Section-5

ANNEXURE - B

TECHNICAL SPECIFICATION FOR SF6 GAS INSULATED SWITCHGEAR (GIS)

1.0 INTENT

The intent of this specification is to design, manufacture, factory test and supply of Gas Insulated Switchgear and its accessories for proposed 400KV GIS Korattur Project of TANTRANSCO.

The workmanship of fabrication, painting and wiring should be of highest quality.

b. It is not the intent to specify each and every construction requirement and usage requirement through the specification.

c. The GIS shall be supplied complete with all auxiliary equipment necessary for operation, routine maintenance, repairs or extension. The equipments shall be designed to withstand normal operating voltage even if the inside gas pressure decreases to atmospheric pressure as long as no switching operation are performed.

d. The intent of this specification is to design, manufacture, factory test and supply of Gas Insulated Switchgear and its accessories for proposed 400/230-110KV/33KV GIS Korattur Project of TANTRANSCO.

e. The workmanship of fabrication, painting and wiring should be of highest quality.

f. It is not the intent to specify each and every construction requirement and usage requirement through the specification.
2.0 GENERAL CHARACTERISTICS

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its live constituent parts. It should be designed for indoor/outdoor (as specified) application with meteorological conditions at site. All parts of the switchgear should be single phase enclosed for 500 kV & 245KV single phase/three phases enclosed for 110 kV.

The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. As the 500/230/110/33 kV GIS is likely to be extended in future, the Supplier shall make available during detailed engineering stage, all details such as cross section, gas pressure, extension conductor piece to extend existing bus bar and all required material etc. for design of adopter in future for extension of GIS. GIS must be complete in all respects for future extension and there should be no requirement of any component/material of GIS from the present supplier at the time of future extension by another GIS manufacturer.

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

The required overall parameters of GIS are as follows

<table>
<thead>
<tr>
<th>SI.N</th>
<th>Technical</th>
<th>500 kV</th>
<th>230 kV</th>
<th>110 System</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Rated Voltage</td>
<td>550 kV (rms)</td>
<td>245 kV (rms)</td>
<td>145 kV (rms)</td>
</tr>
<tr>
<td>b</td>
<td>Rated frequency</td>
<td>50 Hz</td>
<td>50 Hz</td>
<td>50 Hz</td>
</tr>
<tr>
<td>c</td>
<td>Grounding</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d</td>
<td>Rated power frequency withstand Voltage (1 min) line to earth</td>
<td>710 kV (rms)</td>
<td>460 kV (rms)</td>
<td>310 kV (rms)</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
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<td>---</td>
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</tr>
<tr>
<td>E</td>
<td>Impulse withstand BIL(1.2/50/mic. Sec) Line to earth</td>
<td>±1550 KVp</td>
<td>±1050 KVp</td>
<td>±650 KVp</td>
</tr>
<tr>
<td>F</td>
<td>Switching impulse voltage (250/2500 mic.-sec)</td>
<td>1050 KVp</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G</td>
<td>Rated short time withstand current (1 sec)</td>
<td>63 KA for 1 sec</td>
<td>50KA for 3 sec</td>
<td>50KA for 3 sec</td>
</tr>
<tr>
<td>H</td>
<td>Rated peak withstand Current</td>
<td>157.5 kA (peak)</td>
<td>157.5 kA (peak)</td>
<td>157.5 KA (peak)</td>
</tr>
<tr>
<td>I</td>
<td>Guaranteed maximum gas losses for</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>J</td>
<td>Rated current normal/ at site (at 50 degree)</td>
<td>4000A</td>
<td>3150A</td>
<td>2000A</td>
</tr>
<tr>
<td>k</td>
<td>Seismic level</td>
<td>Zone- IV(III), as per IS-1893, Year-2002</td>
<td>Zone- IV(III), as per IS-1893, Year-2002</td>
<td>Zone- IV, as per IS-1893, Year-2002</td>
</tr>
</tbody>
</table>

The metal-enclosed gas insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the IEC-62271-203 publications including their parts and supplements as amended or revised to date.

