GAS INSULATED SWITCHGEAR

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Engineering Department

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GAS INSULATED SWITCHGEAR

1.0 Scope

This specification applies to the design, engineering, manufacturing/fabrication, assembly, inspection, testing of indoor gas insulated switchgear (GIS) as specified in the following sections of this document.

2.0 Reference Standards & Codes

All electrical switchgear, the components of the control system, the protection scheme shall be conforming to the relevant IEC standards and publications of the latest issue.

The standards as laid down are applicable in the relevant parts to the individual components of the gas-insulted switchgear:

IEC 62271-1	High-voltage switchgear and control gear Part 1: Common specifications
IEC 62271-203	HV metal enclosed switchgear for rated voltage of 72.5kV and above
IEC 62271-100	High-voltage alternating-current circuit breakers.
IEC 62271-102	Alternating current disconnector and earthing switches.
IEC 60694	Common clauses for HV switchgear and control gear standards.
IEC 60044-1/IEC 60044-2	Current transformers & Voltage transformers.
IEC 60060 / IEC 60071	High voltage test techniques./ Insulation coordination
IEC 60099-4/ IEC 60859	Surge arresters/ Cable connections for GIS.
IEC 60137	Bushings for alternating voltage above 1000V.
IEC 60255/ IEC 60265	Electrical Relays./High voltage switches.
IEC 60270	Partial discharge measurement.
IEC 60376 / IEC 60480	Specification and acceptance of new sulfur-hexa-fluoride./ Guide to checking of sulphur hexafluoride (SF6) taken from electrical equipment.
IEC 60529/ IEC 60815	Degrees of protection/ Pollution levels
IEC 61000 / IEC 61634	Electromagnetic compatibility (EMC) / Use and handling of SF6.
IEC 61639	Direct connections Transformer – GIS.
IEC 60364/60479/60621/IEEE std. 80-1986	Standards for station grounding for GIS CENELEC/SVDB Pressure vessel codes. All other relevant IS/IEC/IEEE

3.0 COMPLIANCE TO SPECIFICATION & DEVIATION:

Normally the offer should be as per Technical Specification without any deviation.

If any modification felt necessary to improve performance, efficiency and utility of equipment, the same must be mentioned in the 'Modification schedule' with reasons duly supported by documentary evidences and advantages. Such modifications suggested may or may not be accepted, but the same must be submitted along with Pre-Bid Queries. The modifications not mentioned in Schedule will not be considered.

The successful bidder shall also submit the GTP after placement of LOA as per GTP Format duly signed with date & company seal for acceptance of WBSETCL for approval of manufacturing clearance.

4.0 General Consideration

a) The Tenderer shall have to submit the **Type Test Reports** of the particular GIS modules that is offered in the bid with the **Performance Certificate** of the same type tested GIS modules.

b) The tenderer has to furnish all relevant & necessary information for various equipment to be proposed under the offer in conformity to this technical specification including design parameters, test requirements, installation, operation and maintenance.

c) The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its live constituent parts. All parts of the switchgear should be single phase enclosed for 400 kV and single phase/three phases enclosed for 220 kV & 132 KV. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make on either end without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included.

d) This scope also includes structural support, access platform, ladders, stairs, cable raceway, conduit and other auxiliary equipment for operation and maintenance purposes. Wherever applicable, supply and erection of XLPE Cable/Duct supporting structures for incoming and outgoing XLPE cables/Duct at GIS cable spreader room/PEB for the bays with provision of future bays shall be within the scope of the tenderer.

e) Any special tools needed for maintenance, operation and inspection shall be included by the bidder for supply.

f) The required overall parameters of GIS are as follows:

SL NO	TECHNICAL PARAMETERS	400 KV SYSTEM	220 KV SYSTEM	132 KV SYSTEM
1.	Rated Voltage	420 KV (rms)	245 KV (rms)	145 KV (rms)
2.	Rated Frequency	50 Hz	50 Hz	50 Hz
3.	Grounding	Effectively Earthed	Effectively Earthed	Effectively Earthed
4.	Rated Power Frequency Withstand Voltage (1 min)	520 KV (rms)	460 KV (rms)	275 KV (rms)
5.	Lightning Impulse withstand (1.2/50 micro Sec) Line to earth	±1425 kVp impulse on one terminal & 240KVp PF Voltage of opposite polarity on other terminal	±1050 kVp	±650 kVp
6.	Switching impulse voltage(250/2500 micro-sec)	±1050 kVp	X	X
7.	Rated short time withstand current (1 sec)	50 kA (rms) for 1 sec	40 kA (rms) for 3 sec	31.5 kA (rms)for 3 sec
8.	Rated Dynamic peak withstand current (1 sec)	125 kA (peak)	100 kA (peak)	80 kA (peak)
9.	Guaranteed maximum gas losses for complete installation as well as for all individual sections in %	As per IEC-62271-203	As per IEC- 62271-203	As per IEC-62271-203
10.	Seismic level	Zone- IV, as perIS-1893 Year-2002	Zone- IV, as perIS-1893 Year-2002	Zone- IV, as perIS-1893 Year-2002

5.0 Definitions

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

ii) **Bay**
Bay refers to the area occupied by one Circuit Breaker and associated equipment used to protect one feeders/line/bus coupler in double bus scheme.

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

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

v) **Manual Operation**
Manual operation means operation by hand without using any other source of Power.

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

vii) **Reservoir**
When used in conjunction with GIS equipment reservoir refers to a larger gastight volume.

6.0 General Design & Safety :

A. Assembly

The GIS assembly shall consist of separate modular compartments such as Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. And the sections shall be designed to minimize the quantity of gas that has to be evacuated and recharged before and after maintaining any item of equipment. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment. Compartment arrangement at the end of Bus shall be such that shutdown may be avoided for a long during future extension job.

