MONITORING DEVICES

Temperature-compensated gas density monitoring devices shall be provided for each gas compartment. The devices shall provide continuous and automatic monitoring of the density of the gas. The monitoring device shall have two alarm settings. These shall be set so that:

First stage: Advanced warning can be given that the gas density is approaching an unacceptably low level

Second stage: The relevant GCB can be locked for tripping/ closing.

3.1.9 GAS LOSS

Maximum guaranteed gas leakage loss of the switchgear shall be in no case be more than **0.5%** per year.

3.1.10 SF6 GAS TREATMENT

Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. Normally closed valve shall be provided to facilitate filling and recharging. In all gas compartments permanent efficient filters and drying agent shall be at least effective for the duration of time between major overhauls. The filters shall be capable of absorbing the by-products of SF6 gas during interruption.

3.1.11 SUPPLY OF SF6 GAS

The tender shall include the supply of all SF6 gas necessary for filling and putting in commercial operation the complete switchgear installation with recommended extra quantity (minimum 10% extra). The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions. The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations IS: 4379 Identification of the contents of industrial gas cylinders.

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

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the owner indicating all test results as per IEC standards for each lot of SF6 gas. Further, site tests for moisture, air content, flash point and dielectric strength to be done during commissioning of GIS equipment. Gas bottles should be tested for leakage during receipt at site. The contractor shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

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

3.1.12 PRESSURE RELIEF

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.

3.1.13 SWITCHGEAR ENCLOSURES

The metal enclosures for the GIS equipment modules shall be made from Aluminum alloy and tubular in construction. The tenderer shall state the material used for his particular design. All flanges shall be directly bolted together with good metallic contact to make enclosures equipotential.

Enclosures shall withstand normal and transient pressure in operation. They shall be designed and manufactured according to the related standards to guarantee safety and reliability of material, construction, welding technology and testing.

Enclosures shall be designed to withstand any internal arc specified in IEC 62271-203.

The gas-filled enclosures shall comply to the pressure vessel code applied in the country of manufacturer and shall be suitable for purchaser's environmental condition.

3.1.14 EXPANSION JOINTS AND FLEXIBLE CONNECTION

Expansion and installation alignment shall be considered in the design of the bus and enclosure. The continuity of service during thermal expansion / contraction and vibrations shall be ensured. The switchgear shall be fixed to the floor with minimum requirement on floor preparation. If

required, expansion joints shall be provided with compensator for the enclosure and sliding plug-in contacts for the conductors. Expansion joints and flexible connections shall be considered in the design of the bus and enclosure to take care of thermal expansion / contraction and vibrations during service and to absorb the relative movement between the switchgear equipment and its fixing structure / floor. The position of expansion joints or flexible connections are to be considered by the manufacturer to ensure that the complete installation will not be subject to expansion stresses which could lead to distortion or failure of any piece of the SF6 equipment, support structures or foundations. These expansion joints shall be provided with each bay, which will provide maximum tolerance and the flexibility during the installation & maintenance.

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

3.1.14.1 UHF sensors for PD detection:

400 & 220 KV GIS Equipment shall be provided with adequate number of UHF sensors in the offered GIS for detection of Partial discharge (of 5 pC and above) as per IEC 60270 through Partial Discharge (PD) monitoring system and the number and location of these sensors shall be subject to approval of the employer. Further UHF sensors shall necessarily be provided in close proximity to VT compartments. However adequacy of number of sensors and their location shall be verified at site by the contractor as per recommendations of CIGRE task force TF 15/33.03.05 (Task force on Partial discharge detection system for GIS: Sensitivity verification for the UHF method and the coustic method). In case during site testing additional UHF sensors are required, the same shall also be supplied& installed to complete the technical requirement.

3.1.15 FINISH OF SURFACE AND CLEANING

The finish of interior surfaces of the GIS enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall not deteriorate when exposed to the SF6 gas and arc products, etc., that may be present in the enclosures. They shall not contain any substances which could contaminate the enclosed SF6 gas or affect its insulating properties over a period of time.

The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness. Before factory tests and packing for shipment, interior surfaces, insulators, barriers etc., must be thoroughly cleaned.

3.1.16 SUPPORTING STRUCTURES

All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied.

Access has to be considered in the design of the structures to all equipment of the GIS. It has to be possible to surround the GIS with the gas cart.

The specified stresses for outdoor equipment like wind, earthquake, snow, ice and thermal expansion due to current and sun radiation have to be considered.

Proper surface treatment for all parts especially in outdoor situation has to be considered. All steel members have to be hot-dipped galvanized according to DIN standards for heavily polluted environment.

3.1.17 FUTURE EXTENSION

For double bus-bar and one and half breaker configuration, it shall be possible to extend the switchgear by adding future feeders as decided by the owner with at least one of the bus bar systems service continuously and the existing feeders remaining in service continuously. The

Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect.

3.1.18 REPAIR

In case of any internal fault in the bus bar or bus bar dis - connector, circuit breaker, repair works must be possible with at least one busbar in service

Any failure shall be immediately signaled by the systems inherent self-supervision with clear description of the nature and the location of this failure. Generally any failure shall have impact only on the direct related devices and the rest of the substation shall remain in normal operation.

3.1.19 REMOVAL OF COMPONENTS

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

3.1.20 EARTHING OF THE SWITCHGEAR

GROUNDING: The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic 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, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected externally with Copper /Aluminum bonds of suitable size to bridge the flanges. Subassembly to subassembly bonding shall be provided to bridge the gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

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

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

(a) EARTHING OF MAIN CIRCUITS

To ensure safety during maintenance work all parts of the main circuit, to which access is required, shall be provided with provision of earthing through earth switch as applicable.

(b) EARTHING OF ENCLOSURE

The enclosure shall be connected to earth. All metal parts other than main and auxiliary circuits shall be earthed. Separate earthing strips to short circuit flanges and earth switches are not allowed. Earthing switches shall be connected to earth through enclosures. Individual earth leads for the earth Switches are not recommended. The continuity of the earthing circuits shall be ensured taking into account thermal and electrical stresses caused by the current they have to carry.

Each of the earthing strips shall be connected to the main earthing mesh installed below the GIS, at two ends.

(c) EARTHING OF GIS

The earthing system shall be based on a multi-point design ensuring the protection in case of indirect contact (Touch or step voltages, in case of system fault) and transient phenomena in case of lightning or switching operations.

Earthing conductors shall allow fault with short circuit current for at least 1 sec. Separate ground strips to short circuit flanges and earthing switches are not allowed. Grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed.

3.1.21 AUXILIARY CONTACTS

Each equipment shall be furnished with adequate number of electrically independent contacts at user's disposal. They shall be wired to terminals located in the local control cabinet of the circuit breaker bay. Installation of auxiliary relays (contact multiplication) may be used to meet the overall control and protection requirements.

3.1.22 SPECIAL TOOLS

Any special tools needed for installation, operation and inspection shall be included in the quotation. **These special tools shall be supplied along with the GIS and shall not be taken back by the bidder.** For gas handling purpose following tools shall be quoted as a minimum:

- i) SF6 Gas Analyser
- ii) Leakage detector
- iii) Precision pressure gauge

3.2 TECHNICAL SPECIFICATION OF THE HIGH VOLTAGE COMPONENTS OF GIS

3.2.1 CIRCUIT BREAKER

1. General

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

Circuit-breakers shall be the SF6 gas insulated type of single phase for 400kV & 220 KV & three phase encapsulated for 132kV design with the specified ratings. The breaker shall be Self-Blast / auto Puffer type principle and consist of one interrupting arcing chambers.

Each circuit-breaker including the drive mechanism shall be completely factory assembled, adjusted and tested. The breaker shall include a suitable operating mechanism to assure proper opening and closing, and shall permit checking adjustments and opening characteristics. Each mechanism shall include dual trip coils in redundant design. The mechanism shall be capable of re-closing within the range specified in the applicable standards. The breakers are to be re-strike-free. The Circuit breaker shall be C2 class type and 400 kV, 'k' should be 1.4 times.

Breaker disposition must be horizontal/vertical (as per type tested) to provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favorable and considered in the evaluation.

2. Technical Particulars

		420kV / 220 KV / 132kV
Nominal operating Voltage	kV	400 / 220 / 132
Highest system Voltage	kV	420 / 245 / 145
Nominal operating current(at 40°C)	A	4000A (400kV) & 3150 (220 & 132kV)
System earthing		Solidly earthed
Rated withstand voltage with respect to earth		
Lightning	kV	1425 / 1050 / 650
Power frequency	kV	650 / 460 / 275

Rated short-circuit breaking current (r.m.s.), 3s:	kA	63 / 50 / 40
Rated making current (peak):	kA	157.5 / 125 / 100
Rated break time	ms	≤ 2 cycle for 400 KV & < 3 cycle for 220/132 KV
Rated opening time	ms	As per IEC-62271-100
Rated closing time	ms	< 5 cycle
Close-open time	ms	As per IEC-62271-100
Rated cable and line charging breaking current	A	400 (400kV), 250 & 125 (220kV) and 160 & 50 (145 KV)
Number of breaks per pole	Nos.	1
First pole to clear factor		1.3 minimum
Operating mechanism :		Spring-Spring
Rated operating sequence		O-0.3s-CO-3 min-CO / CO-15sec-CO
Time for recharging CO cycle		
Type		Spring-spring
Number of trip coils		2 in each pole
Number of closing coils		1 in each pole
Rated control voltage (DC)	V	220 DC
Number of operations permissible without maintenance: At no load At rated current At 40/50 kA	CO CO CO	10'000 6000 As per IEC

Auxiliary electrical equipment shall be suitable for operation on the following supply system.

(a)	Power Devices like drive Motors of rating maximum 1 KW	415 V, 3 phase 4 wire/230V 50Hz, neutral grounded AC supply.
(b)	Lighting, space heaters and Fractional KW motors.	240 V, single phase, 50 Hz neutral grounded AC supply.
(c)	Alarm, control and Protective devices.	220 V DC, 2 wire

Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Supplier's scope include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

I) AC supply : voltage $\pm 10\%$ frequency $\pm 5\%$

II) DC supply : - 15% to + 10%

3. Constructional features

All making and breaking 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 replacements due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

Main contacts shall be first to open and last to close so that there is little contact burning and wear. Contacts shall be kept permanently under pressure of SF6 gas.

Arcing contacts shall be first to close and last to open. These shall be easily accessible for inspection & replacements.

Any devices 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 to that of the breaker as a whole.

Breaker shall be so designed that when operated within its specified rating, the temperature of each part is limited to the values consistent with a long life or the material used. The temperature shall not exceed the values indicated in IEC60694 under specified ambient conditions.

The material used in the construction of the circuit breaker shall be such as to be fully compatible with SF6 gas decomposition products.

All gasket surfaces shall be smooth, straight and reinforced.

4. Breaking capacity

The total breaking time from energizing of the trip coil at rated control voltage to final arc extinction shall be as short as possible.

The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC publications. Official test reports shall be submitted with the tender as evidence that the offered circuit breaker meets the specific rating.

5. Interrupting Duty:

Circuit breakers must be capable of coping with the interrupting duties produced by the switching of transformer magnetizing currents, line charging currents, cable charging currents, capacitor banks, short-line faults and out-of-phase switching duties.

6. Auto-reclosing

The circuit-breakers shall be capable of tripping and re closing according to the specified duty cycle.

7. Closing devices

All electrically operated closing devices and any mechanism charging motors or devices shall be suitable for operation at any voltage between 110% and 85% of the nominal control voltage measured at the device terminals.

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

Closing coil rating shall be as per GIS manufacturers standard.

8. Tripping devices

All electrical tripping devices shall be suitable for operation at any voltage between 110% and 70% of the nominal voltage, measured at the device terminals. Tripping device tolerance shall be as per IEC/ANSI.

An emergency hand tripping (mechanical) device shall be provided in the operating mechanism. Trip coil rating shall be as per GIS manufacturers standard

9. Operating mechanism

Spring-Spring operating mechanism/spring operating mechanism shall be supplied for each circuit-breaker. The operating mechanism should be spring loaded for single and three pole operation in any type of mechanism. Electric motor for the mechanism shall be DC operated. In case of failure of auxiliary supply, the mechanism shall have sufficient energy stored to perform at least a O-CO cycle. Additionally, it should also be possible to operate the mechanism manually as a safety

requirement (e.g. to ensure that the stored energy has been released in case of any assembly, maintenance or replacement work)

In order to reduce maintenance work and outage time, pneumatic operating mechanisms or pure hydraulic mechanism is not be accepted.

The mechanism shall be strong and rigid and shall be suitable for high speed auto re-closing and other duties specified.