The Switchgear shall be preassembled at the factory and installed at the site using bolts and sealed flange connections. Welding of enclosures at field is not acceptable. In order to ensure electrical
continuity the metal clad enclosures shall be bonded together by metal to metal contact, straps across the different chamber for electrical continuity shall not be accepted.

1. The potential free contact provided in the GIS equipment for all the GIS stage alarms and operating mechanism alarms should be minimum 2 nos preferably with dedicated DC source for each contact. All alarms for LCC and SAS multiplied from 1no contact of GIS is not acceptable as failure of this contact fails the GIS equipment safety and protection.
2. Interlock of isolator for Feeder/Line / Reactor shall include also the gas low stage-2 alarm of adjacent GIS compartments until the next isolator compartment.
3. For phase segregated GIS compartments, Phase wise separate alarms should be provided for each stage of GIS alarms with sufficient auxiliary contacts for wiring to LCC as well as the SAS.

The integrated design has to fulfil the following requirements:

1. 500 kV GIS Feeder Dia with one and half breaker scheme with double bus arrangement single phase enclosure along with all accessories includes the following
   b. Circuit breaker – 3 Nos.
   c. Current transformer – 6 sets.( with 5 cores )
   d. Group operated Disconnector with High Speed Earth Switch (HSES) for Line – 2 No.
   e. Group operated Disconnector with earth switch (LSES) assembly for line – 2 Nos.
   f. Group operated Disconnector with earth switch (LSES) assembly for tie breaker – 2 Nos
   g. Group operated Disconnector with earth switch (LSES) assembly for T section – 2 Nos
   h. 400 KV single phase Voltage transformer in all phases with group operated disconnector in separate chamber for line – 2 sets. ( with 3 sec cores ).
   i. Connection with Busbar – 1 Lot
   j. Local Control Cubicle – 3 Nos.

2. 500 kV GIS Transformer Dia with one and half breaker scheme with double bus arrangement single phase enclosure along with all accessories includes the following
   a. Group operated Disconnector with earth switch (LSES) assembly
for Bus – 2 Nos.
b. Circuit breaker with CSD arrangements – 3 Nos.
c. Current transformer – 6 sets. (with 5 sec cores)
d. Group operated Low Speed Earth Switch (LSES) – 2 No.
e. Group operated Disconnector with earth switch (LSES) assembly – 2 Nos.
f. Group operated Disconnector with earth switch (LSES) assembly for tie breaker – 2 Nos
g. Group operated Disconnector with earth switch (LSES) assembly for T section – 2 Nos
h. Connection with Busbar – 1 Lot
i. Local Control Cubicle – 3 Nos.

3. 500 kV GIS Bus Reactor Dia with one and half breaker scheme with double bus arrangement single phase enclosure along with all accessories includes the following
j. Group operated Disconnector with earth switch (LSES) assembly for Bus – 2 Nos.
k. Circuit breaker with CSD arrangements – 3 Nos.
l. Current transformer – 6 sets. (with 5 sec cores)
m. Group operated Low Speed Earth Switch (LSES) – 2 No.
n. Group operated Disconnector with earth switch (LSES) assembly – 2 Nos.
o. Group operated Disconnector with earth switch (LSES) assembly for tie breaker – 2 Nos
p. Group operated Disconnector with earth switch (LSES) assembly for T section – 2 Nos
q. Connection with Busbar – 1 Lot
r. Local Control Cubicle – 3 Nos.

4. The 400 kv potential transformer module comprising of following
a. One no. group operated disconnector,
b. Three nos. of single phase potential transformer with three secondary cores.
c. Connection with GIS Busbar

5. High Speed Earth Switch (HSES) for Bus – I & II – 2 Nos.

230KV GIS EQUIPMENTS:

A. Bus Enclosure:
1. Single phase enclosure for main bus I and II.
2. Single phase earthing switch in separate enclosure for each bus bar in main bus I and II.
3. Single phase VT with disconnector on each phase with three secondary winding for main bus I & II.
4. Online partial discharge monitoring.