B. Switchgear

i) The switchgear shall be of modular design. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be free of any voids and free of partial discharge at a voltage which is at least 5 % greater than the rated voltage .They should be

designed to have high structural and dielectric strength properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

ii) The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of aluminium / copper tubes of cross sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

iii) The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.

iv) The thermal rating of all current carrying parts shall be minimum for one sec. (1 second) for the rated symmetrical short circuit current.

v) The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high-voltage equipment installed inside gas insulated metallic and earthed enclosures, suitably sub-divided into individual arc and gas proof compartments for the items as detailed.

a) Bus bars
b) Intermediate compartment
c) Circuit breakers
d) Line disconnector
e) Voltage Transformers
f) Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.
g) Gas Insulated bus section between GIS & Oil filled Transformer/ Reactor (if applicable)
h) Surge / Lightning arrester (if applicable)

vi) The equipment will be operated under the following ambient conditions:
a) The ambient temperature varies between 0 degree-C and 50 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
b) The humidity will be about 95% (indoors)
c) The elevation is less than 1000 meters.

vii) The arrangement of the individual switchgear bays shall be such so as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance. The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

viii) The heaters shall be provided, wherever required, for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phsase. 4-wire load. The possibility of using heaters without thermostats in order to achieve the higher reliability may be examined by the bidder and accordingly included in the offer but it shall be ensured by the bidder that the temperature rise of different enclosures where heating is provided should be within safe limits as per relevant standards. One copy of the relevant extract of standard to which the above arrangement conforms along with cost reduction in offer. If any, shall also be furnished along with the offer. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

ix) Provision shall have to be made to the switchgear for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

C. Insulator

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

ii) The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

D. Enclosure

i) **Pressure Vessel/ Enclosure:** The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC/DIN or equivalent code for pressure Vessel.) Each enclosure has to be tested as a routine test at 1.5 time the design pressure for one minute. The bursting strength of Aluminium castings has to be a at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

ii) The material and thickness of the enclosures shall be such as to withstand an internal flashover without burn through for a period of 300 ms at rated short time withstand current. The material

shall be such that it has no effect of environment as well as from the by-products of SF6 breakdown under arcing condition. The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.

iii) The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, (latest version). The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

iv) **Temperature rise of current carrying** parts shall be limited to the values stipulated in IEC-694, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure and the enclosures which are accessible but need not be touched during normal operation, shall be as per IS 62271-203.

v) The fabricated metal enclosures shall be of Aluminium alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system.

vi) Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

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

viii) The enclosure & support structure shall be designed that a mechanic 1780 mm in height and 80 Kg in weight is able to climb on the equipment for maintenance.

ix) The Average Intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The contractor shall confirm the same preferably with all calculations and documents in support of the above during detailed engineering.

E. Compartment

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

ii) Each individual gas-filled compartment shall be guaranteed that the **pressure loss within each compartment shall not be more than half percent (0.5%) per year**. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into

the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

iii) The bus & bay enclosure should be sectionalized in such a manner that maintenance work can be carried out by isolating and evacuating the small effected section and the other bus & bays should remain in service. The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies.

iv) The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

v) **Pressure Relief :** Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction). Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the owner the detailed criteria/ design regarding location of pressure relief devices/rupture diaphragms.

vi) **Bellows or Compensating Units: -** Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The bellows shall be metallic (preferably of stainless steel) of following types or other suitable equivalent arrangement shall be provided wherever necessary.

1 Lateral / Vertical mounting units: These shall be inserted, as required, between sections of bus bars, on transformer, shunt reactor and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.

2 Axial compensators: These shall be provided to accommodate changes in length of bus bars due to temperature variations.

3 Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.

4 Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.

5 Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers and shunt reactors when connected to SF6 switchgear by oil- SF6 bushings.

6. The electrical connections across the bellows or compensating units shall be made by means of suitable connectors.

F. Operation & Maintenance

a. All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they cannot be operated easily, i.e. the operator must use tools or brute force to over-ride them.

b. It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.

c. In case of any repair or maintenance on one busbar disconnector, the other busbar should be live and in service.

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

e. The removed interrupter assembly must be easily and safely accessible for inspection and possible repairs.

f. Suitable disconnector and earth switch arrangement with separate compartment shall be provided at the end of bus to facilitate smooth execution of future GIS extension, if any without affecting existing portion.

g. A portable ladder with adjustable height may also be supplied to access to the equipment. The ladders and walkways shall be provided wherever necessary for access to the equipment.

7 Local Control Cubicle:-

Standalone Local control cubicle including gas monitoring arrangement shall be provided for each bay which shall be installed with the switchgear for local control & monitoring of respective switchgear bay. Local control cubicle for GIS shall be equipped with suitable hardware & software for remote control operation and conform to the bay level controller as detailed in Substation Automation System.

Alarm& Indications

Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

Gas Insulating System:

a) Loss of Gas Density.
b) Loss of Heater power (if required)
c) Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System:

a) Low operating pressure.
b) Loss of Heater power.
c) Loss of operating power.
d) Loss of control.
e) Pole Discrepancy

Indicators shall be provided on all circuit breakers, isolators and earth-switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment. Windows shall also be provided with all isolators and earth switches so that the switch contact positions can be verified by direct visual inspection.

The construction, scheme, design and features of the Local Control Cubicle shall be in line with WBSETCL Control and Relay panel specification.

From switchgear to Local Control Cubicle all the Control cables shall be of grey colour with core number printed in black (in line with WBSETCL LT Control and Power cable specification).

Separate cables shall be used for individual CT cores.

8 Grounding

IEEE-80-2000 and CIGRE-44 should be followed for design and provision for grounding system to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

The GIS supplier shall define clearly what constitute the main grounding bus of the GIS. The GIS supplier must supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. Conductors with copper bars are preferred over copper wires. The GIS supplier should supply all the earthing conductors and associated hardware material for the following:

1) Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.