The mechanism shall be anti-pumping and trip free under every method of closing.
Spring operated mechanisms shall be complete with all control equipment. The only external requirement for operation shall be electrical supply.

Spring-Spring operating mechanism/spring operating mechanism shall be complete with all control equipment. The only external requirement for operation shall be electrical supply. Low stored operating energy shall be detected as per following operations:

1. Spring charge motor
2. block auto-reclosing if stored operating energy is insufficient to complete a break-make-break operation
3. block closing if stored operating energy is insufficient to complete a make-break operation
4. block tripping if stored operating energy is insufficient to complete a break operation

Charging of the operating mechanism shall be possible in the event of failure of the motor drive.

The mechanism shall be in a dust and vermin proof box for indoor installation or in a weatherproof box for outdoor installation.

Each breaker shall have sufficient auxiliary switches all wired to terminals located in the local control cubicle.

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

Operation counter: Each circuit -breaker shall be provided with an operation counter per mechanism to record the number of tripping operations performed.

Discrepancy circuit shall be provided which shall detect pole position discrepancy.

Design of circuit breaker shall ensure that the contacts will not 'close' / 'open' automatically upon loss of gas pressure. The circuit breaker shall retain and continue to remain in the position prior to the loss of pressure.

10. Anti pumping

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

11. Position indicating devices

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

3.2.2 DISCONNECTOR

1 General

The GIS dis connectors shall comply with the following general and the latest revision of the relevant IEC standards. Dis connectors shall be three pole, group operated, no-load break, with one motor operated mechanism per three-pole. They shall also have facilities for emergency manual

operation and the necessary operating handles or hand cranks shall be supplied. Dis connector shall be interlocked to prevent the earthing switch from closing on a energized bus section.

All main contacts shall either be silver plated or shall have silver inserts. Each dis connector shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed. The dis connectors shall be located as shown in single line diagram.

2 Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	kV	420 / 245 / 145
- Lightning	kV	1425 / 1050 / 750
- Power frequency	kV	815 / 460 / 315
Nominal operating current(at 40°C)	A	3150 / 2000
Rated short-circuit withstand current (r.m.s.), 1s	kA	63 / 50 / 40
Type of operating mechanism		Motor
Number of drives per 3 phase		1
Control voltage (DC)	V	220 DC
Number of CO permissible without maintenance	No.	As per latest IEC standard or equivalent.

Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular disconnect switch operate simultaneously. All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation in an unmanned substation.

For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided. Manual operation shall be prevented if the interlocking conditions have not been satisfied. The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.

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

3. Position indicating

External mechanically connected position indicators shall be provided showing either open or close position.

3.2.3 MAINTENANCE EARTHING SWITCH

1. General

The GIS earthing switches shall comply with the following general requirements and the latest revision of the relevant IEC standards. Maintenance earthing switches shall be three pole, group operated, no-load break, with one motor operated mechanism per three-pole. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

Maintenance earthing switches shall be electrically interlocked to prevent the earthing switch from closing on an energized bus section. The common point of the two bus bars along with earth switch shall be designed and housed in a **single** compartment so as to avoid complete shutdown of the system in case of maintenance required in any disconnecter.

All main contacts shall either be silver plated or shall have silver inserts. Each earthing switch shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

The maintenance earthing switches shall be located as shown in the single line diagram.

2. Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	KV	420 / 245 / 145
- Lightning	kV	1425/ 1050/ 750
- Power frequency	kV	815 / 460 / 315
Rated current	A	NA
Rated short-circuit withstand current (r.m.s.), 1s:	kA	63 / 50 / 40
Type of operating mechanism		Motor
Number of drives per 3 phase	Nos.	1
Control voltage (DC)	V	220 DC
Number of CO permissible without maintenance	Nos.	As per latest IEC standard or equivalent.

3. Operating mechanism

Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular earthing switch operate simultaneously.

All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation in an unmanned substation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided.

Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.

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

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

4. Position indicating devices

External mechanically connected position indicators shall be provided showing either open or close position.

3.2.5 FAST ACTING EARTHING SWITCH

1. General

Fast acting earthing switches shall be located at the busbar and at all external HV connections of feeders (like HV cable or overhead line). The switching capability shall be class B (Earthing switches designated to be used in circuits having relatively long lines or high coupling to adjacent energized circuits) as per IEC 62271-102 Annex C standard. Furthermore it shall withstand the full making capability.

The fast acting earthing switches shall comply with the following general requirements of fast acting earthing switches and the latest revision of the relevant IEC specifications.

Fast acting earthing switches shall be three pole group operated, with one motor operated mechanism for three phase. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.

Fast acting earthing switches shall be electrically interlocked to prevent the fast acting earthing switch from closing on an energized bus section.

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

Each fast acting earthing switch shall open or close only due to motor-driven or manual operation. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated,

the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.

2. Technical Particulars

		400kV / 220 KV / 132kV
Rated Voltage	kV	420kV / 245 / 145
Rated short-circuit withstand current 1s, (r.m.s.):	kA	63 / 50 / 40
Inductive current switching capability	A , kV	As per IE C standard
Capacitive current switching capability	A , kV	As per IEC standard
Type of Mechanism		Motor
No. of drives per three phase	Nos.	1
Closing time	ms	As per manufacturer standard
Control voltage	V	220 DC
Number of permissible CO without maintenance	Nos.	As per IEC
Short-circuit making:	Class	E1

3. Operating mechanism

Electric motor for the driving mechanism shall be DC operated. Mechanisms shall be arranged (mechanically ganged) so that all three phases of any particular fast acting earthing switch operate simultaneously.

All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs for energy storage and closing. Motors shall be suitable for operation at any voltage between 85% and 110% of the rated auxiliary voltage.

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

The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually. The mechanisms shall be arranged for locking in the open and in the closed position.

4. Auxiliary switches

Each fast acting earthing switch shall be furnished with adequate number of electrically independent contacts at user's disposal. The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.

5. Position indicating devices

External mechanically connected position indicators shall also be provided.

3.2.6 CURRENT TRANSFORMERS

1. General

The current transformers shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC.

Each current transformer shall be arranged so that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured.

Current transformer secondary cores shall be terminated to shorting terminal blocks.

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

2. Position of the Current Transformers and Cores, Ratios and Characteristics.

The number and position of the current transformers relative to the circuit-breakers, disconnectors and earthing switches shall be as detailed in the attached single line diagram. However, there must have possibility of provision of CT on either side of CB.

The rating, ratio, accuracy class etc. for the individual current transformer secondary cores shall be as specified. Where multi-ratio current transformers are required, the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

However, CT ratio shall be finalized during detailed engineering.

3. Rating and Diagram Plates

Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture.

The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2). The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

4. Constructional Details:

The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal enclosed type. The secondary windings shall be air insulated/Gas insulated with terminals brought out for secondary connection.

All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

Each Set of current transformers shall be equipped with a **terminal box with** terminals for the secondary circuits, which are connected to the local control cubicle or CT secondary terminals shall be directly terminated to the local control cubicle to avoid open circuiting in marshalling box. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

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

The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.

The current transformers shall be suitable for high speed auto re-closing.

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

Technical Particulars

		400kV / 220 KV / 132kV
Core number per phase	Nos.	06/05/04 cores *
Accuracy - Metering - Protection		Metering 0.2s & protection PS class *
Rating Primary	A	3000-2000-1000/1600-800/800-400-200*
Rated secondary current	A	1
Continuous Thermal rating	%	120
Accuracy Class		400 KV:PS-PS-0.2S-0.2S-PS-PS 220 KV:PS-PS-0.2s-PS-PS 132 KV:PS-PS-0.2s-PS
Burden in VA	Metering	20

	core	
Max exc current at V _k		400KV: 20ma on 3000 tap, 30ma on 2000 tap & 40ma on 1000 tap. 220KV: 20ma on 1600 tap, 40ma on 800 tap.
Max CT sec resistance in Ohms at 75 deg C		400KV:15/10/5 220KV:8/4
Rated short-circuit withstand current 1s, (r.m.s.):	kA	63 / 50 / 40

*All protection Cores shall be of accuracy class TPS as per IEC: 60044-6. However, if a Higher accuracy class CT is required for protection, the same shall be provided.

*The details will be finalized later, based on the protection relay study.

3.2.7 POTENTIAL TRANSFORMERS (PT): Bus PT/Line PT.

1. General

The voltage transformers shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC.

Each voltage transformer shall be an electromagnetic, dry type SF6 –enclosed single phase unit with the specified ratings.

The voltage transformers are to be connected as shown in the attached single line diagram.

Voltage transformers shall be attached to the gas-insulated system in such a manner that they can be readily disconnected from the system if required for dielectric testing. The metal housing of the voltage transformer shall be connected to the metal enclosure of the GIS with a flanged, bolted and gasketed joint so that the transformer housing is thoroughly grounded to the GIS enclosure. Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits which might result from very fast transients (VFT) or ferro-resonance.

2. Ratios and Characteristics

The rating, ratio, accuracy class, connection, etc. for the voltage transformers shall be as specified below.

This shall be (400kV), (220kV), (132kV) / ($\sqrt{3}$)/110V/ ($\sqrt{3}$)/110V($\sqrt{3}$ / 110V/($\sqrt{3}$)/ accuracy class 0.2/3P/3P, connection Y/Y-Y-Y. The voltage transformers shall have 3 secondary windings, each winding with one tap.

3. Rating and diagram plates

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

4. Secondary Terminals, Earthing, MCB's and Fuses

The beginning and end of each secondary winding and all secondary taps shall be wired to suitable terminals accommodated in the local control cabinet for the feeder bay. Fuses / MCBs shall be also located in the local control cabinet.

All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Secondary terminals shall have permanent marking as identification of polarity, in accordance with IEC. Provision shall be made for earthing of the secondary windings inside the terminal box.

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

The accuracy class will be at maximum tap.

5. Constructional Details of Potential Transformers:

The potential transformers shall be located in a separate bay module on the bus and will be connected phase to ground and shall be used for protection, metering and synchronization.

The potential transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The potential transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have two secondary windings

Potential transformer's secondary shall be protected by fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the PT's shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

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

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

6. Technical Particulars

		400kV / 220 KV / 132kV
Rated voltage	KV	420 / 245 / 145
Primary winding	kV	(400), (220), (132)/ $\sqrt{3}$
Secondary winding	V	110/ $\sqrt{3}$
No of secondary windings	Nos.	3
Accuracy of secondary winding class		0.2 /3P/3P
Burden VA		50 / 50 /50
Partial discharge level at 1.5 U//3	pC	As per IEC
One minute power frequency withstand voltage for secondary winding		3 kV (rms)
Radio interference voltage at 1.1 Un/ $\sqrt{3}$ and frequency range 0.5 to 2 MHz		1000 μ V/1000 μ V/500 μ V
Phase angle error		\pm 10 minutes (for metering core)
Rated voltage factor		1.2 times continuously & 1.5 times for 30 Sec

3.2.8 SURGE ARRESTERS:

When necessary, AIS surge arresters shall be placed at the line exits in close proximity to the line entrance.

GIS Surge Arresters shall be "Zinc Oxide" resistors type without spark gaps and with impulse characteristics suitable for use with SF6 gas insulated equipments. It shall be single phase SF6 insulated, self cooled suitable for installation as integrated part of GIS switchgear. Surge arresters shall be designed and tested in accordance with the requirements of IEC 60099-4/5 or latest.

The surge arresters form part of the overall GIS switchgear therefore they shall be positioned as near to the equipment to be protected and must be connected with as short connectors as possible to both line and earth; so that surge arresters can provide maximum protection in accordance with IEC 60099. All surge arresters shall be fitted with a pressure relief diaphragm which shall prevent explosive shattering of the housing in the event of an arrester failure and the arrester shall be tested accordingly to the high and low current tests specified in IEC 60099-1.

Each surge arrester shall be identified by a rating plate in accordance with the requirements of IEC 60099-4. Surge counters shall be provided as one per phase. The leakage current meters shall be

for installation in the earth connection of the surge arresters and shall be designed for continuous operation and shall be placed in an accessible and visible location to be read from ground level with the arrester

Technical Particulars

		400kV / 220kV / 132kV
Rated voltage	KV	390 / 192 / 102
Long duration discharge class		4/3/3
Rated Frequency		50 HZ
Minimum discharge capability voltage corresponding to minimum discharge characteristic		400 KV: 12 KJ/kV at rated arrester voltage 220 KV: 10 KJ/kV at rated arrester voltage. 132 KV: 5 KJ/kV at rated arrester voltage.
Nominal discharge current (8/20 μ s)	kAp	20/10/10
Max. Lighting Impulse Residual Voltage with 8/20 μ s	kVp	As per IEC
Partial discharge at 1.05 COV (pC)		Not more than 5
High current short duration test value (4/10 micro second wave)	kAp	100
Max. residual voltage at 10 kA nominal discharge current		800 kVp/ 600 kVp/ 330 kVp
Max. residual voltage at 20 kA nominal discharge current		800 kVp/-
Max. switching surge residual voltage		650 kVp (500A) / 500 kVp / 330 kVp
RIV at 1.1 Un/ $\sqrt{3}$ kV rms(micro volts)		Less than 1000/ Less than 500/ Less than 500

Note: The detailed parameters of surge arrestors will be finalized during detailed engineering.