B. Feeder bay arrangement includes in each phase:
1. Circuit breaker.
2. 2 Nos. maintenance earth switch for circuit breaker.
3. 2 Nos. Bus bar disconnector for main bus I and II.
4. 1 No. disconnector for circuit breaker.
5. 1 No. disconnector for line side.
6. 1 No. disconnector for by pass operation.
7. 1 No. high speed earth switch.
8. Connection with bus bar.
10. 3 Nos. Single phase VT with disconnector in line side with 3 core secondary windings.
11. Connection for XLPE cable.
12. Local control cubicle.
13. Copper flat of required size to connect the GIS equipments with main earthing system at multi points.
14. Shielded Control cable to connect the GIS bay with their LCC panels.
15. Online partial discharge monitoring.

C. Transformer bay arrangement includes in each phase:
1. Circuit breaker.
2. 2 Nos. maintenance earth switch for circuit breaker.
3. 2 Nos. Bus bar disconnector for main bus I and II.
4. 1 No. disconnector for Transformer.
5. 1 No. disconnector for line side.
6. 1 No. disconnector for by pass operation.
7. 1 No. high speed earth switch.
8. Connection with bus bar.
10. Connection for XLPE cable.
11. Local control cubicle.
12. Copper flat of required size to connect the GIS equipments with main earthing system at multi points.
13. Shielded control cable to connect the GIS bay with their LCC panels.

110KV GIS EQUIPMENTS:
A. Bus Enclosure:
1. Three phase enclosure for main bus I and II.
2. Three phase earthing switch in separate enclosure for each bus bar in main bus I and II.
3. Three phase VT with disconnector with three secondary winding for main bus I & II.
4. Online partial discharge monitoring.

B. Feeder bay arrangement:
1. Circuit breaker.
2. 2 Nos. maintenance earth switch for circuit breaker.
3. 2 Nos. Bus bar disconnector for main bus I and II.
4. 1 No. disconncetor for line side.
5. 1 No. high speed earth switch.
6. Connection with bus bar.
7. Current transformer with 5 core secondary winding.
8. Three phase VT with disconnector in line side with 3 core secondary windings.
9. Connection for XLPE cable.
10. Local control cubicle.
11. Copper flat of required size to connect the GIS equipments with main earthing system at multi points.
12. Shielded control cable to connect the GIS bay with their LCC panels.

C. Transformer bay arrangement includes in each phase:
1. Circuit breaker.
2. 2 Nos. maintenance earth switch for circuit breaker.
3. 2 Nos. Bus bar disconnector for main bus I and II.
4. 1 No. disconncetor for line side.
5. 1 No. high speed earth switch.
6. Connection with bus bar.
7. Current transformer with 5 core secondary winding.
8. Connection for XLPE cable.
9. Local control cubicle.
10. Copper flat of required size to connect the GIS equipments with main earthing system at multi points.
11. Shielded control cable to connect the GIS bay with their LCC panels.
12. Online partial discharge monitoring.
3.0. REFERENCE STANDARDS

3.1.1
The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) Publications including their parts and supplements as amended or revised to date:

IEC 62271-203 Gas Insulated metal-enclosed switchgear for rated voltages above 52KV
IEC 60376 New sulphur hexafluoride
IEC 62271-100 High voltage alternating current Circuit breakers
IEC 60694 Common clauses for high voltage Switchgear and control-gear standards
IEC 62271-102 Alternating current disconnectors (isolators) and earthing switches
IEC 61129 Alternating current earthing switches. Induced current switching
IEC 60044-1 Current Transformers
IEC 60044-2 Voltage transformers
IEC 60137 Bushings for alternating voltages above 1000 V
IEC 60859 Cable connections for gas-insulated switchgear
IEC 60480 Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099 -1/4 Non-linear resistor type arresters for AC systems

IEC 60439 Factory-built assemblies of low-voltage switchgear and control Gear.

IEC 60427 Report on synthetic testing of high-voltage alternating-current breaker.


CIGRE-44 Earthing of GIS- an application guide. (Electra no.151, Dec'93).

IEC 61639 Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above.

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

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

3 DEFINITIONS

3.1 Assembly

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

Bay refers to the area occupied by one Circuit Breaker and associated equipments used to protect one
line/transformer/reactor/bus coupler in Double bus scheme, One
and a half breaker scheme for 500KV GIS and Double bus single
breaker scheme for 230 & 110 KV GIS which comprises of at
least one circuit breaker, two disconnectors, two earthing
switches, one fast earthing switch and three nos. of single
phase CTs and three single phase potential transformers for
500KV & 230KV Lines and one three phase potential transformer
for 110KV Line.