2) Grounding of transformer, reactor, CVT, SA and other outdoor switchyard equipment/ structures etc.

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

The grounding continuity between each enclosure shall be effectively interconnected with Cu/ Al bonds of suitable size to bridge the flanges. In case the bidder does not offer external bonding, the bidder shall demonstrate that the connectivity offered by them between each enclosure is effective and does not require external bonding**.** Further similar design should have been in service.

Subassembly to subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

Each marshalling box, local control panel, power and control cable sheaths and other noncurrent 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 inducted into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

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

The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, ph./ earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures.

The contractor shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Air termination, SF6/ Transformer or Reactor termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

9 CIRCUIT BREAKERS :

9.1 General

SF6 gas insulated metal enclosed circuit breakers shall comply with the latest revisions of IEC-62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified.

Circuit breakers shall be equipped with the operating mechanism. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase reclosing (as the case may be) with an operating sequence and timing as specified.

9.2 Duty Requirements

Circuit breaker shall be C2 - M2 class as per IEC 62271-100. Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on 400 KV, 220 kV, 132 KV effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

The circuit breaker shall be capable of:

i) Interrupting the steady and transient magnetizing current corresponding to connected transformers.

ii) Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors.

iii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iv) Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

v) The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.

Total Break Time

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

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

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

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

9.3 CONSTRUCTIONAL FEATURES

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

A. Contacts

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

b) Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable of that of the breaker as a whole.

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

d) The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)

e) In the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products

f) Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site.

B. OPERATING MECHANISM

General Requirements:

a) Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these. The mechanism shall be housed in a dust proof cabinet and shall have IP : 42 degree of protection.

b) The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.

c) The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti pumping and trip free (as per IEC definition) under every method of closing, where applicable.

d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

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

f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

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

C. Control

a) The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

b) For 220KV and above, each breaker pole shall be provided with two (2) independent tripping circuits, valves, pressure switches, and coils each connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker central control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuit shall be monitored and for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

D. Spring operated Mechanism

a) Spring operated mechanism shall be complete with motor. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 60 seconds for full charging of the closing spring.

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

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position.

i) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

E. Hydraulically Operated Mechanism:

a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor etc.

b) The hydraulic oil used shall be fully compatible for the temperature range to be encountered during operation.

c) The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate no. of spare contacts, for continuous monitoring of low pressure, high pressure etc. at switchyard control room.

d) The mechanism shall be suitable for at-least two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.

e) The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up.

f) Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for lost of Nitrogen shall also be provided.

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

F. ADDITIONAL DATA TO BE FURNISHED ALONGWITH THE OFFER:

a) Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

c) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.

d) Rated line charging interrupting current at 90 deg. Leading power factor angle (Arms) as per IEC. The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4 as per IEC-62271-100)

G. TESTS

In accordance with the requirements stipulated under Section General Technical Requirement the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

Routine Tests

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

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

H. Technical Parameters of Breakers :

VOLTAGE : RATED /MAXIMUM	400 KV / 420 KV	220 KV / 245 KV	132 KV/ 145 KV
FREQUENCY	50 Hz	50 Hz	50 Hz
EARTHING	EFFECTIVE	EFFECTIVE	EFFECTIVE
TYPE OF BREAKER	SF6 CB	SF6 CB	SF6 CB
RATED NORMAL CURRENT	3150 A	2000 A	2000 A
RATED SHORT TIME BREAKING CURRENT	50 KA for 1 sec	40 KA for 3 sec	31.5 KA for 3 sec
RATED MAKING CURRENT	125 KA	100 KA	80 KA
RATED LINE CHARGING BREAKING CURRENT	400 A rms	125 A rms	50 A rms
RATED CABLE CHARGING BREAKING CURRENT	400 A rms	250 A rms	160 A rms
OPERATING SEQUENCE	O - *t* - CO - *t'* – CO t=0. 3 sec; t'= 3 min.	O - *t* - CO - *t'* – CO t=0. 3 sec; t'= 3 min.	O - *t* - CO - *t'* – CO t=0. 3 sec; t'= 3 min.
LIGHTNING IMPULSE WITHSTAND VOLTAGE	1425 KV peak	1050 KV peak	650 KV r m s
MAXIMUM PERMISSIBLE SWITCHING OVER VOLTAGE TO EARTH	1050 KV peak	600 KV peak	415 KV peak
FIRST POLE TO CLEAR FACTOR	1.3	1.3	1.3
DC OPERATING VOLTAGE	220 V ±10%	220 V ±10%	220 V ±10%
NUMBER OF TRIP COIL	2	2	2
AUXILIARY CONTACTS	10 NO + 10 NC	10 NO + 10 NC	10 NO + 10 NC

10 DISCONNECTORS

Disconnector shall be of the single-pole, group operated type, installed in the switchgear to provide electrical isolation of the circuit breakers, the transformers, shunt reactor, double bus and transmission lines. The disconnector shall conform to IEC- 62271-102 and shall have the following ratings as specified.