3.2.9 SF6/AIR BUSHINGS

1. General

Outdoor SF6 to air bushings, for the connection between the GIS and overhead lines or conventional air insulated equipment shall be furnished where specified.

OUTDOOR BUSHINGS:

Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in GTR. The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC -60137. Insulation levels and Creepage distances: All bushings shall have an impulse and power frequency withstands level that is greater than or equal to the levels specified for GIS. The creepage distance over the external surface of outdoor bushings shall not be less than 31mm/kV. Bushing types and fitting: The details of bushing shall be as follows:

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

Sl No.	Description	420KV	245 KV	145 KV
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1	Rated Current (Amp)	2000/3150/ 5000 as applicable	1600	600
2.1	1.2/50 micro second impulse voltage (Lightning impulse withstand voltage)	1425 kVp	1050 kVp	630 kVp
2.2	250/2500 micro second switching impulse voltage	1050 kVp	-	-
3	One minute power frequency withstand voltage	650kV (rms)	460 kV (rms)	250kV(rms)
4	Minimum total Creepage distance in mm	10500	6125	3625
5	Minimum Cantilever strength (kN)	10	8	8
6	Rated Voltage	420KV	245 KV	145 KV

2. Insulation levels and creep age distances:

The insulation levels are applicable to normal sea level atmospheric conditions. The creep age distance over the external surface of outdoor bushings shall not be less than 25 mm/kV.

3. Mechanical forces on bushing terminals:

Outdoor bushings must be capable of withstanding a cantilever force as per IEC standard

4. Interface definition

The flange and conductor connection between bushing and GIS component shall be the standard of the GIS supplier.

3.2.10 GAS INSULATED BUS DUCT

The components of the GIS shall be connected by a single phase bus ducts for 400kV & 220kV. The enclosure shall be connected by use of bolted and gasketed joints. The bus conductor shall be connected with plug in contacts with silver plated contact surface. The bus system shall be capable of withstand the mechanical and thermal stresses due to short circuit currents, as well as thermal expansion and contraction created by temperature cycling.

3.2.10 EHV-POWER CABLE CONNECTION

1. General

The design of the cable end box shall fully comply with the IEC 62271-209 standard. The Extra high voltage power cables, shall be supplied by the tenderer. The type and size of cables shall be as per requirement. The final connection of the high voltage cable circuits in the GIS will be by means of individual single-phase cables, with one cable per phase.

The cable end unit design shall include a facility for high voltage AC testing of the connected power cable on site. Removable bolted links or similar connections will be accepted. The design of the link and connections shall ensure that when removed the resulting gap can withstand the impulse and power frequency test voltages applicable to the switchgear and the cable high voltage AC test voltage.

2. Interface definition

Dimensions and division of work shall fully comply with IEC 62271-209 standard.

Note: The details of the XLPE cable to be estimated based on the layout during detailed engineering.

3.2.11 LOCAL CONTROL CUBICLE (STAND ALONE TYPE):

1. General

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

The LCC shall operate as a link between GIS and Control, protection and substation automation system (SAS) in Control Room LCC shall generally include:

- mimic showing the single line diagram showing the position of CB, Dis, FAES, MES etc.
- Position indicators of CB, Dis, FAES, MES etc.
- Discrepancy type control switches for breaker, disconnecter and earthing switch
- Local / remote selections
- Alarm and indication devices.
- Aux. relays or other devices as required by the design.

For easy overview, the LCC's should be stand alone in the switchgear in front of the related circuit breaker bay. A general arrangement drawing showing the installation position shall be submitted with the quotation.

The LCC's shall be installed indoors. The LCC's shall also be dust and vermin proof and shall be located near GIS modules.

The control and operation circuits shall be well shielded and with safety measures to protect operator from touching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute. The LCC shall be factory tested and shipped together with the bay as one transport unit.

2. DC Supplies and Circuits

DC supplies shall be provided by the tenderer for all control, interlocking, alarm, indication and power supply circuits. The normal maximum and minimum voltage levels that will occur on the supply are specified.

At least one single MCB outlet from the substation DC distribution board will be provided for each local control cabinet.

The design of all circuits must be such that separately fused or sub fused circuits are always kept electrically separate.

3. A.C. Supplies and Circuits

A.C. power for heaters and other auxiliary loads will be provided by the tenderer by two 240 V, 50 Hz, 3-phase circuits.

The normal maximum and minimum voltages that will occur in the supply are as specified. All equipment supplied shall be capable of running continuously or switching the AC current within the range of the normal maximum and minimum voltages specified.

4. Cable connections within the GIS and their LCC's

All cable connections between the various GIS modules and the LCC's shall be made by prefabricated multi-core cables with multi-point plug-in connections on both ends. PT's and CT's shall be hard wired.

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

Space Heater: Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz Ac supply for the internal heating of the panel.

3.2.12 TOOLS

The Tenderer shall include in his proposal the recommended tools required for installation, commissioning, operation and maintenance.

The following tools shall be supplied as a minimum:

Tools for gas handling plant (CI No. 3.2.18(a))	1 set
Gas Leakage detector	1 piece
SF6 filling device	1 set

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

These tools shall be supplied along with the GIS and shall not be taken back by the bidder.

3.2.13 SPARE PARTS (Refer to the price schedule)

The Tenderer shall include in his proposal the recommended spare parts for installation, commissioning, operation and maintenance.

The following spare parts shall be supplied at a minimum:

(a) Maintenance earthing switch	1 unit
(b) Fast acting earthing switch	1 unit
(c) Disconnecter	1 unit
(d) Density monitors for circuit breaker	1 unit
(e) Density monitors for other gas compartments	1 unit
(f) Drive for circuit breaker	1 unit
(g) Drive for dis connector & Maintenance earthing switch	1 unit
(h) Drive for fast acting earthing switch	1 unit

3.2.14 OTHER SERVICES

The following services shall be included in the proposal or quoted as optional items.

a) Training sessions on installation, commissioning, operation and maintenance of GIS shall be held by an experienced, English speaking instructor.

One week training for installation and commissioning shall be held prior to installation at site or at the owners' premises/at the factory.

One week training for operation and maintenance shall be held after the installation at the site.

b) **Factory inspection/acceptance test: at the factory at least one module of each type (Feeder, Transformer & B/C bay module)**

c) Installation Supervision

The estimated time period for installation supervision shall be shown in the proposal.

d) Commissioning / High voltage test

The estimated time period shall be shown in the proposal.

3.2.15: INTERLOCKS

Electrical interlock shall be provided between :

1. Circuit breakers and disconnecter.
2. Dis connectors and earthing switches.

The principles of electrical interlocks are the following:

On each bay:

- The disconnecter from the bus bar may not be closed if the associated circuit breaker is closed.

The bus bar disconnecter may not be closed if the earthing switch located between itself and the circuit breaker is closed.

- The earthing switch located between the bus bar disconnecter and circuit breaker may not be closed if the bus bar disconnecter is closed.

- The circuit breaker may not be closed if the earthing switch of the associated section of bus bar is closed.
- The feeder disconnecter may not be closed or opened if the associated circuit breaker is closed.
- The feeder disconnecter may not be closed if the earthing switch is closed.

On the bus bar:

- cable disconnecter can be opened and earthing switch can be closed only if the voltage transformer reads zero.
- Cable earth switch can be closed only if cable disconnecter is opened.
- Cable disconnecter can be opened only if the associated circuit breaker is opened.
- The feeder disconnecter cannot be closed if the switchgear is closed and bus bar disconnecter is closed.
- The earthing switch of each bus bar may be closed only if all the bus bar disconnections are opened.

3.2.16: ARRANGEMENTS

Wiring

The wiring must be carried out with stranded copper conductors of at least 7 strands. The size of the conductors shall be suitable enough for the expected usage, but it must not be less than 2.5 sq.mm. All precautions should be taken to minimize the inductive and capacity coupling between circuits of especially with the wiring of the AC and DC circuits. The cable trays shall be designed in such a way that it has at least 20% space for future usage.

Terminal Blocks

The design of the terminal shall be as per the relevant standards in vogue. The terminals permitting the direct control of SF 6 surveillance from pressure monitoring devices must be fitted with test point.

The outgoing terminal connection must be unique and comprises of 2 distinct parts:

- an arrangement for auxiliary voltage supply (alternating or direct current)
- an arrangement for control common.

Worker Safety

All precautions must be taken to ensure an efficient protection against accidental contact with the live elements.

Degree of protection

The required level of protection shall be established for the enclosures of boxes and cubicles as per the relevant standards in vogue.

Frame work

The boxes and cubicles shall have metallic enclosures to ensure effective protection against radio interference. If these enclosures are of non-metallic materials, the screen shall be connected to the earth to ensure efficient protection.

Cable entrance

Cable glands or grommets shall be provided for cable entry through the lower side. These cable glands should avoid electrolytic corrosion at the lower side of the box.

Closing devices

A simple handle will be suffice at the door of the cubicles.

The door must open at at least 120 deg.

Lighting and socket :

Lighting facility at the cubicles shall be activated by opening the door.

In each local control cubicle a single phase 3 pin socket with switch shall also be provided. The lighting points and sockets should be connected by a circuit separate from other circuits.

Space heaters

In each box and local control cubicle a space heater is required to prevent condensation. It should be connected by the same separate A.C. circuit as above.

The manufacturer shall indicate the electrical power of each heater.

Earthing of boxes and cubicles

Depending upon the location of boxes and cubicles, the earthing terminal is either linked to the metal enclosure, or linked directly to the general earth mat by an earthing conductor of reduced cross – section.

Equipotential connections between boxes, cubicles and doors shall be provided to ensure that no movable part of the enclosure can, once it is in place, be isolated from the part to which the earthing terminal is connected.

Voltage transformer

The cable from voltage transformers shall be terminated in the cubicles and VT box shall be padlocked. Provision of required rating MCB's in the LCC.

The fuses are connected in such a way that the locking devices forbid access to the cells corresponding to the conductors from the voltage transformers.

The fuse units shall be of 25 amp rating with a 6amp fuse cartridge.

Boxes and cubicles.

Other than stainless steel, all the boxes and cubicles shall be painted with a minimum one primer coat and one top coat.

Bolts, screws and nuts.

In case of stainless steel a diameter of 16mm and above shall be provided.

If the diameter is below 16mm hot galvanized will be allowed and in such case the thickness of zinc plating shall be 375 g /sq.m.

All precautions shall be taken:

- to ensure that contacting materials do not cause electrolytic corrosion.
- to avoid water stagnation.

The manufacturer shall specify the measures adopted to ensure the above conditions.

3.2.17: LOW VOLTAGE CABLES & CONTROL CABLES

The Low voltage cables & control cables shall be of 1.1 kV XLPE/PVC insulated copper tape shielded control cables shall be complied with IEC 60502 and flame retardant to IEC 60332-1. The size of the above cables is more than 2.5 sqmm.

3.2.18: ACCESSORIES:

SF6 GAS SERVICE CART (SF6 Gas Filling, Evacuating, Filtering, Drying, Pumping & Storage Plant)

The SF6 gas service cart shall be adequate to:

- refill each compartment between the first or second level of SF6 gas pressure to the rated pressure.
- check the SF6 monitoring.

The SF6 Gas Filling, Evacuating, Filtering, Drying, Pumping & Storage Plant with spares for 5 years Operation.

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

(1) **400/220 KV:** Vacuum Pump: 60 M3/Hour (Nominal suction pressure) & Compressor: 15 M3/Hour (Delivery).

(2) **220/132/33 & 220/33 & 132/33 KV:** Vacuum Pump: 40 M3/Hour (Nominal suction pressure) & Compressor: 6.5 M3/Hour (Delivery).

The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases. The gases compartments shall be fitted with permanent non-return valves through which the gas is pumped into or evacuated from the compartments.

(a) SF6 HANDLING PLANT

The SF6 handling plant shall contain compressors and vacuum pump necessary for recovering vacuum and filling SF6 gas. It shall be movable with wheels.

It shall allow the storage of SF6 in liquid state in a built – in tank having capacity sufficient to empty any three adjacent compartment of 400kV / 220 KV / 132kV GIS.