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

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.)

Manual Operations : Manual operation means operation by hand
without using any other source of Power.

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

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

4 GENERAL DESIGN AND SAFETY REQUIREMENT

4.1 General
The GIS assembly shall consist of separate modular
compartments e.g. 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. 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.

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.

The switchgear, which shall be of modular design, shall have complete phase isolation. 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.
Gas barrier insulators (communication type) shall have the same basis of design and shall have holes on both sides for proper flow of gas.

Gas barrier insulators (Non-communicable type) shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, 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.

The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300 ms at rated short time with stand 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.

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 disconnectors and earth switches.

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 aluminum/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.

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.

The manufacturer shall guarantee that the pressure loss within each individual gas-filled 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 vapor 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.

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

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 subdivided into individual arc and gas-proof compartments preferably for:

Bus bars

Intermediate compartment

Circuit breakers

Line disconnectors

Voltage Transformers

Gas Insulated bus duct section between GIS and XLPE cable/Overhead Conductor.

The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnecter (when bus and bus disconnecter are enclosed in a single enclosure) can be carried out by isolating and evacuating the small effected section and not the entire bus. The design of the 1.5 CB bus scheme GIS shall be such that in case one circuit breaker module is removed for maintenance, there is no disruption in the power flow in any of the two circuits. Further the design of double bus with one and half breaker & double bus with single breaker scheme GIS shall be such that in case a circuit breaker module of a feeder is removed for maintenance, both busbars shall remain in service. For achieving the above requirements, adequate number of intermediate compartments, if required, shall be provided to ensure equipment and operating personnel’s safety.
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 layout of the substation equipment, busbars and switchgear bays shall preferably be based on the principle of “phase grouping”. Switchgear layout based on the “mixed phases” principle shall not be accepted without mutual agreement between supplier and owner. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance.

4.2 Local Control & Substation Automation System

Separate control cubicle including gas monitoring shall be provided for each bay which shall be installed near the switchgear for local control & monitoring of respective switchgear bay.

Local bay 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 Section: Substation Automation System.

Local control cubicle shall preferably be separately mounted, but skid mounted LCC also accepted.

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 neighboring bays.

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

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

In general the contours of energized metal parts of the GIS and any other accessory shall be such 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 when the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

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, Year-2000. The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

The fabricated metal enclosures shall be of Stainless Steel or Aluminum 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.

The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. The removed interrupter assembly must be easily and safely accessible for inspection and possible repairs.
The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.

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.

The Average Intensity of electromagnetic field shall not be more than 50 micro –Tesla on the surface of the enclosure. The supplier shall furnish all calculations and documents in support of the above during detailed engineering.

The Bidder shall furnish the following information regarding the loosely distributed metallic particles within the GIS encapsulation.

Calculations of critical field strength for specific particles of defined mass and geometry.

The methodology and all the equipment for electrical partial discharge (PD) detection, and/or acoustic detection methods, including that mentioned in the specification elsewhere.

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

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

Wherever required, the heaters shall be provided 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-phase 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.

The enclosure & support structure shall be designed in such a way that a person of 1780 mm height (max.) and 80 Kg in weight (max.) is able to climb on the equipment for maintenance.

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

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

Loss of Gas Density.

Any other alarm necessary to indicate deterioration of the gas insulating system.

Operating System

Low operating pressure.
Loss of operating hydraulic mechanism power.

Loss of control cubicle power.

Pole Discrepancy.

4.3 The equipment will be operated under the following ambient conditions

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.

The humidity will be about 95% (indoors)

The elevation is less than 1000 meters.

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 shall not exceed 20 degree C above the ambient temperature of 50 degree C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted up to 30 degree C above the ambient of 50 degree C.

These conditions shall be taken into account by the supplier in the design of the equipment.

4.4 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.

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

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

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

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

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

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

4.5 INDICATION AND VERIFICATION OF SWITCH POSITIONS

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 earthswitches so that the switch contact positions can be verified by direct visual inspection.