1	VOLTAGES : RATED / MAXIMUM	400 KV/ 420 KV	220 KV/ 245 KV	132 KV/ 145 KV
2	FREQUENCY	50 HZ	50 HZ	50 HZ
3	TYPE	SF6 Insulated	SF6 Insulated	SF6 Insulated
4	EARTHING	EFFECTIVELY EARTHED	EFFECTIVELY EARTHED	EFFECTIVELY EARTHED
5	RATED CONTINUOUS CURRENT (for line /bus coupler)	3150 A	1000 A / 2000 A	1000 A / 2000 A
6	SHORT TIME WITHSTAND CURRENT	50 KA for 1 Sec	40 KA for 3 Sec	31.5 KA for 3 Sec
7	RATED SHORT CIRCUIT MAKING CURRENT FOR EARTHING SWITCHES	125 KA peak	100 KA peak	80 KA peak
8	INSULATION LEVEL : PF OV TO EARTH & BETWEEN POLES	520 kV rms	460 kV rms.	275 kV rms.
9	INSULATION LEVEL : PF OV TO ISOLATING DISTANCE	610 kV rms	530 KV rms	315 KV rms
9	INSULATION LEVEL : LI WITHSTAND VOLTAGE TO EARTH & BETWEEN POLES	±1425 KV peak	±1050 KV peak	±650 KV peak
10	INSULATION LEVEL : LI WITHSTAND VOLTAGE TO ISOLATING DISTANCE	±1425 KV peak impulse on one terminal & 240KVp PF Voltage of opposite polarity on other terminal	±1200 KV peak	±750 KV peak
11	NO OF AUXILIARY CONTRACT WITH SPARE	10 NO + 10 NC	8 NO + 8 NC	8 NO + 8 NC

a) The single / three pole group operated disconnector shall be operated by electric motor suitable for use on 220 v DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit. The operating mechanisms shall be complete with all necessary linkages, clamps, couplings,

operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.
It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation. The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

b) Disconnector shall be designed as per relevant IEC. These shall be suitable to make and break the charging currents during their opening and closing. They shall also be able to make and break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent re-strikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

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

d) It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

e) The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet. Remote control of the disconnectors from the control room shall be made by means of Remote/ Local Transfer switch.

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

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

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

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

All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously. The auxiliary switches shall be capable of breaking at least 2 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds. The disconnectors and safety grounding switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnector when the grounding switch is in the closed position.

The local control of the Isolator and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local. All electrical sequence interlocks will apply in both remote and local control modes.

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

POSITION	SIGN	COLOUR
OPEN	OPEN / O	GREEN
CLOSE	CLOSED / I	RED

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

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

11 SAFETY GROUNDING SWITCHES

a) Three-pole, group operated, safety grounding switches shall be operated by electric motor for use on 220 V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit

b) Each safety grounding switch shall be electrically interlocked with its associate disconnector and circuit breaker such that it can only be closed if both the circuit breaker and disconnector are in open position. Safety grounding switch shall also be mechanical key interlocked with its associated disconnector.

c) Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Control room. The details of the inscription and colouring for the indicator are given as under :

POSITION	SIGN	COLOUR
OPEN	OPEN / O	GREEN
CLOSE	CLOSED / I	RED

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

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

f) Provision shall be made for padlocking the ground switches in either the open or closed position. All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross sectional area of 100 sq. mm. The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid. The safety grounding switches shall conform to the requirements of IEC-62271- 102. Mechanical position indication shall be provided locally at each switch and remotely at each bay module control cabinet/ substation automation system

12 HIGH SPEED MAKE PROOF GROUNDING SWITCHES

a) Grounding switches located at the beginning of the line feeder bay modules shall be of the high speed, make proof type and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive currents and to withstand the associated TRV.

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

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

d) The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 100 kA (As applicable). The switches shall have inductive/ capacitive current switching capacity as per IEC-62271-102. Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal Control Room.

13 INSTRUMENT TRANSFORMERS : CURRENT TRANSFORMER

a) General:

i) The current transformers and accessories shall conform to IEC: 60044-1 and other relevant standards except to the extent explicitly modified in the specification.

ii) The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

b) Ratios and Characteristics

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

c) 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.

d) Constructional Details:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal- enclosed type. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. 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.

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

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

e) The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably built in construction of the CTs.

f) The wiring diagram, for the interconnections of the CTs shall be provided inside the marshalling box.

g) The current transformers shall be suitable for high speed auto-reclosing.

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

i) Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

CT core details shall be as per core particulars tabulated in the Specification of Current Transformers.

14 VOLTAGE TRANSFORMERS

General

The voltage transformers shall conform to IEC- 60044-2 and other relevant standards except to the extent explicitly modified in the specification. Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

Ratios and Characteristics

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table.

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.

Secondary Terminals, Earthing and Fuses

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear. All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

The transformer shall be able to sustain full line to line voltage without saturation of transformer. The accuracy class will be at maximum tap.

Constructional Details of Voltage Transformers:

a) The voltage 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.

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

c) Voltage transformers secondary shall be protected by HRC cartridge type 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 VT's shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

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

e) The accuracy of 0.2 on secondary III should be maintained through out the entire burden range up to 100 VA on all the three windings without any adjustments during operation.

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

Tests

Currentandvoltagetransformersshallconformtotypetestsandshallbesubjectedto routine test in accordance with IEC.

Technical Parameters : Voltage Transformer

VOLTAGE : RATED / MAXIMUM	400 KV / 420 KV	220 KV / 245 KV	132 KV/ 145 KV
PD LEVEL	10 PICO-COULOMB	10 PICO-COULOMB	10 PICO-COULOMB
VOLTAGE FACTOR	CONTINUOUS – 1.2 FOR 30 SECS – 1.5	CONTINUOUS – 1.2 FOR 30 SECS – 1.5	CONTINUOUS – 1.2 FOR 30 SECS – 1.5
PHASE ANGLE ERROR	±20 minutes	±20 minutes	±20 minutes

VT core details shall be as per core particulars tabulated in the Specification of Potential Transformers.

15 SF6/AIR BUSHINGS

Outdoor SF6 to air bushings, for the connection between the GIS and overhead lines or conventional air insulated equipment shall be furnished where specified. Bushings shall comply with the relevant IEC standards. The same should be type tested as per relevant IEC / IS.

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.

Mechanical forces on bushing terminals: Outdoor bushings must be capable of withstanding a cantilever force and all other system stress as per IEC standard.

16 GAS INSULATED BUS DUCT (where applicable)

The components of the GIS shall be connected by a single phase bus ducts for 400kV and single phase / three phase bus ducts for 220 & 132KV. 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.