The capacity of compressors and vacuum pumps shall be selected in such a way for

- filling a compartment to the rated pressure within one hour.

- recovering SF6 gas from any compartment to the built in tank from the rated pressure to 50mb pressure within three hours.

- evacuating a compartment from 50 mb pressure to less than 1 mb pressure within one hour.

The cart shall have the following provisions:

- accessories for connections and operation (valves and coupling)

- dry type filters, dust and oil traps,

- tools and spares for operation and Maintenance,

- hand- book for description, commissioning, operation, and Maintenance.

(b) 400kV / 220 KV /132 kV GIS Equipment HV testing (at field after erection at site including conditioning and PD measurement):

Required testing equipment for HV testing at the time of commissioning to be considered by the supplier (Supplier scope but will be taken back by the supplier after commissioning).

3.2.19: EARTHING

CONNECTION TO THE GENERAL EARTH MAT:

All metal parts intended which does not belong to a main or an auxiliary circuit, shall be connected to earth.

The general **HDG MS earth flat** earth circuit of the substation shall be formed by an uninterrupted loop which originates from the buried **HDG MS earth flat** conductor of a cross section of **750 sq.mm (75X10) for 220 & 132 KV & 40 mm dia MS Rod for 400 KV**. These loops shall be fixed to the base of the chassis with the help of an earth riser connection bolted into a hole in the chassis or frame by the manufacturer of the metal-clad equipment, and situated at 0.30 m above the floor level of the switchgear. The general earth mat design, the connection device and the bimetallic plate shall be supplied by the GIS manufacturer. The earth connection from earth pad of equipment to the general earth mat near shall be provided by the supplier. The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stress by the current they may have to carry. The riser shall be of **copper flat size of 50X6 mm** with bi-metallic arrangement to connect from the ground earth mat to enclosure of the GIS equipment.

EQUIPOTENTIAL EARTH MAT:

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.

Five copies of equipotential earth mat drawings along with design calculations may be submitted for approval by the successful Bidder.

3.2.20: TESTING & COMMISSIONING:

(a) TYPE TEST:

Type tests shall be according to the **IEC 62271-203** and other relevant IEC standards. Copies of the type tests conducted shall be furnished along with the BID failing which the Bid is liable for rejection. These type tests should have been conducted in a Recognized independent institution / Laboratory. The type test reports of the manufacturer or its principal (holding company) shall be acceptable, if the manufacturer is of international repute.

(b) ROUTINE TESTS :

Routine tests shall be as per the IEC 62271-203 and other relevant standards. The manufacturer shall provide all the testing equipment required for the site tests.

(c) COMMISSIONING TESTS/ON SITE TESTS AFTER ERECTION :

After erection, and before putting into service, the gas-insulated metal enclosed Switchgear shall be tested for the correct operation and dielectric strength of the equipment.

These tests and verifications shall comprise:

(1) Tests to be conducted on the circuit breaker at site

At all required operating sequences

- Measurement of operating time

Checking of wiring and connections and dielectric checks

Indications, alarms and interlocks, auxiliary contacts

Operation at rated control supply voltage/pressure

Operation of anti-pumping device.

(2) Test to be conducted on the Disconnectors at site

Checking of wiring and connections and dielectric checks

Indications, alarms and interlocks, auxiliary contacts

Operation at rated control supply voltage/pressure

(3) Other Tests at Site

- Dielectric tests on auxiliary circuits
- Measurement of the resistance of the main circuit
- Measurement of gas condition
- Gas tightness tests
- General verifications

(4) POWER FREQUENCY TEST: ON SITE TESTING OF GIS

Power frequency tests for the completed GIS at site shall be complied as per **IEC 60270**.

Power frequency tests for the completed GIS at site shall be possible without removing the voltage transformers. The power frequency test voltage at site shall be **80%** of the factory test voltage for 1 minute at **50 Hz**.

The Supplier is responsible to furnish the test equipment for conducting following performance tests at site.

- Voltage tests on main circuits at reduced voltage (80% p.f.) comprising:

- 50 Hz A.C. voltage test for 1 min

- Partial Discharge test

The manufacturer shall provide :

- The test voltage source.

- All connections between the switchgear and the test voltage source.

The procedure to be implemented following a discharge during dielectric tests is as follows :

- if a disruptive discharge occurs at the first test while increasing of test voltage, a second test is performed.

- If a second disruptive discharge occurs in the same compartment before reaching the highest level, there are two possibilities :
 - If the second disruptive discharge is higher than the first voltage again the voltage is immediately increased. If a new discharge occurs the value of which is again higher, a new test is carried out.
 - If the second disruptive discharge is lower than or equal to the first, the test is stopped and the compartment dismantled.
- The process is continued in order to reach the test voltage. If a disruptive discharge occurs at this voltage, there are two possibilities:
- if it is the first disruptive discharge in the compartment since the test was begun, voltage is again increased. If there is no other discharge, the test has been successful. The test is stopped and the compartment dismantled.
 - if some discharge have previously occurred in this compartment during the increase in voltage, the test is stopped and the compartment dismantled.

3.2.21: SCHEDULE OF EQUIPMENT/MATERIALS

Item No	Description of Equipment/Materials	Quantity
1	ACCESSORIES	
	SF6 Gas handling plant of adequate capacity	1 Set
	SF6 gas service cart with all accessories	1 Set
2	TESTING EQUIPMENT	
	GIS testing equipment (Bidder should include all such testing equipment ,which are required for detail testing of GIS system)	1set

3.2.22: SCHEDULE FOR ESSENTIAL TOOLS AND SPARES

Item No	Description	Quantity
1	Single phase voltage transformer	1 Set
2	Single phase current transformer including enclosure (considering all cores) for each voltage level	1 Set each
3	Enclosure insulators and main circuit of bus bar	1 Set
4	Tripping and closing coils	6 Nos (TC) & 3 Nos (CC)
5	SF6 Pressure gauges	2 Sets
6	SF6 Pressure relief devices	2 Sets
7	Auxiliary contacts for circuit breaker	1 Set
8	Auxiliary contacts for DS and ES	1 Set
9	SF6 gas in steel bottle 50 Kg / bottle	2 Nos.
10	spring charge motor for circuit breakers	1 unit
11	Complete drive mechanism for disconnect switches and grounding switches	1 unit
12	Motor for disconnect switches and grounding switches	1 unit
13	Complete drive mechanism for fast acting grounding switches	1 unit
14	Motor for fast acting grounding switches	1 unit
15	Rupture disc for circuit breakers / potential transformer	1 no

16	Set of spares for local control cabinet including M.C.B., fuses, time relays, auxiliary relay and terminals etc. (at least one no. from each type)	1set
17	Rupture disc for other compartments	2 nos
18	SPECIAL TOOLS	
i)	SF6 gas leak detector	1 Set
ii)	SF6 gas analyser	1 Set
iv)	Milli volt drop measurement appliance(contact resistance measurement-600 A DC)	1 Set
v)	One set of Box Spanner	1 Set
vi)	One set of adjustable Spanner	1 Set
vii)	Sf6 gas bottle locking, measuring and filling assembly with all hose	2 Set
viii)	Infra red camera	1 set

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

4.1 ELECTRIC OVERHEAD CRANE:

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

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

The Crane shall be used for the erection and maintenance of the GIS switchgear component and all plant installed in the GIS switchgear room .On completion of erection of the switchgear, the Contractor shall completely service the crane before the Taking Over Certificate is issued. Crane hook approaches shall be of the minimum possible dimensions to ensure maximum coverage of the plant area.

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

The crane shall have minimum speeds under full load of:

Speed

- (a) Hoisting 2 meters/minute
- (b) Cross Travel 10 meters/minute
- (c) Long Travel 20 meters/minute
- (d) Creep speed shall be of 25% of operating speed

The electric overhead cranes shall be provided with walkways, platforms. Guard hand rails shall be provided along the bridge rails and on the crab of EOT crane to facilitate cleaning/maintenance of the crane and to give access to the GIS room high bay lighting and ventilation duct and grilles. The platform and walkways shall be designed to support any weight to be imposed upon them during crane overhaul. An access platform shall be provided together with a guarded ladder on the crane to allow access to the bridge rails.

The crane shall be possible to be operated through the cable, through the pendant control and which shall be easily accessible from the floor of GIS building and through remote control device. Manufacturer/contractor shall submit the capacity calculation of crane for GIS hall considering a factor of safety of 5.

- a) The crane for 400kV GIS hall shall have capacity of minimum 7T safe working load & minimum height of crane have shall be 9.0 meters or as per actual requirement whichever is higher.
- c) The crane for 220kV GIS/132kV GIS shall have capacity of minimum 5T safe working load & minimum height of crane have shall be 8.0 meters or as per actual requirement whichever is higher.
- In case the GIS hall is to be extended, the scope of work also involves extension of EOT crane girders to facilitate movement of EOT crane in the extended portion of GIS hall.

The following tests may be EOT Crane

1. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test .
2. Further the following tests may be done at site after installation of the crane at site
 - a. Check althea accessories for proper function

The following tests may be EOT Crane

1. The crane shall be tested at manufacturer work under full load and 25 percent overload of hoisting and cross transverse motions as a routine test.
2. Further the following tests may be done at site after installation of the crane at site
 - a. Check all the accessories for proper function
 - b. No load test
 - c. Load test as per site conditions.

**Guaranteed Technical particulars
400/220/132KV GAS INSULATED SWITCHGEAR**

SNO.	DESCRIPTION	400 KV GIS	220 KV GIS	132KV GIS
A	General			
1	Installation			
2	Model			
3	Make			
4	Reference standard			
5	Enclosure design code			
6	Type of material of enclosure			
7	Type of material of air bushings			
8	Ambient temperature (design value)			
9	Nominal Operating Voltage			
10	Highest System Voltage			
11	Phase Design Encapsulation			
	a) Busbars			
	b) Feeders			
12	Rated insulation level (withstand voltages, to ground)			
	a) At power freq 1 min			
	b) At impulse (1.2/50)			
13	Rated current of			
	a) Busbars			
	b) Other Bays			

14	Rated current at 50 °C			
15	Rated 1 sec withstand current			
16	Rated peak withstand current			
17	Internal fault withstand time without burn through			
18	Temp rise at rated service current-			
	a) Joint			
	b) Conductor			
	c) Enclosure			
19	Design pressure of enclosures:			
	a) Circuit Breakers			
	b) Other Compartments			
20	SF6 gas pressure at 20 °C (actual value shall be submitted by the manufacturer)			
	a) Filling Pressure			
	b) Alarm Pressure			
	c) Blocking Pressure			
21	Operating pressure of the pressure relief devices			
	a) Circuit Breakers			
	b) Other Compartments			
	c) Type of device			
	d) Material			
22	Type test pressure of enclosures			
	a) Circuit Breakers			
	b) Other Compartments			
23	Routine test pressure of enclosures			
	a) Circuit Breakers			
	b) Other Compartments			
24	Alarm Pressure			
	a) Circuit Breakers			
	b) Other Compartments			
25	Blocking pressure			
	a) Circuit Breakers			
	b) Other Compartments			
26	Is each gas compartment equipped with			
	a) Pressure relief valve			

	b) Absorber of moisture			
	c) Density switch			
27	Weight of each bay of GIS -			
	A) Line bays			
	b) I/C Trans bays			
	c) O/G Trans bays			
	d) B/C bays			
	e) B/B earthing & measuring bay			
28	Total weight of the offered GIS			
29	Total weight of the SF6 in the offered GIS			
30	Anticipated loss of SF6 per year			
31	Maximum PD at 1.2 times rated voltage in factory			
32	Conductor : Material			
	a) Ends / plating			
	b) Contacts			
	c) Contact type			
33	No of operations w/o maintenance at No load / at full load / at S/C current			
	a) CB			
	b) Disconnecter with integrated earth switch			
	c) Fast acting Earth Switch			
34	Gas Barriers			
	a)Material			
	b)pressure withstand			
35	PD test			
36	Support Insulators Material			
37	PD test			
38	Sealing :			
	a) Material of rings			
	b) method of sealing			
39	Feeder Connection Type			
	a) for Line Bay			
	b) for ICT Bay			
	c) for GT Bay			
	c) for Bus Reactor Bay			