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

4.7 PRESSURE VESSEL REQUIREMENTS

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 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 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.

4.8 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 GIS supplier must supply the entire material for grounding bus of GIS viz conductor, clamps, joints, operating and safety platforms etc. The GIS supplier is also required to supply all the earthing conductors and associated hardware material for the following:
Connecting all GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS building.

Grounding of transformer, reactor, CVT, SA and other outdoor switchyard equipments/structures etc.

The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with Copper 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 non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

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

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

The Supplier 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.

5 CIRCUIT BREAKERS

5.1 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. Circuit breakers shall be of single pressure type. 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 with an operating sequence and timing as specified.

5.2 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 400/230/110 kV effectively grounded system, with
transmission lines of lengths and characteristics as indicated in Section Project and perform make and break operations as per the stipulated duty cycles satisfactorily.

TERMINAL FAULT

Close.... 1 Min......... Open...... Close open 2 min......... close ....... 1 Min......... open close open.

6.3.2 RECLOSING AGAINST TRAPPED CHARGES

Duty same as under (i) above. The first, third and fourth closures are to be on de-energized line while second closing is to be made with lines against trapped charge of 1.2 p.u. (Based on 1 pu = 653kV) of opposite polarity.

OUT OF PHASE CLOSING

One closing operation under phase opposition that is with twice the voltage across the terminals.

No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished along with the bid. The calculations shall take care of adverse tolerances on resistance values and time settings.

6.3 The circuit breaker shall be capable of

Interrupting the steady and transient magnetizing current corresponding to 500 kV/230 kV/110 KV class transformers of 200 MVA to 630 MVA ratings on both 500 KV, 230 kV & 110 KV side.

Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors.
Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

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

The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of shunt reactor and/or series capacitor compensated lines with trapped charges.

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

500 kV breakers shall be able to switch in and out the 500 kV shunt reactor for any value from 50 MVAR up to 80 MVAR without giving rise to over voltage more than 2.3 p.u.

6.4 Controlled Switching Requirements

The Circuit Breaker shall be equipped with controlled switching with consequent optimization of switching behavior when used in switching of 500kV Bus reactor & switchable Line reactor. The controller shall be provided in Main & Tie circuit breakers of Bus reactors (in case of 1.5 CB scheme).

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

Technical Requirement for controlled switching device.
The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary AC & DC voltages and frequency as specified in section - GTR.

The controller shall meet the requirements of IEC-60255-4 Appendix ‘E’ class III regarding HF disturbance test, and fast transient test shall be as per IEC-61000 – 4 level III and insulation test as per 60255 – 5.

The controller shall have functions for switching ON & OFF the circuit breakers.

The controller shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

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

The controller should have display facility at the front for the settings and measured values.
The controller should be PC compatible for the setting of various parameters and downloading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the Supplier to be used on the owner’s PC.

The controller shall have self-monitoring facility. The controller shall be suitable for current input of 1 amp from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The controller shall also take care of transient and dynamic state values of the current from the secondary of the CTs and CVTs.

The controller shall have time setting resolution of 0.1 ms or better.

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

The CSD shall be mounted in the 400KV relay panel of the respective ICTs, Reactors. In respect of tie breaker the CSD shall be mounted in the 400kv Tie breaker relay panel. The 400KV breaker to be provided with CSD is inclusive of all the associated materials such as necessary sensors, cables etc. stipulated in the specification of CSD.

a) Control switching device (CSD) shall be inclusive of both the 400KV Main breakers and 400 kV Tie breaker for the 400KV Diameter connected to the 400 KV Bus reactors.

b) Control switching device (CSD) shall be inclusive of both the 400KV Main breaker and 400 kV Tie breaker feeding the 400 KV ICTs, this is applicable similarly for 400KV Spare ICT also.
6.5 Total Break Time
The total break time shall not be exceeded under any of the following duties:

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

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

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

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

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

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

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.
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.

The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pres-sure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)

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.

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

**6.7 OPERATING MECHANISM**

General Requirements:

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.

The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.
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 antipumping and trip free (as per IEC definition) under every method of closing.

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.

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.

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

The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker.

Control

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

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.

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.

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

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.