Necessary supporting calculation towards withstanding the stresses is to be submitted during detailed engineering by the successful bidder.

17 EHV-POWER CABLE CONNECTION (where applicable)

The design of the cable end box shall fully comply with the IEC 62271-209 standard. 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.

18 Seismic Design Criteria

a) The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non-concurrently. Seismic level Zone- IV, as per new IS- 1893, Year-2002 has to be considered for the design of equipment.

b) The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipment along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes.

c) The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. **If the equipment has not been type tested earlier, design calculations of simulate parameters should be furnished along with the offer.**

To prevent the movement of GIS sub-assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub-assemblies to the foundation.

d) The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub-assemblies to the foundation shall be designed to withstand the seismic events. It will also be ensured that the special devices as well as bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the purchase's approval.

19 PARTIAL DISCHARGE MONITORING SYSTEM & DEW POINT METER

Partial Discharge Monitoring System & Dew point meter shall be offered if specifically mentioned in schedule.

DEW POINT METER

The meter shall be capable of measuring the dew point of SF6 Gas of the GIS equipment. The meter shall be provided with due point hygrometer with digital indication to display the due point temperature in degree C., degree F or PPM. It should be capable of measuring the corresponding pressure at which due point is being measured.

The measurement and use of the instrument must be simple, direct without the use of any other material/ chemical like dry ice/ acetone etc. It should be suitable for operation on 220 Volts AC mains supply. Technical specification:

Measuring Range	Up to minus (–) 50 degree Centigrade Dew Point
Accuracy	+ 2 deg. C
Display	4 Digit LCD, 0.5 inch. High

PORTABLE PARTIAL DISCHARGE MONITORING SYSTEM

The system shall be used for detecting different types of defects in Gas Insulated Switchgears (GIS) & GIB 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.

A The system shall be capable for measuring PD in charged Gas Insulated environment. The principal of operation shall be based on UHF with internal sensors.

The instrument shall also be able to detect partial discharges in GIB, cable joints, terminations, CTs and PTs etc. also.

B 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.

C Details of internally fitted PD sensors (location and numbers) in GIS equipment & GIB shall be shown in relevant drawings and finalised during detailed engineering.

D **The PDM system shall be designed in such a manner that it can detect Partial Discharge of 5 pC or above generated within any part of GIS & GIB.** The same is required to be demonstrated as a part of site test during commissioning.

E The PDM kit shall be supplied from a manufacturer renowned worldwide who have service facility at India.

F The sensitivity of the offered system shall be in accordance with CIGRE document for UHF detection TF 15/33.03.05 that will be verified as part of site sensitivity tests.

Technical Specification

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

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

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

D) 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.

E) The measuring instrument shall be of minimum 6 channels and the system shall be supplied with all required accessories like - sensors with mounting arrangements, connecting cables to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply etc. so as to cover entire GIS & GIB portion to detect any sort of partial discharge of 5 pC & above in any part.

F) The function of software shall be covering the following:

- Data recording, storage and retrieval in computer
- Data base analysis
- Accurate location of fault inside the GIS & GIB (within 0.5 mtr range)
- Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.
- Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
- Report generation

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

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

I) Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS & GIB.

J) Instrument shall be robust and conform to relevant standard.

k) The PDM system shall have the capacity to integrate with SAS and send data through it.

20 QUALITY OF SF6 GAS

a) a) 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.

b) 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)

21. EXHAUST LOUVER AND VACUUM CLEANER

Adequate number of exhaust louvers depending upon the size of GIS Hall for release of SF6 gas in case of any leakage shall have to be provided. Size and location of above shall be shown in relevant drawing during detailed engineering.

22 TRANSPORT OF EQUIPMENT TO SITE.

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities .All transport packages containing critical units viz Circuit breakers, disconnectors, earth-switches, surge arrestors and bus sections exceeding3 metres length shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all

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

23 PACKING, STORAGE AND UNPACKING.

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

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

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

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

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

Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.

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

The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungoral growth.

The scope of providing the necessary protection, storing off the ground, as required etc. is included in the works to be performed by the contractor.

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

24 Training before Commissioning

After complete Erection & Installation of the GIS modules, the successful bidder with the help of the GIS manufacturer for bought out GIS modules or the competent person of the bidder for own supplied GIS modules shall deliver Operation & Maintenance Training at the substation to the personnel as deputed by the awarding authority. The successful bidder shall submit the training schedule to the site authority for fixing the training program. The Training should be comprehensive to the satisfaction of the trainees. The Trainer should cover both theoretical & practical aspects of the modules, operation & maintenance requirements of the modules etc. The trainer shall also exhibit major components of the GIS modules separately for visual clarity of the trainees with better understanding. The successful bidder shall bear every cost required for the Training.

25 Test of GIS Equipment

I. Type Tests

All equipment proposed according to this specification/schedule for type tests shall be type tested for typical units in accordance with the latest relevant IEC Standards. An evidence of type testing at reputed Government approved International Test Laboratory for the particular model and similar configuration being offered shall be submitted with the proposal. The test reports shall be in English Version.

The following type tests shall have been performed :

1. Dielectric voltage withstand tests
   - Power frequency withstand voltage

- Impulse withstand voltage
- Switching impulse withstand voltage

2. Making and breaking capability test
3. Short time current test and peak current test
4. Mechanical endurance test
5. Continuous current carrying and temperature rise test
6. Current path resistance measurement
7. Pressure Tests
8. Partial discharge test

II. Production / Factory Tests

Production tests shall be made either in the course of component assembly, and/or on the complete shipping unit assembly.
Routing tests shall be performed at the factory on every unit of GIS as per relevant IEC and to be submitted with inspection offer letter.