40	Local Control Cabinet Integral/ Non integral			
B	400 KV GIS CIRCUIT BREAKER	UNIT	DATA	
1	Make			
2	Model			
3	Nominal Operating Voltage			
4	Highest System Voltage			
5	Phase Design (1 OR 3 phase)			
6	BIL (across open contacts)			
7	Rated current			
8	Rated current at 50 °C			
9	Rated short time(1 sec) current			
10	Rated making current (rms)			
11	Rated making current (peak)			
12	Rated break current			
13	Rated closing time			
14	Rated opening time			
15	Rated break time			
16	Close-open time			
17	Out of phase breaking current, voltage factor 2.5			
18	Rated cable & line charging breaking current			
19	Number of breaks per pole			
20	Auto reclose			
21	Operating mechanism : (No per single phase CB)			
22	Rated Operating sequence			
23	Type of operating mechanism			
24	Number of trip coils			
25	Number of closing coils			
26	Rated Control Voltage			
27	Closing voltage range			
28	Trip device voltage range			
29	Charging without motor drive			
C	400/220/132 KV GIS DISCONNECTING SWITCH	UNIT	DATA	
1	Make			

2	Type			
3	Withstand voltages, (P to E / P to P)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
4	Rated cont current			
5	Rated 1 sec withstand current			
6	Peak withstand current			
7	Type of operating mechanism			
8	Number of drives per 3 phase			
9	Number of CO operations without maintenance			
10	Facility for emergency manual operation			
11	Interlocking with earthing switch			
12	Plating of main contacts			
13	Ganged operation			
14	Facility for padlock			
15	Modes			
D	400/220/132 KV GIS MAINTENANCE EARTHING SWITCH	UNIT	DATA	
1	Type			
2	Rated insulation level(withstand voltages, to ground)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
3	Rated 1 sec withstand current			
4	Peak withstand current			
5	Type of operating mechanism			
6	Number of drives per 3 phase			
7	Number of CO operations without maintenance			
8	Interlocking with isolator switch			
9	Plating of main contacts			
10	Ganged operation			
11	Facility for padlock			
12	View ports for inspection			
13	Mechanical position indicator			
E	400/220/132 KV GIS FAST ACTING EARTH SWITCH	UNIT	DATA	

1	Type			
2	Rated insulation level(withstand voltages, to ground)			
	a) At power freq, 1 min			
	b) At impulse (1.2 / 50)			
3	Rated 1 sec withstand current			
4	Peak withstand current			
5	Inductive Current switching capability.			
6	Capacitive Current switching capability.			
7	Closing time			
8	Type of operating mechanism			
9	Number of drives per 3 phase			
10	Number of CO operations without maintenance			
11	Energy storage springs			
12	Motor operation range			
13	Interlocking with isolator switch			
14	Plating of main contacts			
15	Ganged operation			
16	Facility for locking			
17	View ports for inspection			
18	Mechanical position indicator			
F	400/220/132 KV GIS CURRENT TRANSFORMER	UNIT	DATA	
1	Type			
2	Polarity			
3	RATIO / Class / Burden			
	a) Core-1			
	b) Core-2			
	c) Core-3			
	d) Core-4			
	e) Core-5			
4	Rated insulation level			
	a) At power freq, 1 min (main / sec)			
	b) At impulse (1.2 / 50)			
5	Rated 1 sec withstand current			
G	400/220/132 kV GIS Voltage Transformer			

1	Type			
2	Applying Standard			
3	Primary voltage			
4	Secondary voltage			
5	No of secondaries			
6	Accuracy & burden :			
	a) Core-1			
	b) Core-2			
	c) Core-3			
7	Voltage factor			
8	Rated insulation level			
	a) At power freq, 1 min (main / sec)			
	b) At impulse (1.2 / 50)			

TECHNICAL SPECIFICATIONS FOR CUBICLE INDOOR TYPE

33KV SF6 GAS INSULATED SWITCHGEAR (GIS)

DESIGN, CONSTRUCTION, PERFORMANCE TESTING, INSPECTION, PACKING AND DELIVERY OF 33kV CUBICLE GIS

1. SCOPE

1.1 This specification calls for supply of 33kV CUBICLE TYPE GAS INSULATED SWITCHGEAR (33kV GIS) and associated accessories as specified herein, for OPTCL.. The scope covers design, manufacture, inspection and testing at the VENDOR's and/or his SUB-VENDOR's works; packing for shipment and delivery to OPTCL site including complete erection, testing & commissioning. GIS Manufacturer shall undertake Supervision activity for erection, site testing and commissioning of 33 kV Gas Insulated cubicle type switchgear and accessories, including the associated main bus bars and cable termination assemblies and associated platforms, supports and internal wiring etc.

1.2 **The intent of this specification is to provide the work enumerated to be fully complete in every detail for the function designated. It is hereby required that the BIDDER, in accepting the contract, agrees to furnish all apparatus, appliances, material not herein specifically mentioned or included, but which may be found necessary to complete, perfect or test any portion of the apparatus or equipment herein specified in a substantial manner, and in compliance with the requirements implied in this specification and without extra cost to the PURCHASER.**

1.3 It is not the intent to specify completely herein, all details of design and construction of the equipment. However, the equipment shall conform in all respects to high standards of engineering design and workmanship and be capable of performing in continuous commercial operation up to the VENDOR's guarantees in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work / material which in his judgment is not in full accordance therewith.

1.4 Whether called for specifically or not, all accessories required for normal operation of equipment are deemed to be a part of VENDOR's scope of supply.

2. STANDARDS

2.1 The design, material, construction, manufacture, inspection, testing and performance of 33kV GIS shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The GIS equipment shall also conform to the IEC 62271-200.

3. **TYPE & RATING:** The 33kV GIS shall be of cubicle type and shall comprise three phase copper main bus bars, circuit breakers, isolators, earth switches, CTs, VTs, Surge Arresters and other accessories with rating and electrical characteristics as given in the specific requirements.

4. FREQUENCY

The 33kV GIS shall be suitable for continuous operation with a frequency variation of 5% from normal of 50 Hz.

5. Availability Requirements:

5.1 The gas insulated switchgear and accessories shall be designed for maximum reliability and availability.

5.2 The design ambient temperature considered for continuous rating of the equipment shall be 40°C.

5.3 It shall be possible to interchange various cubicles. Bidders shall clearly bring out the

modifications required to be carried out for interchanging/converting incomer/transformer bays and outgoing feeder bays.

- 5.4 Gas compartments shall be segregated from each other and the panels shall also be physically segregated from each other. Unified (continuous) busbar compartment is not acceptable.
- 5.5 Each gas compartment shall be internal arc tested. In the event of an internal arc the plasma shall be carried through a duct outside the switchgear room.
- 5.6 Cable compartment shall also be internal arc tested. In the event of an internal arc the plasma shall be carried through a rear duct outside the switchgear room. Release of plasma in the cable basement is not acceptable.
- 5.7 Entry of the power cable shall be from bottom. The Internal **arc classification-IAC AFLR** (Authorized person access permitted from Lateral Front & Rear side).
- 5.8 Panel to panel connection shall be fully enclosed and shall not remain open. Gas handling shall not be required during coupling of panels or during future extension of switchboard.

6. **Layout Requirements:**

- 6.1 It is intended that the GIS shall be located indoors.
- 6.2 The GIS will be mounted on concrete foundations. Any necessary supporting framework and base plates shall be provided by the BIDDER.
- 6.3 Bidder shall indicate recommended clearance from the top of panel to the ceiling and also material handling facility. The BIDDER shall specifically review the area indicated and confirm suitability of the equipment offered to fit into the space shown including area required for future extensions. Deviations, if any, shall be highlighted in the bid
- 6.4 The bidder shall ensure that dimensions and weight of the largest package shipping/transport do not exceed the permissible values imposed by Transporting Authorities.

The 33KV Cubicle type GIS shall be with Double Bus bar (Both the bus shall be as Main Bus) as mentioned in the tender

7.0 SWITCHGEAR ASSEMBLY

The switchgear assembly shall essentially consist of following items:

- a. Circuit breakers
- b. Disconnect Switches (Isolators) and earth switches
- c. Voltage transformers, Current transformers and Surge Arresters
- d. Cable chamber for termination of Power cables along with termination arrangement
- e. Isolated or 3-phase main bus enclosures and accessories.
- f. Local control cubicle.
- g. SF6 gas sufficient for the entire switchgear including loss during installation + 10% extra SF6 gas.
- h. Dummy panels wherever necessary.

8.1 **CIRCUIT BREAKERS**

8.1.1 **General**

1 The circuit breakers shall be vacuum type isolated phase, for independent pole operation and shall have duplicate trip coils. They shall be electrically and mechanically trip free where applicable and anti-pumping with either or both of the duplicate trip circuits connected. A manual emergency trip facility is required to be provided.

- 2 The circuit breaker shall normally be suitable for remote electrical operation at DC voltage as specified in the "Specific Requirements" with either or both of the duplicate trip circuits connected. Pole discrepancy tripping shall be provided, if applicable.
- 3 The breaker enclosure shall have provision for easy with drawl of the interrupter assemblies. Checking the contact condition of the interrupter elements must be possible without disturbing any other gas compartment.
- 4 The name plate shall display the actual site rating of the equipment.

8.1.2 Circuit Breaker Performances

- 1 Duty Cycle: Open-0.3 seconds-Close-Open-3.0 minutes-Close-Open.
- 2 Breaking time : The maximum breaking time at the minimum operating pressure of the mechanism shall be 3.0 cycles.

8.1.3 Circuit Breaker Construction Features

The vacuum circuit breakers, vacuum monitor device shall be supplied to aid maintenance personnel to estimate whether vacuum levels are within acceptable/ permissible limits. This device can be portable and shall be designed to permit easy connection/ disconnection with any breaker without in any manner influencing the integrity of sealing of the vacuum interrupter.

It shall be possible to quickly isolate mechanically the interrupter unit of a vacuum circuit breaker from the breaker operating mechanism for checking loss of vacuum inside the interrupter.

Vacuum circuit breaker shall be provided with a suitable metal shield for protecting the testing/ maintenance engineer from X-ray radiations emitted during high voltage testing of interrupter unit.

8.1.5 Operating Mechanism

- 1 Circuit breakers shall be power operated by a motor charged spring operated mechanism. Main poles of the breaker shall be such that the design shall ensure a close pole spread with timings as per GIS manufacturers' standard.
- 2 Circuit breakers shall feature high repeatability of absolute closing time over a wide range of parameters (ambient temperature, control voltages, etc.).
- 3 Main poles shall operate simultaneously. There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong, rigid, positive and fast in operation.
- 4 Trip coil shall be rating shall be specified by the bidder for continuous rating.
- 5 A mechanical indicator shall be provided to indicate open and closed positions at a location from where it will be visible to a man standing on the ground. An operation counter shall also be provided.
- 6 A closing release shall operate correctly at all values of control voltage between 80% and 110% of the rated voltage. A shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of control supply voltage between 70% and 110% of rated voltage.
- 7 Working parts of the mechanism shall be of corrosion resisting material. Bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing of adjustment with repeated operation of the breaker.

8.1.6 Spring Operated Mechanism

- 1) Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.
- 2) As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.
- 3) After failure of power supply to the motor, at least one close-open (CO) operations of the circuit breaker shall be possible.
- 4) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.
- 5) Closing action of the circuit breaker shall compress the opening spring ready for tripping.
- 6) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.

8.1.8 Contacts

- 1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be easily replaceable and shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.
- 2 Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping.

8.2 **DISCONNECT SWITCHES (ISOLATORS) AND EARTH SWITCHES**

8.2.1 Construction Features

- 1 The Isolators, earth switches and maintenance earth switches, as applicable, shall be complete with all parts that are necessary or essential for efficient and safe operation. Such parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.
- 2 All similar parts shall be interchangeable.
- 3 The design shall be such that no lubrication of any part is required except at very infrequent intervals.
- 4 The isolator and earthing switch shall be provided with high current carrying contacts on the hinge and jaw ends and all contact surfaces shall be of silver/tinned faced copper, if required.
- 5 Arrangement shall be provided to enable manual operation of Isolators and earth switches. Whenever the emergency manual handle is inserted into the drive mechanism, it shall not be possible to control the device electrically.

8.2.2 Accessories

- 1 Position Indicator: A mechanical position indicating device shall be provided for each

isolator/earthing switch which shall be clearly visible from ground.

- 2 Name Plate: A weather-proof and corrosion-proof name plate shall be provided on each isolator, earthing switch and operating devices etc. The name plates shall conform to applicable standards.

8.2.3 Earthing Switch

- 1 Earthing switch shall be designed in a manner to prevent transmitting of impact to earth switch bushing during high speed closing operation of the earth switch.
- 2 The earth switches shall have fault current rating as specified.
- 3 Earth switches shall be either be motor driven or stored energy operated and controlled from the local control panel as specified. After removal of the ground initiated by a fault making ground switch, it must be possible to re-energize the system without first carrying out maintenance. The BIDDER shall state what precautions are taken to minimize the accidental discharge of the stored energy operating mechanisms. This will not be applicable for hand operated earth switches.
- 4 A positive interlock shall be provided such that the circuit breaker shall be closed only when all three phases reach end position of "Earth" during earthing operation. Bidder shall clearly explain this interlock in the technical offer.