Densimeter contacts and pressure switch contacts shall be suitable for direct use as permissives in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe 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.

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

**6.8 Spring operated Mechanism**

Spring operated mechanism shall be complete with motor in accordance with Section GTR. 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.

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.

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

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.

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

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.

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

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

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.
6.9 Hydraulically Operated Mechanism

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

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

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.

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.

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.

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.

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

6.10 ADDITIONAL DATA TO BE FURNISHED ALONGWITH THE OFFER & ON AWARD OF CONTRACT

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

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

6.11 TESTS
The circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

6.12 Routine Tests
Routine tests as per IEC : 62271-100 shall be performed on all circuit breakers.

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

Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto- reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, Hydraulic / 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 alongwith necessary transducers, cables, console etc. shall be furnished as mandatory maintenance equipment.
### 6.13 TECHNICAL PARAMETERS

<table>
<thead>
<tr>
<th>S.N o</th>
<th>Description</th>
<th>500KV GIS</th>
<th>230KV GIS</th>
<th>110KV GIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Rated voltage kV (rms)</td>
<td>500</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>b.</td>
<td>Rated frequency (Hz)</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>c.</td>
<td>No. of poles</td>
<td>1(3)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>d.</td>
<td>Type of circuit breaker</td>
<td>SF6 insulated.</td>
<td>SF6 insulated</td>
<td>SF6 insulated</td>
</tr>
<tr>
<td>e.</td>
<td>Rated continuous current (A) at an ambient</td>
<td>4000A (for line / bus-coupler /Tr. Bay-breaker)</td>
<td>2000A (3150A)</td>
<td>2000A</td>
</tr>
<tr>
<td></td>
<td>temperature of 50-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Rated short circuit capacity</td>
<td>63KA for 1 sec with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions</td>
<td>50kA for 3 sec with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions</td>
<td>50KA for 3 sec with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions</td>
</tr>
<tr>
<td>S.N o</td>
<td>Description</td>
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<td>110KV GIS</td>
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<tr>
<td></td>
<td>as specified.</td>
<td>as specified.</td>
<td>as specified.</td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>Symmetrical interrupting capability kA (rms)</td>
<td>63</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>h.</td>
<td>Rated short circuit making current kAp Peak</td>
<td>157.5kA</td>
<td>157.5 kA</td>
<td>157.5</td>
</tr>
<tr>
<td>i.</td>
<td>Short time current carrying capability for three second kA (rms)</td>
<td>63KA</td>
<td>50KA</td>
<td>40KA</td>
</tr>
<tr>
<td>j.</td>
<td>Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms)</td>
<td>As per IEC</td>
<td>As per IEC</td>
<td>As per IEC</td>
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<tr>
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<td></td>
<td>rated line charging current with test voltage immediately before opening equal to the product of $\frac{U}{\sqrt{3}}$ and 1.4 as per IEC-62271-100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k)</td>