III. Test at Factory and Test Certificates:

Following Routine/Acceptance Tests on GIS Assembly (for any one no. line feeder bay or transformer feeder bay and separately one no. Bus Coupler bay – applicable for 400KV, 220 KV & 132 KV GIS separately) at GIS manufacturers works shall be carried out in presence of representatives of WBSETCL as per relevant IS/IEC.

1. **Power Frequency Voltage Withstand test** on main circuit (as per IEC 62271-203, sub-clause 7.1.1) shall be carried out combined with partial discharge measurement (as per IEC 62271-203, sub-clause 7.1.2). This includes measurement of resistance of main circuit as per sub clause 7.3, IEC 62271-203.

2. **Gas Tightness Test** (as per IEC 62271-203, sub clause 7.4) will be carried out on any one of the feeder bay. Additionally checking by Gas Leakage Detector will be carried out on each bay assembly.

3. **Circuit Breakers** : Following tests shall be carried out on circuit breaker.

   a. Mechanical operation test as per sub-clause 7.102, IEC 62271-203

   b. Dielectric test on auxiliary & control circuit as per sub-clause 7.2, IEC 62271-203

   c. Test on auxiliary circuit, equipment and interlocks in the control mechanism as per sub-clause 7.103, IEC 62271-203

4. **Disconnector / Earthing Switches :**

   a. Mechanical operation test as per sub-clause 7.102, IEC 62271-203

   b. Dielectric test on auxiliary & control circuit as per sub-clause 7.2, IEC 62271-203

   c. Test on auxiliary circuit, equipment and interlocks in the control mechanism as per sub-clause 7.103, IEC 62271-203

5. **Current Transformer & Voltage Transformer**

   a. Visual check for verification of nameplate, terminal markings etc as per IEC 60044-1 for CT & IEC 60044-2 for VT and approved drawing.

b. Verification of Factory acceptance/routine test report (to be submitted alongwith inspection call letter)

6. **Verification of Factory Routine/acceptance test reports** of offered GIS assembly (to be submitted alongwith inspection call letter).

7. **Calibration certificates** for the test equipments shall be handed over to the WBSETCL representative at manufacturer's premises during inspection.

8. **Visual/dimensional check** of each complete bay of GIS assembly.

IV. Site Tests

The following tests shall be performed on the completely assembled switchgear at site after installation. Test results as well as test conditions like ambient temperature, gas pressure, dew point etc. shall be documented and the results compared with the relevant instructions and factory test reports. A final site test report shall be supplied to the owner within 4 weeks after the tests have been finished.

1. Visual inspection, checks and verifications.
2. SF6 gas leakage test.
3. DC resistance measurement of the main circuits :
4. Gas density monitor check
5. Interlock test
6. Measurement of moisture content :
7. Manual operating check of circuit breaker, disconnect switch, earthing switch and fault making earthing switch.
8. Power frequency withstand or main circuit.
9. Power frequency test of control circuit 2KV r.m.s. (1 min.)
10. CT and VT Test
11. Partial Discharge measurement Test.