8.2.4 Interlocks among circuit breaker, earthing switches and doors shall be as per the recommendations of the GIS manufacturer.

8.2.5 Operating Mechanism and Controls

1. Isolators shall be motor operated and controlled from the local control panel and from a remote point. Connections, interlocking requirements and auxiliary switches shall be in accordance with the PURCHASER's requirements.
2. The operating mechanism shall provide a quick, simple and effective operation. One man shall be able to operate the isolator/earthing switch (when manually operated) without undue effort.
3. The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsion and bending stresses due to operation of the isolator.
4. In addition to the limit switch contacts required for control of power operated isolators, the number of auxiliary contacts shall be provided. These switch contacts shall be positive acting type and shall be directly driven from the isolator shaft through minimum linkages. The auxiliary contacts shall be of silver faced copper. When make before break contacts are specified, they shall be wiping type. The contacts (including limit switch contacts) shall be designed to carry 10A continuously without undue temperature rise. All contacts (including limit switch contacts) shall be suitable for breaking an inductive current of 2A at specified DC voltage.
5. A local isolating switch fuse unit for disconnection of power supply, a local/remote selector switch and a set of open/close push buttons shall be provided in the associated local control panel for motor operated isolators.
6. The control shall be arranged such that the desired operation shall be completed when corresponding push button is pressed even momentarily. The control circuit shall be so designed that necessary interlocks with associated breakers and earthing switch shall be incorporated in it.
7. Arrangement shall be provided to permit manual operation of isolators. The arrangements shall be such that when manual operating handle is in the engaged position, the power operation shall be

made inoperative.

8. Disconnecter and earthing switch mechanisms shall be able to store energy to always assure completed operations.

9. If the power supply to Isolator/ earthing switch is initially off and open/close command is given to isolator/earth switch which cannot be carried out due to non-availability of power at that moment, the operation of Isolator/Earth switch shall not take place when power supply is restored subsequently.

8.2.6 Short Circuit Requirements (except for Disconnecter for VT in incoming panel)

1. The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:
 - a) Mechanical damage to any part of the isolator or earthing switch.
 - b) Separation of the contacts or contact welding.
 - c) A temperature rise likely to damage insulation.
2. After the passage of these currents, the isolator shall be able to carry its rated current under specified conditions and the operation of the operating device shall not be impaired.
3. If earthing switch is combined with an isolator as a single unit, the rated peak short circuit current and the rated short time current of the earthing switch shall be at least equal to those specified for the isolator.

8.3 CURRENT AND VOLTAGE TRANSFORMERS

8.3.1 General Requirements

1. Secondary terminals of each voltage and current transformers shall be brought out in a weather-proof terminal box. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal box. The star point whenever required shall be formed at the terminal box only.
2. Terminal and polarity marks shall be indelibly marked on each VT & CT on the associated terminals and these marks shall be in accordance with relevant standards.
3. In case of unearthed voltage transformers both the terminals of the primary winding shall be brought out through bushings rated for full line voltage. In case of earthed voltage transformers, the end of the primary winding intended to be earthed shall be brought out through a bushing and earthing connection shall be made outside. This is required to facilitate meggering of the primary winding for which the earth connection has to be removed. The neutral side bushings of the voltage transformers shall be rated for 1.1 kV class.
4. The secondary terminal box for the voltage transformers shall also include necessary MCBs for protecting the secondary circuit
5. Whenever a VT secondary winding is used for both measurement and protection application, it shall have dual accuracy class of 0.2/3P, unless otherwise specified.
6. All CT cores in this specification shall be of low reactance type except metering core.
7. No turns compensation shall be used in case of 'Class PS' CTs.

8. Turns compensation, if any, should be clearly brought out in the offer in guaranteed particulars.
9. In case of multi ratio CTs, the minimum specified requirements in respect of VA, accuracy and knee point voltage (KPV) and maximum secondary resistance specified shall be met at all taps.
10. Magnetizing characteristics (extending well beyond KPV) and secondary impedance values shall be furnished in guaranteed particulars for all protection cores.
11. Voltage transformers shall be of electromagnetic type. Capacitor voltage transformers shall not be acceptable.
12. Voltage and current transformers shall be provided with the following accessories:
13. Voltage and current transformers shall be given tropicalised treatment for satisfactory operation in hot and humid climate.
 - a) Two earthing terminals for connecting the PURCHASER's earthing conductors specified.
 - b) Rating and diagram plates shall be provided as per IEC standards.

8.3.2 VOLTAGE TRANSFORMERS

- 1 Voltage transformers shall be of the metal enclosed, gas-insulated inductive type, mounted directly on the high voltage enclosure with plug in contacts without fuse that allow easy removal.
- 2 Minimum accuracy, burden and transient response characteristics shall be in accordance with the specification.
- 3 Secondary terminals must be located in accessible grounded terminal boxes on the PT enclosure itself. The secondary connections must be wired to the terminal strip in the respective bay marshalling cubicle.
- 4 BIDDER shall provide the VT selection scheme for outgoing feeders ie. potential supply to protection system shall be switched to bus VT depending on position of bus side disconnect switch (power supply to the feeder and VT potential supply for protection shall be from the same bus.)

8.3.3 CURRENT TRANSFORMERS

8.3.3.1 Number and Location of CTs

- a) The CTs shall be provided as per specification.
- b) The physical relative location of CT cores should be as per the locations shown in the single line diagrams, to ensure overlapping of protective zones.

8.3.3.2 Minimum Accuracy for Relaying Cores

PS class, Class 0.2s & Class PS shall be as per specification. The relaying cores shall be of low remanence design. Gaps in the core shall not be larger than necessary to limit remanence. The core remanence shall not exceed 10% of the saturation flux that is created by the application of 10 DC ampere turns per inch length of core around the magnetic path.

8.3.3.4 Other CT Requirements.

- a) For each type of CT, application data shall be supplied in accordance with IEC 60185.
- b) Readily accessible name plate(s) shall be provided for each CT showing ratings, terminal markings and low remanence designation.
- c) The position of each primary terminal in the current transformer shall be clearly marked by two plates permanently fixed to the metal cladding at each end of the current transformer section.
- d) In addition to the information requested, short time rating factors for 5, 15, 30 and 60 minutes shall also be provided.

8.3.3.5 Current transformers must have secondary terminals outside the high voltage enclosure, mounted in suitable accessible terminal boxes. All secondary leads of all CTs must be wired to

shorting type terminals on the terminal strip in the local control panel of each breaker bay.

Note: The details of the CTs will be finalized later, based on the protection relay study.

8.4 Surge Arresters

The specifications and characteristics of the surge arresters shall be finalized during detailed engineering.

8.5 LOW VOLTAGE PANELS

The accessories and auxiliary equipment required for the correct functioning of each circuit element shall be installed in conveniently located mechanism cabinet or could be an integral part of the circuit element.

8.5.1 General Requirements

a) Individual local control panels/Cabinets/Cubicles for each circuit shall be supplied as a part of this contract to facilitate local control of circuit breakers, isolators and earth switches. These panels shall also house the various relays, timers, etc. to realise various interlocks as per PURCHASER's requirement among circuit breakers, isolators and earth switches. The contacts, signals and conditions originating from/going to the gas insulated switchgear, associated auxiliary and monitoring equipment shall be wired up to the local control panel, for PURCHASER's further use.

b) Completely separate and isolated circuit shall be used for switchgear control, tripping, alarms and auxiliary devices. CLOSE and TRIP circuits shall be kept isolated to their final mechanical or electrical actuators. Trip circuits shall be individually and permanently monitored for continuity.

Each auxiliary control circuit shall be monitored and shall be protected by a two pole miniature circuit breaker with auxiliary contacts.

c) Constructional Features

1. All panels shall be totally enclosed rigid sheet steel structures. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual fuses, switches, MCBs without danger of contact with live metal.

2. A ground bar for terminating the ground wires of shielded control cables shall be located near the cable entrance location.

3. A receptacle rated 415V, 20A, AC 3 phase, 4 wire shall be installed in each panel in addition to a light point with door switch and one 6 pin, 240V AC, 5/15A socket outlet.

4. Adequate safety precautions shall be taken to avoid accidental contact with 415V potential. The following precautions shall be observed:

i) All live parts shall be completely shielded using a halogen free fire retardant insulating material.

ii) 600V terminal blocks shall have removable covers and wiring shall be separated from other potentials.

iii) A clear and legible warning notice carrying wording "DANGER-415V" shall be located on the enclosure door.

5. All control equipment shall be suitable for operating in an ambient temperature varying between +10 deg. C and +40 deg.C.

6. Cabinet doors shall have provision for padlocking. Door shall be constructed such that they do not seize in the event of an internal fire.
7. All live parts shall be provided with at least phase to phase and phase to earth clearance in air of 25 mm and 20 mm respectively.
8. Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands including cable glands for cables from control room to GIS shall be supplied and fitted on to this gland plate. Cable glands shall be screwed-on type and made of brass. The cable entry shall be from bottom only.
9. All the hardware required for fixing the panel shall be in BIDDER's scope.
10. Terminal blocks for terminating all control, indication and monitoring wiring from the associated circuit element shall be installed in each cabinet. All terminal blocks shall be identified with marking strips. The conductor size range which the terminals can accommodate shall be clearly shown on the BIDDERS drawings. The terminal blocks used for cable connections shall be disconnecting type. All terminal blocks shall be covered by acrylic covers.
11. Disconnecting type terminal links shall be provided for current transformer circuits.

d) Switches/ MCBs

- 1 Switches/MCBs shall be hand operated, air break, heavy duty, quick make, quick break type conforming to applicable IEC standards.
- 2 It shall be the responsibility of the VENDOR to fully coordinate the overload and short circuit tripping of the MCBs with the downstream MCBs/fuses provide satisfactory discrimination.
- 3 A single throw isolating switches for complete isolation of the DC control circuits shall be provided.

f) Control & Auxiliary Power Supply

- 1 All control equipment shall be suitable for operation on specified DC voltage system.
- 2 In case two systems are working on two different battery potentials, say A and B, both A and B potentials shall not be connected to the contacts of same relay. However, it is permissible to use, for example, the relay coil on A and the contacts on B battery. Dissimilar potentials shall not occur on contacts of same relay.
- 3 DC & AC power supply shall be done in a manner which will enable isolation of individual equipment. Common supply bus will be formed in the cubicle and then power supply shall be distributed into individual equipment through MCCBs.
- 4 Separate circuits with switches, fuses etc of adequate rating shall be provided for control of space heater, lighting and power receptacle etc. These shall be on 240V, 1 phase AC supply.

g) Relays

- 1 Relays for various control, monitoring and blocking functions of a particular circuit element shall be installed in associated local control panel. Protective relays shall be subject to transient tests and shall be approved by the PURCHASER. All relay shall have dust covers. Please refer Section C3 for detailed specifications of BCUs and BCPUs.
- 2 Necessary auxiliary relays for alarm, time-delay relays, voltage relays as required for control and protection shall be mounted inside the local control panel. Voltage relays shall have sufficient

thermal capacity for continuous energisation, using external resistors, if necessary.

3 Auxiliary relays shall be rated to operate satisfactorily between 80% and 110% of the rated voltage.

4 Each relay shall be provided with at least 4 NO and 4 NC potential free contacts for the PURCHASER's use.

5 Coils of all the relays shall be adequately rated to avoid spurious operation of relays on DC system ground or induced surges. Minimum pick up current of relay coil shall be 100 milli amps.

6 All relays shall be tropicalized and suitable for maximum ambient temperature of 40 deg. C.

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

h) Space Heater

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

i) Interior Lighting and Receptacle

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

j) Internal Wiring

1 LV control panels shall be completely wired, ready for the PURCHASER's external connections at the terminal blocks. All wiring shall be carried out with wires of 600V grade, stranded copper conductors. The insulation shall be fire retardant low smoke type, approved and tested in accordance with PURCHARSER's requirement. Power circuits shall be wired with stranded tinned copper conductors of adequate sizes to suit the rated current. Alarm and indication circuits shall be wired with stranded, tinned copper conductors of sizes not smaller than 1.25 sq.mm and shall be shielded type. CT circuits shall be wired with stranded copper conductor of size not smaller than 2.0 sq.mm.

2 Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire. All wiring shall be terminated on terminal blocks. Terminals shall be adequately rated for the circuit current the minimum rating shall be 20 A. Control wiring shall be protected against mechanical damage and shall be colour coded in accordance with PURCHASER's requirement. Colour sleeves may be used in lieu of continuous colouring. Physical separation between various colour wiring shall be maintained as much as possible.