<td>First pole to clear factor</td>
<td>$\geq 1.3$</td>
<td>$\geq 1.3$</td>
<td>$\geq 1.3$</td>
</tr>
<tr>
<td>l)</td>
<td>Rated break time as IEC (ms)</td>
<td>40</td>
<td>60($\leq 60$)</td>
<td>60 - 100</td>
</tr>
<tr>
<td>m)</td>
<td>Total break time (ms)</td>
<td>45</td>
<td>65($\leq 65$)</td>
<td>60 - 100</td>
</tr>
<tr>
<td>n)</td>
<td>Total closing time (ms)</td>
<td>Not more than 150</td>
<td>Not more than 200</td>
<td>Not more than 200</td>
</tr>
<tr>
<td>o)</td>
<td>Rated operating duty cycle</td>
<td>O-0.3s-CO-3 min-CO</td>
<td>O-0.3s-CO-3 min-CO</td>
<td>O-0.3s-CO-3 min-CO</td>
</tr>
<tr>
<td>p)</td>
<td>Reclosing</td>
<td>Single phase &amp;Three phase auto</td>
<td>Single phase/T hree phase</td>
<td>-</td>
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<tr>
<td>S.N o</td>
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<tr>
<td></td>
<td>reclosing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>q)</td>
<td>Rated insulation levels</td>
<td></td>
<td>± 1550 kVp</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td></td>
<td>Full wave impulse withstand (1.2x50 micro sec.) between line terminals and ground:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between terminals with circuit breaker open:</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Impulse on one terminal &amp; 315 kVp of opposite polarity on the other terminal.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>Rated switching impulse withstand</td>
<td></td>
<td>±460 kVp</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>1175 kVp</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>Description</td>
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<tr>
<td></td>
<td>voltage (250/2500 micro-sec.)Dry &amp; wet.</td>
<td>+900 kVp impulse on one terminal &amp; + 450 kVp of opposite polarity on the other terminal.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t)</td>
<td>One minute power frequency withstand voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- between line terminals and ground</td>
<td>710 kV rms.</td>
<td>460 kV rms.</td>
<td>275kV rms</td>
</tr>
<tr>
<td></td>
<td>- between terminals with circuit</td>
<td>925 kV rms.</td>
<td>530 kV rms.</td>
<td>343kV rms</td>
</tr>
<tr>
<td>S.N o</td>
<td>Description</td>
<td>500KV GIS</td>
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<td>110KV GIS</td>
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<tr>
<td></td>
<td>breaker open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>u)</td>
<td>Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 266 kV (Micro volts)</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>v)</td>
<td>Max. difference in the instants of closing/opening of contacts (ms) between poles</td>
<td>As per IEC</td>
<td>As per IEC</td>
<td>As per IEC</td>
</tr>
<tr>
<td>w)</td>
<td>Trip coil and closing coil voltage</td>
<td>220V DC</td>
<td>220V DC</td>
<td>220V DC</td>
</tr>
<tr>
<td>x)</td>
<td>Auxiliary Contacts Auxiliary switch shall also comply with requirements</td>
<td>Each circuit breaker pole shall be provided with an auxiliary</td>
<td>Each circuit breaker pole shall be provided with an auxiliary</td>
<td>Each circuit breaker pole shall be provided with an auxiliary</td>
</tr>
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<tr>
<td></td>
<td>as given. independent single pole reversible contacts (from NO to NC &amp; vice versa)</td>
<td>switch with 20% of spare – NO and 20% spare NC contact for use in future.</td>
<td>anauxiliary switch with 20% of spare – NO and 20% spare NC contact for use in future.</td>
<td>switch with 20% of spare – NO and 20% spare NC contact for use in future.</td>
</tr>
<tr>
<td></td>
<td>Rating of Auxiliary contacts</td>
<td>10A at 220 V DC</td>
<td>10A at 220 V DC</td>
<td>10A at 220 V DC</td>
</tr>
<tr>
<td></td>
<td>Breaking capacity of Aux. Contacts less than 20 ms.</td>
<td>2A DC with the circuit time constant of not less than 20 ms.</td>
<td>2A DC with the circuit time constant of not less than 20 ms.</td>
<td>2A DC with the circuit time constant of not less than 20 ms.</td>
</tr>
<tr>
<td></td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
</tbody>
</table>