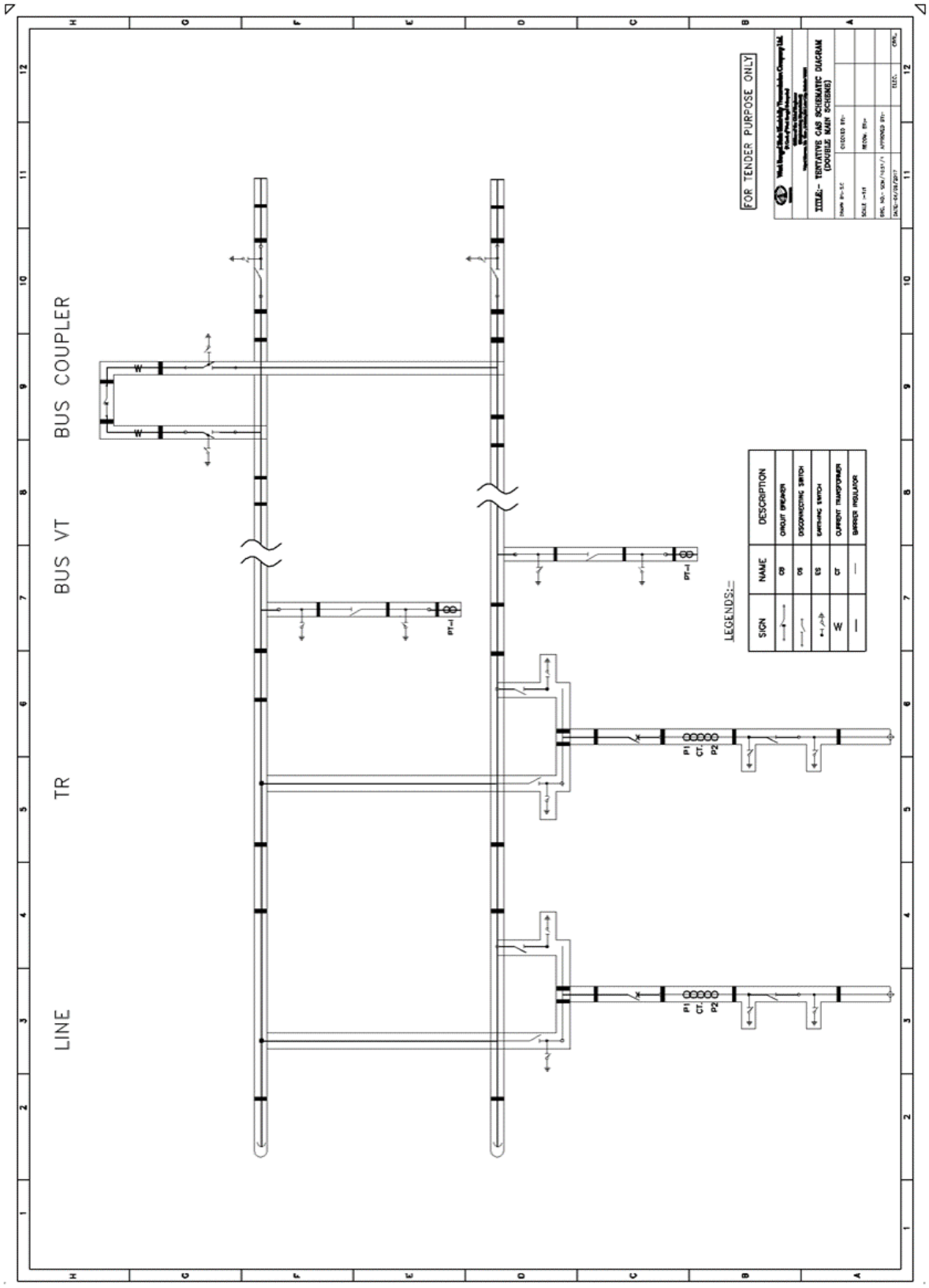
26 Documents for Extension

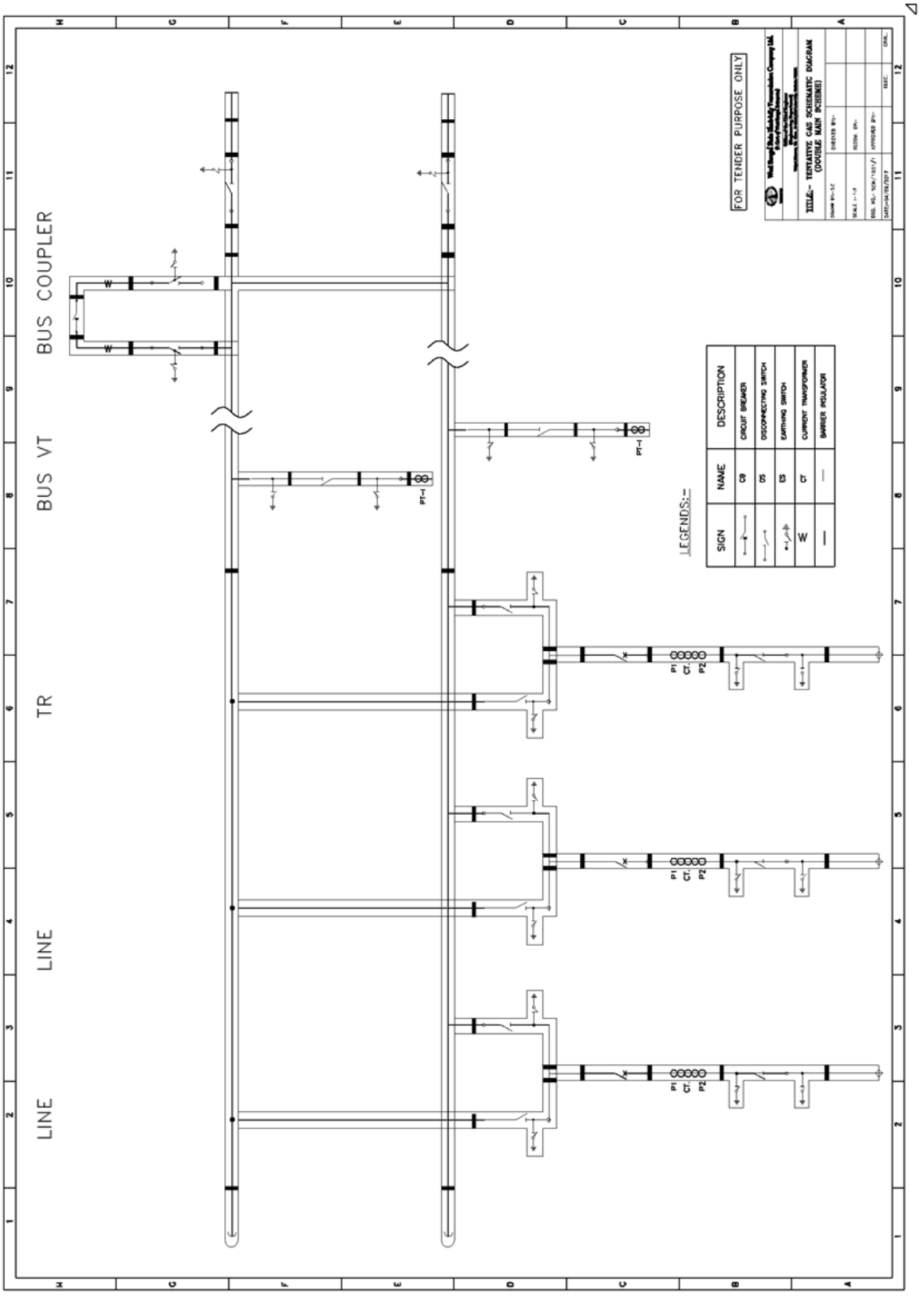
During detailed engineering, following drawings and documents are to be submitted for reference