3 The wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip insulation and conduction.

4 Panel wiring shall be securely supported, neatly installed by lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant plastic wiring channels/troughs with strap on covers shall be used for this purpose.

k) Mimic Diagrams (Optional)

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

l) Local Alarm/Annunciation

1 Window type alarm annunciation shall be provided on local control panels of each bay for various abnormal conditions. The alarm windows should have provisions for detecting cleared and un-cleared faults and flashing for new faults.

2 The following abnormal conditions shall be annunciated (additional to list). i) Low gas pressure for each gas compartment of the bay. ii) Low-Low gas pressure for each gas compartment of the bay. iii) High gas pressure for each gas compartment of the bay. iv) Spring motor excessive start. v) Spring motor run excessive. vi) Spring motor overload. vii) Spring motor circuit trouble. viii) Spring is charged. xiii) Breaker pole discrepancy. xiv) Isolator open/close incomplete. xv) Isolator motor overload, one for each bay, xvi) D.C. control supply failure. xvii) Alarm circuit D.C. healthy (continuously 'ON'), xviii) Selector switch local, xix) Four spare windows.

m) Labels and Diagram Plate

1 Every equipment mounted in the cabinet shall be provided with individual labels with equipment designation/rating. Also, the cabinet shall be provided on the front with a non-rusting label engraved with the designation of the cabinet.

2 Inside the door, a circuit diagram engraved on non-rusting metal shall be fixed for reference.

9. SF6 Gas

9.1 Density and Pressure

The nominal operating pressure of SF6 insulated gas in the equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks and to ensure that there is no chance of the gas liquefying at the lowest ambient temperature. The initial gas pressure or density at the time of charging the equipment shall provide a sufficient margin above the minimum allowable pressure for the plant to be safely operated for a reasonably long period before recharging is necessary.

10.2 SF6 Gas Purity

a) The SF6 switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC-60376 at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC. 60376.

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

c) The SF6 gas shall have the following characteristics:

1) Physical properties: Colourless, odourless, non-toxic and non-flammable.

2) Density at 20°C and/Bar 6.08 g/l 8) Preferred cylinder size 40 Ltr.

3) Type of cylinder Seamless type

10.3 SF6 Gas Monitoring Devices

1. All gas compartments must have their own independent gas supervision and alarm systems. Each gas supervision circuit shall be equipped with a temperature compensated pressure gauge, test connection point and maintenance connection point and the same shall be easily accessible. Bus bar side Disconnector (DS)/Earth Switches (ES) shall have common gas density monitor for all the three phase.

All other equipments such as Circuit breaker, Line side DS/ES can either have common or separate gas density monitor system for all the three phases.

2. The gas density and pressure sensitive devices, together with all relays supplied by the manufacturer for use in protection, shall be approved by the PURCHASER. It shall be possible to test all gas monitoring relays without de-energising the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes; the pressure/density device shall be suitable for connecting to the male portion of the plug.

3. Two potential free electrical contacts shall be provided with each and every alarm condition. These are to be grouped together and wired to the cable termination blocks in the local control panels to give remote alarm indications/annunciations in equipment being supplied by the PURCHASER. The BIDDER will be advised of the grouping required after the contract has been placed.

4. BIDDER shall advise if the breakers are suitable for breaking the load current even if SF6 gas pressure has reduced to atmospheric pressure.

10.5 Sectionalisation

10.5.1 The assembly shall consist of completely separate, pressurized sections. The switchgear gas enclosures must be sectionalised with gastight barriers between sections or compartments as per the below:

- a) One compartment for bus bar, Isolator and earthing switch
- b) One compartment of circuit breaker and cable connection

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

10.6 Support Insulators and Section Barriers

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

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

10.6.3 The Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier i.e with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over pressure, at least equal to the operating pressure of the relief devices, that could be attained with a persistent internal arc fault.

10.7 Gas Seals

All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all normal pressure, temperature, electrical load and fault conditions.

10.8 Expansion Joints and Flexible Connections

10.8.1 Expansion joints or flexible connections, in the metal enclosures, to absorb the actual or relative thermal expansion and contraction of the SF6 equipment as well as structures, foundations and floors on which the equipment is mounted, resulting from variations in the temperature of the switchgear equipment shall be provided, if required.

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

10.8.3 Electrical continuity of the connection for all enclosures across bolted joints/expansion/flexible connections shall be achieved.

10.9 Supply of SF6 Gas

The contract shall include the supply of all the SF6 gas necessary for filling and putting into commercial operation the complete switchgear installation being supplied including loss during installation. In addition, ten percent of the total SF6 gas required for the GIS shall be supplied as spare and shall be included in the contract.

11. Earthing

1. The MANUFACTURER shall provide a "Main Ground Bus", rated 31.5 kA for 3 sec to which all intentionally earthed parts of the assembly must be connected.
2. It shall be the responsibility of the VENDOR to provide a sufficient number of earth points so that dangerous voltages are not induced in the enclosure by the fault currents circulating in the inner conductor.
3. Every section of the SF6 switchgear equipment including all panels, cubicles, kiosks and boxes shall be solidly bonded to the earthing system.
4. Earth switches, voltage transformers and panels shall be bonded to the earthing system as specified in the relevant previous clauses.
8. All steelwork, access decking, handrails etc., shall also be effectively bonded to the earthing system.
9. The design of the earthing system shall be such as to ensure the safety and protection of all operating and maintenance personnel under all normal and fault conditions.
10. The enclosure of the equipment and support structure of GIS shall be earthed in such a way that the following conditions are obtained:
 - (a) The touch potential at any part of the enclosure is less than 65 V.
 - (b) The induced current during normal operation is prevented from entering the earthing grid.

12. Interlocks

All interlocks required between circuit breaker, disconnect and earth switches shall be as per the recommendation of the GIS manufacturer.

13. Future Extension

It is proposed to make provision for additional bays at a later date.

1 It shall be possible in future to extend the bus bars. BIDDER shall separately quote for additional items required to be provided now to facilitate future extension without necessitating complete outage of the bus bars.

2 It is a firm requirement that no changes are made to the enclosure during future extension. Also, the downtime must be minimum when extension is carried out. During erection/testing of extension, outage of only one bus section and associated equipment will be available. Under no circumstances outage of both the bus sections (resulting in complete shutdown of the station) will be permissible. The BIDDER is required to bring out in detail his proposal for achieving future extension and indicate if shutdown of any part of the equipment/circuit will be required for erection, dielectric testing along with Gas Line Diagram etc. The bidder will give step by step procedure for extension of bays on either side of GIS, at later date.

14. Foundation Channels & Supporting frame work

1 All supporting steel structures for switchgear bays, bus duct support, etc. shall be a part of Bidder's supply.

2 All 33kV GIS shall be supplied with bolts, nuts, washers and accessories required for fixing the GIS to the foundation.

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

16. Gas Leakage The guaranteed maximum gas leakage shall be less than 1% per year for any individual gas compartment and for the whole equipment.

17. Losses Manufacturers shall provide details of the losses at rated current.

18. Tests and Test Reports

19.1 The Type test reports shall be submitted with the bid.

19.2 Acceptance and routine tests for all supply equipments/components parts shall be carried out as per the relevant standards for the respective equipment. These test reports and shall be submitted to the PURCHASER before despatch of the equipment.

19.3 Local control panel shall be subjected to the following tests:

i. High Voltage test (2000V for 1 minute)

ii Megger test.

iii Electrical control, interlock and sequential operation tests

20. DRAWINGS DATA AND GUARANTEED TECHNICAL PARTICULARS TO BE FURNISHED BY THE BIDDER

20.1 The following drawings/information for each items are to be supplied as part of this contract:

a) Outline dimensional drawings of 33kV GIS and accessories.

- b) Shipping drawings showing dimensions and weights of each package.
- c) Assembly drawings and weights of main component parts.
- d) Drawings giving the weights for foundations.
- e) Name plate diagrams.
- f) Schematic control along with logic block diagram and wiring diagram for all auxiliary equipment.
- j) Test reports
- k) Crane requirements for assembly and dismantling
- l) Cable box connections.
- m) Foundation drawing of GIS, support structures, cable box etc.

20.2 Manufacturer shall submit following for Purchaser's reference before despatch of the transformer.

- a) Six (06) copies of instruction books/operation and maintenance manuals and spare part bulletins.
- b) Descriptions literature and data on GIS construction.

20.3 After the award of the contract six (6) copies of drawings, drawn to scale, describing the equipment in detail shall be forwarded for Purchasers approval, and shall subsequently provide eight (8) complete sets of final drawings, one of which shall be auto positive and editable soft copy suitable for reproduction, before the despatch of the equipment.

21. Technical particulars of 33KV Cubicle GIS.

Sl. No.	Particulars	33 kV GIS (Cubicle type)
1.		
a)	Type (Model No.)	To be specified by the bidder.
b)	Standard Applicable	IEC-62271-100 / IEC-62271-200
2.	Service	Indoor
3.	Enclosure	Sheet Steel with anti corrosion paints.
4.	Nominal System Voltage	33 kV
5.	Highest System Voltage	36 kV
6.	No. of phases and frequency	3ph. 50 Hz
7.	Busbar material	Aluminium
8.	Bus Color code	RYB
9.	System Earthing	Solidly earthed
10.	Circuit Breaker Rating	
10.1	Continuous Current Rating at 40 Deg C	2000A
10.2	Short Circuit Rating	31.5 kA
10.3	Short Circuit duration	3 sec
11.	Rated making Current	As per IEC-62271
12	Operating duty	O-0.3sec-CO-3 minutes -CO
13	Leakage rate per year in gas compartment	Less than 0.2%
12.	Busbar rating	As per SLD
13.	Outgoing feeder rating	As per SLD
13.	Power Frequency Withstand voltage	70 kV for 1 minute
14.	Impulse withstand voltage (1.2/50 micro sec)	170 kV
15.	Control Voltage	220 V DC
16	Spring charge motor voltage	220 V DC
17.	CT Ratio	Secondary Current 1A (Ratio during detail engineering)
18.	PT ratio -STAR/ STAR/ Open delta	(33//3) / (.11//3) / (. 11/3)
19.	Aux. Contacts	As per manufacturer standard
20.	Termination	
20.1	Incomers	XLPE Cables **
20.2	Outgoings	XLPE Cables **
21.	Degree of protection (HV equipment)	IP – 65 for Gas Compartment

** Notes:

- 1) The length details of the XLPE cables shall be estimated during detailed engineering.
- 2) Interface of 33kV GIS the feeder bays to be finalized during detailed engineering.
- 3) From the 33 KV GIS XLPE cable shall be used for station transformers.

GUARANTEED TECHNICAL PARTICULARS FOR 33KV GIS
SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR BREAKERS / PANELS

01.	Manufacturer's Name and Country of origin	
02.	Manufacturer's Design / type Ref	
03.	Frequency	
04.	Rated Voltage	
05.	Highest system voltage	
06.	Rated current	
07.	Short Circuit current rating with duration	
08.	Certificate or report of short circuit type test	
09.	Rated operating duty cycle	
10.	Short Circuit Breaking Current : (a) Symmetrical (b) Symmetrical at rated voltage (c) Asymmetrical at rated voltage (i) Per Phase (ii) Average (iii) D.C.Component	
11	Arcing time (at rated breaking current) in ms.	
12	Opening time	
13	Total break time in milli sec.	
	(a) At 10% rated interrupting capacity (b) At rated interrupting capacity	
14.	Make time in ms.	
15.	Dry 1 minute power frequency withstand test voltage (a) Between line terminal and Earth KV rms (b) Between terminals with breaker contacts open	
16.	1.2/50 full wave impulse withstand test voltage (a) Between line terminal and Earth KV p (b) Between terminals with breaker contacts open KVp	
17.	Contact pressure	
18.	Contact Resistance	
19	Control Circuit Voltage AC / DC	
20	Power required for Closing Coil at 220 V	
21	Power required for Tripping Coil at 220V	
22	Whether Trip free or not	
23	Whether all the interlocks provided	
24	Overall dimensions	
25	Gauge of the MS sheet used for the fabrication of the cubicle Size and type of stiffeners used	
26	Total weight of one complete Breaker	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV CURRENT TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design Ref / Model	
03.	Applicable Standards	
04.	Type	
05.	Rated Primary current	
06.	Rated secondary current	
07.	Rated frequency	
08.	Transformation ratios	
09	Number of cores	