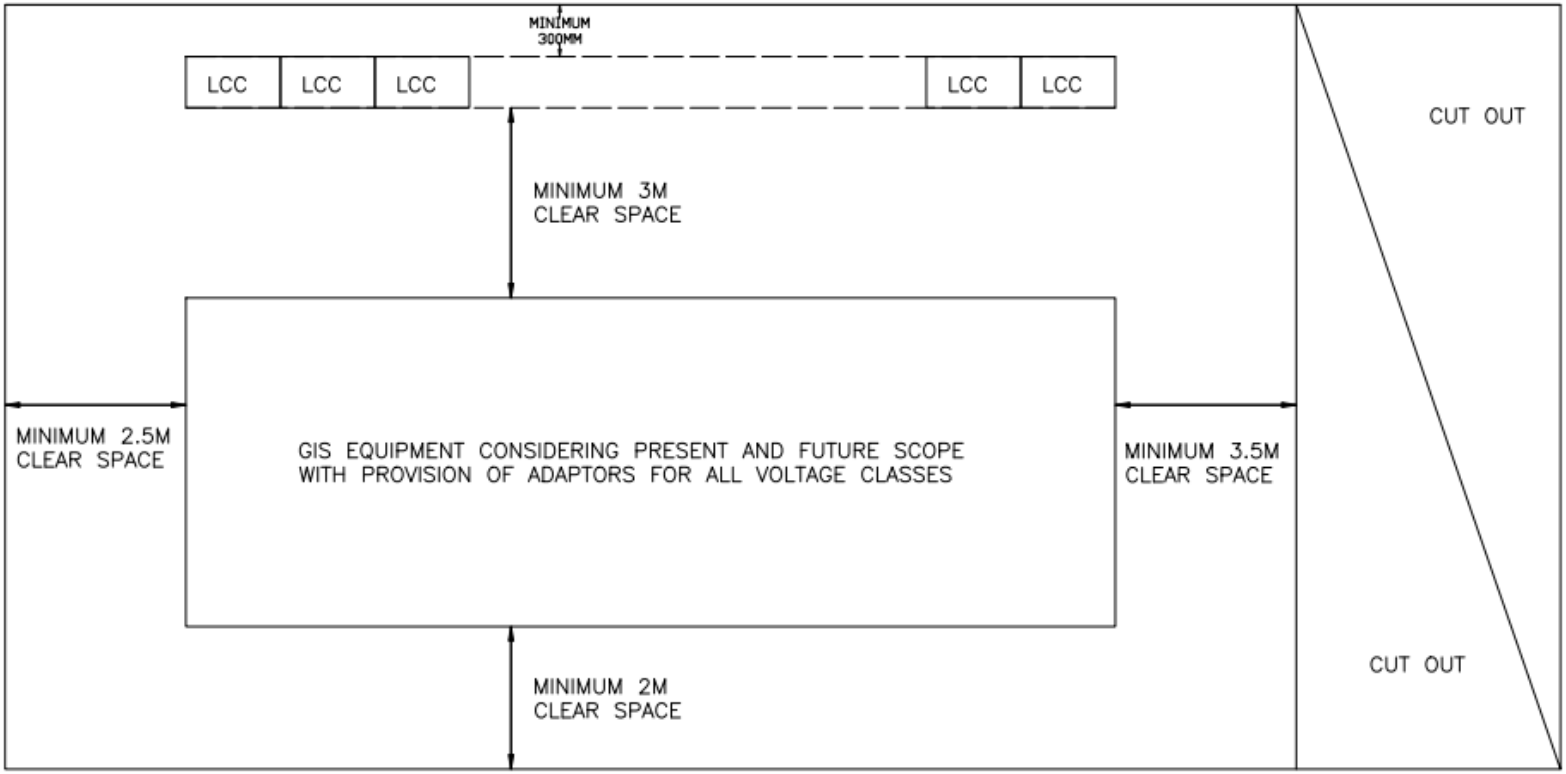
A. Conductor Profile
B. Fitment details with drawing of nuts bolts and accessories
C. Internal and external details of enclosure with dimension
D. Internal and external details of Gas Barriers
E. Any other relevant data necessary for future extension of GIS by any approved manufacturer

During extension process any arrangement necessary for technical support and protection/safety of existing system shall have to be extended by GIS manufacturer at free of cost.

In this regard guidelines of IEC : 62271-203 as per clause no. 5.107.4 (Interfaces for future extensions) may please be followed.


FOR TENDER PURPOSE ONLY
TITLE:- TENTATIVE GAS SCHEMATIC DIAGRAM (DOUBLE MAIN SCHEME)
LEGENDS:-
SIGN
NAME
DESCRIPTION
CB
CIRCUIT BREAKER
DS
DISCONNECTING SWITCH
ES
EARTHING SWITCH
CT
CURRENT TRANSFORMER
BARRIER INSULATOR
BUS COUPLER
BUS VT
TR
LINE
P1
CT
P2
PT


FOR TENDER PURPOSE ONLY
TITLE:- TENTATIVE GAS SCHEMATIC DIAGRAM (DOUBLE MAIN SCHEME)
LEGENDS:-
SIGN
NAME
DESCRIPTION
CB
CIRCUIT BREAKER
DS
DISCONNECTING SWITCH
ES
EARTHING SWITCH
CT
CURRENT TRANSFORMER
BARRIER INSULATOR
BUS COUPLER
BUS VT
TR
LINE
LINE
PT-I
P1
CT.
P2



MINIMUN CLEARANCE REQUIREMENT FOR GIS HALL

NOTE:–

1) MINIMUM CRANE HOOK HEIGHT IN THE GIS HALL SHOULD BE GREATER THAN MAXIMUM INSTALLED GIS/ BUS DUCT HEIGHT PLUS MAXIMUM TRANSPORT UNIT HEIGHT PLUS 300MM.

2) SUFFICENT SPACE BETWEEN TOP OF CRANE GIRDER AND BOTTOM OF THE ROOF BEAM IS TO BE KEPT FOR EASY MOVEMENT.

3) MINIMUM 2.0M CLEAR SPACE IS REQUIRED TO KEEP BETWEEN GIS OF DIFFERENT VOLTAGE CLASSES.

4) THE DIMENSIONS MENTIONED IN BUILDING DRAWING PROVIDED WITH TENDER DOCUMENTS ARE TO BE MAINTAINED. HOWEVER, TO KEEP THE CLEARENCES AS MAINTAINED IN THIS DRAWING, IF BUILDING DIMENSIONS INCREASE, THE SAME IS TO BE DONE WITHOUT ANY ADDITIONAL PRICE IMPLICATION TO WBSETCL.