10	Rated output (Core wise)	
11	Class of insulation	
12	Class of accuracy (a) For metering (b) For Protection	
13	Short circuit current rating and its duration	
14	Secondary resistance at 70 Deg C	
15	Continuous over load (percentage)	
16	One minute power frequency dry withstand voltage	
17	1.2/50 micro sec. impulse withstand test voltage	
18	One minute power frequency withstand test voltage on secondary	
19	Instrument safety factor	
20	Type of primary winding	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV POTENTIAL TRANSFORMERS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design reference	
03.	Applicable Standards	
04.	Type	
05.	Ratio	
06.	Rated Primary voltage	
07.	Rated secondary voltage	
08.	Rated frequency	
09.	Class of accuracy	
10.	No. of phase and method of connection	
11.	Burden	
12.	One min. power frequency dry flash over voltage	
13.	1.2/50 micro sec. impulse withstand test voltage	
14.	Class of insulation	

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR NUMERICAL RELAYS

01.	Manufacturer's Name and country of origin	
02.	Manufacturer's design Ref / Type	
03.	Applicable Standards	
04	Current setting range for	
	(a) Over current relay	IDMTL Instantaneous
	(b) Earth-fault relay	IDMTL Instantaneous
	(c) Contact Rating	
05.	Details on IDMTL characteristics	
06	Whether High Set is Transient free	
07	Whether separate Time setting for IDMTL / Instantaneous Elements available	
08	Whether Relay senses True RMS Current	
09.	Accuracy for different settings and limits of errors	
10	Whether settings site selectable and HMI provided	
11	Whether Alpha Numeric LED display	
12.	Whether Compatible for 220 V DC	
13	Whether Compatible for 1 A CT Secondary	
14	Whether Self diagnostic features available	
15	Whether Communication Port RS 485 Compatible for MODBUS / IEC / DNP.3 provided	

16.	Whether Blocking characteristics available for blocking the unscrupulous tripping of Upstream Breakers	
17.	a) Whether relay test block is provided b) Type of test block with literature	
18.	Whether draw out type unit or not	
19.	Types of case	
20.	Reset time	
21.	Burden of relay	
22.	Maximum and Minimum operating ambient air temperature	

PARTIAL DISCHARGE MONITORING SYSTEM

(A) Specification for Online Partial Discharge (PD) Monitoring System for EHV GIS

GIS equipment shall be designed so as to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.

An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.

The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble free online PD monitoring of complete GIS installation shall be considered as included in the scope.

The PDM system shall be provided with capacity for readily interfacing with UHF PD couplers of present and future GIS Bays as shown in SLD plus 20% additional as spare. Details of it shall be submitted during engineering stage for approval. The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer. The workstation PC shall be powered by suitable dedicated UPS and same is included in the present scope.

A proven and well established online continuous partial discharge monitoring must be supplied with every high voltage GIS module complying the following key features:

1. Standards:

- The System shall be type tested by independent accredited test house to ES BN 55022 (CISPR22), IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-27, IEC 60068-2-56, IEC 60255-5, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-9, IEC 61000-4-10, IEC 61000-4-12, IEC-61850, IEC-60270 standards for use within EHV substations

2. Sensors:

- Meet sensitivity according to CIGRE TF15/33.03.05 1998 or latest at every place in the GIS (5pC or better) will be verified as part of site sensitivity tests. A sensor location drawing has to be submitted by the bidder.
- The PD couplers shall be of passive, maintenance free antenna type meeting CIGRE TF15/33.03.05 standards with detection spectra range: 250 MHz to 1.5 GHz. Pre-amplifier installed as part of the coupler is not acceptable. UHF amplification or conditioning is only allowed at electronic node unit.
- Calibration: The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

3. Analyser:

- Continuous real-time measurement and PD analysis; not multiplexed data collection.

- Supports up to 200 to 300 UHF sensors on one system and shall have a signal sensitivity of -75dBm or better with fixed broadband monitoring (bandwidth ≥ 1 GHz) and historical PRPD over 5, 10 or 15 minute recording period (software selectable).
- The System shall be capable of synchronizing, capturing and displaying PD data for a power test frequency in the range 40Hz to 220Hz. The System shall be capable of operation during and assisting with HV testing of the GIS.
- The PDM System shall be able to discriminate between partial discharge sources, external interference and transients resulting from switching operations of the high-voltage equipment either by Smart Gating with external type noise antenna and/or Smart Coincidence Filter and/or Artificial Intelligence Software detection package.
- Multiple UHF channels (on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF Technique) shall be monitored continuously and simultaneously to ensure no PD pulses are missed. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity
- The System shall be sensitive to partial discharge signals throughout the frequency range 250-1500 MHz. However, it is recognised that in some cases the use of filters may be necessary to reduce the sensitivity of the System at certain frequencies to signals arising from telecommunications and other external sources.

4. Software:

- IEC61850 standard for communications within substations with Node communication must be by Ethernet, scalable, industrial standard between data nodes central server by Node data connection via both Copper Ethernet and Multi Mode Fibre Optic.
- >2M defect records from multiple customer sites.
- UHF Signal classification (5 types or better) for GIS by Separate Multiple Hybrid Expert System and the multiphase analysis result shall be clearly indicated to the operator. The PDM System shall, combine Artificial Neural Networks (ANNs), Genetic Algorithms (GAs) and Fuzzy Logics (FLs).
- The System shall have time synchronisation facility, individual channel control and PD Alarm Wizard for configuration of all PD alarms within substations including station auxiliary supply failure.
- Automatic report generator, alarm and configurable by customer over web or client server interface with provision of SMS & E-Mail.
- The System application software shall incorporate function for the complete recording of PD activity during GIS HV tests. The function shall allow complete review of PD activity during or after the test.
- The System shall have provision for connecting to a PC at OPTCL headquarters location with remote application software which can automatically support remote accessing for remote substations.
- Ability to call and display, within Application software, 2 Dimensional GIS Schematics showing spatial relationship between couplers in the GIS, 3 Dimensional GIS models (Optional) showing spatial relationship between couplers.
- History data shall be recorded up to 15 minutes in software selectable steps. History plots shall be capable of being displayed over a period up to 5 years.
- The HMI system shall be equipped with Relational Database Management System (RDBMS) which is compliant to Microsoft ODBC (Open Database Connectivity), ANSI 92 SQL (Structured Query Language), Allow remote database access in the designated room application for further study. Examples of ODBC compliant RDBMS that provide remote access are Microsoft SQL Server, Oracle and IBM DB2. Proper authorisation and authentication shall be provided to use such software's from original producer.
- Data shall be displayed in three dimensional oblique, snapshot and real time, two dimensional point on wave (both amplitude and discharge rate), PRPD (phase resolved partial discharge) online and historical, STT (short term trends) and 24 hour Summary
- System shall record switching transient generated by CBs and dis-connectors. (Optional analysis of switching patterns)

5. Every Day Use & Maintenance: The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

6. Computers and Peripherals: The PC operating system shall be the latest version of MS Windows. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type subject to EMPLOYER'S / Engineer approval. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LCD type of reputed make.

7. Filtering Facility: The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If, hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document. The noise filters shall be selectable individually coupler-wise.

8. Self-Test (Diagnostic) Facility: Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.

9. Trend Plot: The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.

10. PD Monitoring modes: There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day today operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature. In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.

11. Alarm Facility: The PDM system shall generate alarm when action is required; viz. a) PD alarm (abnormal PD activity indicating a risk of failure) & b) PD system fail alarm to be connected to SAS.

12. Real Time Display: The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators.

13. Schematics: The PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.

14. Print Option/Facility: PDM system should have the option/facility of printing all trend plots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.

15. Data Archives: This is to provide access to historical data and file storage with date and time stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.

16. PD Fault Identification & Location/Pattern Recognition/Predictive Maintenance Diagnostic Software: In order 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. Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.

17. Fault investigation: In case of any indication of suspected PD activity by the on line system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty period.

18. Special Tools / equipment, Spare Parts, software packages

18.1 Special Tools: Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.

18.2 Spare parts: The contractor has to supply critical spares with replacement procedure for the trouble free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included in the tender and also submitted for EMPLOYER'S approval during the detailed engineering stage.

18.3 Software Packages: The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. The list shall be submitted for reference.

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

PORTABLE PARTIAL DISCHARGE MONITORING

(B). Portable Partial Discharge (PD) monitoring system (Shall generally applicable for 220kV&132 kV)

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

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

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

The equipment shall meet the following requirements

1. Measurement shall be possible in noisy environment.

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

(a) The no. of channels shall be minimum 6 nos. for PD monitoring

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

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

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

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

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

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

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

9. Supplier shall have "Adequate after sales service" facility in India.

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

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

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

GIS BUILDING

- 1.1. The buildings shall house each voltage class Gas Insulated Switchgear (GIS) separately and other associated equipment inside in each of the GIS buildings. GIS building(s) shall be constructed for the specified number of bays/diameters as per section project.
- 1.2. Wherever GIS hall of proposed voltage is already existing, then the existing GIS hall of respective class shall be suitably extended (wherever applicable) to accommodate the number of bays/diameters as specified in the Section Project.
- 1.3. The contractor shall submit the design & construction proposal of the building along with necessary information, data, and drawings during the detailed engineering according to the complete requirements.
- 1.4. The area for GIS hall(s) is indicated in the enclosed General Arrangement drawing. The area given is for reference only and may vary according to requirement of the equipment to be installed inside. The contractor shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance and future expansion.
- 1.5. The contractor shall place their panels i.e. Bay level units, bay mimic, relay and protection panels, RTCC panels, PLCC panels etc. in a separate room in the GIS building.. The size of the room shall be such that all the panels for the future bays/ diameters as per clause 1.1 shall be accommodated in the above room. The panel room shall be air-conditioned. Further, the temperature of the room shall be monitored through substation automation system by providing necessary temperature transducers.

Ventilation system

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

The ventilation of the GIS hall shall be of a positive pressure type. The pressure inside the GIS hall shall be maintained 5 (five) mm of water (**mmWg**) above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the system to avoid dust accumulation on components present in the GIS hall.

Pressurized Ventilation

Pressurized ventilation system shall be installed in the GIS room for maintaining controlled environment for safe and efficient operation / functioning. It should be designed considering extremely tropical climatic condition and high degree of pollution level.

Design, manufacture, assembly, supply, delivery at site, installation, testing & commissioning of the Pressurized Ventilation system are within the scope of the bidder. This scope also includes supply of all components / parts, accessories / cables etc required for successful commissioning of the system.

System Description

The Ventilation System with Centrifugal Fan and related Accessories should comprise of Pre and Fine air filter, centrifugal fan, ducting network, air supply grilles, gravity dampers, electrical and instrumentation etc.

Dynamically balanced non-return louver shutter shall be provided at fan discharge side. Exhaust fan casing by heavy guage MS sheet (**HDG**) & Impeller by die cast aluminium is to be made.

Fresh outdoor air shall be filtered before being blown into the GIS room by the air fans to avoid dust accumulation on components present in the room. GIS hall shall be provided with Back

Draft / motorized exhaust dampers with local control. To ensure that the air being supplied to the GIS room is free from dust particles, a minimum **two** stage dust filtration process shall be supplied. This shall consist of at least the following:

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

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

GI Ducting

The following codes & Standard shall be followed

IS: 226 Specification for Structural Sheet (Standard Quality)

IS: 655 Specification for metal Air Duct.

IS: 277 Specification for Galvanised Steel Sheets Grade 180

The air distribution system shall be sized to have a constant frictional drop along its length. The maximum air velocity shall be restricted to 7 m/s for ventilation ducts. Ducts shall be supported by 50x50x6 MS(**HDG**) Angle with a distance of not more than 2000 mm. Guide vanes are to be provided in the ducts for proper flow of Air. Flexible connection of at least 150 mm width will be provided where the duct connects to the Fan.

Design Parameters

The following technical data / design parameters are to be considered while designing the above system:

- 1) 5 mm (minimum) of water above the atmospheric pressure to be maintained inside the GIS room. To maintain this overpressure it is to be taken into account that 50% air is to be exhausted. So exhaust air quantity to be arrived from the selected air quantity.
- 2) **Air change per hour** shall be considered as four (**04**) for arriving **Calculated Air quantity** in metre cube per hour. **Selected Air quantity** in metre cube per hour is to be considered accordingly for design purpose. However the inside temperature shall not be more than maximum 3 degree above the design ambient temperature during summer. The criteria which give the higher air flow by air changes criteria or temperature criteria shall be selected (to be supplied by design calculation during detailed engineering).
- 3) Centrifugal Air fan capacity and its make shall be selected for calculation of Pressurized Ventilation system considering the above criteria.
- 4) Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.
- 5) The ducting arrangement shall be done in such a way that the projected portion inside the GIS room will be bare minimum for smooth operation of EOT crane.
- 6) If applicable, back draft damper size and quantity shall be selected considering 50% selected air to be released due to overpressure.
- 7) Necessary measure shall have to be taken to run the system with minimum noise level. Silencers are to be used to keep the noise level below 60 DB.