7 DISCONNECTORS (ISOLATORS)

7.3 General

Disconnectors 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 disconnectors shall conform to IEC-62271-102 and shall have the following ratings as specified.

Technical Parameter

<table>
<thead>
<tr>
<th>S.</th>
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</thead>
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<td>a.</td>
<td>Rated voltage kV (rms)</td>
<td>500</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 HZ</td>
<td>50 HZ</td>
<td>50 HZ</td>
</tr>
<tr>
<td>c)</td>
<td>System earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Type</td>
<td>SF6 insulated</td>
<td>SF6 insulated</td>
<td>SF6 insulated</td>
</tr>
<tr>
<td>e)</td>
<td>Rated continuous current(A) at 400C ambient temp.</td>
<td>4000A</td>
<td>2000A (3150A)</td>
<td>2000A</td>
</tr>
<tr>
<td>f)</td>
<td>Rated short time with stand current of isolator and earth switch</td>
<td>63KA for 1 sec</td>
<td>50KA for 3 sec</td>
<td>50KA for 3 sec</td>
</tr>
<tr>
<td>g)</td>
<td>Rated dynamic short circuit withstand current of isolator and earth switch</td>
<td>157.5 KAP</td>
<td>157.5 KAP</td>
<td>157.5 KAP</td>
</tr>
<tr>
<td>S.</td>
<td>Description</td>
<td>500KV GIS</td>
<td>230KV GIS</td>
<td>110KV GIS</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>h)</td>
<td><strong>Rated insulation level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Withstand voltage:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>To earth: 710 KV rms 460KV rms 275KV rms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Across isolating distance 925 KV rms 530KV rms 310KV rms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Rated insulation levels; 1.2/50 micro sec.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lighting impulse withstand voltage (+ve or –ve polarity)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>To earth: 1550 KVP +1050 KVP 650 KVP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Across isolating distance +1550-/+315 KVP ±1200 KVP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Rated switching impulse withstand voltage (250/2500 micro-sec.) dry &amp; wet</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.</td>
<td>Description</td>
<td>500KV GIS</td>
<td>230KV GIS</td>
<td>110KV GIS</td>
</tr>
<tr>
<td>----</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>between line terminals and ground</td>
<td>+/-1175KVP</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>between terminals with isolator open</td>
<td>+/- 900 kvp impulse on one terminal &amp; 450 kvp of opposite polarity on the other terminal</td>
<td></td>
<td>N.A</td>
</tr>
<tr>
<td>i)</td>
<td>Rated mechanical terminal load</td>
<td>As per IEC</td>
<td>As per IEC</td>
<td>As per IEC</td>
</tr>
<tr>
<td>j)</td>
<td>No. of spare auxiliary contacts on each isolator</td>
<td>4 NO and 4 NC</td>
<td>4 NO and 4 NC</td>
<td>4 NO and 4 NC</td>
</tr>
<tr>
<td>K)</td>
<td>No. of spare auxiliary contacts on each earthing switch</td>
<td>4 NO and 4 NC</td>
<td>4 NO and 4 NC</td>
<td>4 NO and 4 NC</td>
</tr>
</tbody>
</table>

7.4 Construction & Design.

The single pole group operated disconnectors 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.

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

The 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.

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 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.

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

Each disconnector shall be supplied with auxiliary switch having 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 continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.

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

The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated 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 disconnectors when the grounding switch is in the closed position.

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

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

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

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>Closed</td>
<td>Closed</td>
</tr>
</tbody>
</table>

Green 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.
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.

8 SAFETY GROUNDING SWITCHES

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.

Each safety grounding switch shall be electrically interlocked with its associated 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 mechanically key interlocked with its associated disconnector.

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 coloring for the indicator are given as under:

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open position</td>
<td>Open</td>
</tr>
<tr>
<td>Closed position</td>
<td>Closed</td>
</tr>
</tbody>
</table>

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

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 3 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 and shall have electrical endurance class: E0.

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

It shall be possible to use the Grounding switch for CT primary injection test (both sides of CT’s) and also Sheath voltage test of cable using 5kV 50Hz AC. An insulated link shall be provided on ES for the same, so that by removing the link, it shall be possible to apply current/voltage to the GIS/Cable through this phase wise.

9 **HIGH SPEED MAKE PROOF GROUNDING SWITCHES**

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

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

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

The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125 kA. 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.

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

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN POSITION</td>
<td>Open</td>
</tr>
<tr>
<td>CLOSED POSITION</td>
<td>Closed</td>
</tr>
</tbody>
</table>

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

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

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

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

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

The main grounding connection on each grounding switch shall be rated to carry the peak withstand current rating of the switch for 3 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

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

10 CURRENT TRANSFORMERS

10.3 General

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

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.

10.4 Ratios and Characteristics
The CT core distribution in 500Kv, 230kV & 110kV systems shall be as per Annexure-II. The number, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with Table-IA & 1B

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

10.5 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.

10.6 Constructional Details
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.

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.

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

The rated extended primary current shall be 150% at highest ratio.

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.

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

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

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

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

### 10.7 Technical Particulars

<table>
<thead>
<tr>
<th>Sl</th>
<th>Particular</th>
<th>500 kV</th>
<th>230 kV (rms)</th>
<th>110KV (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage</td>
<td>500 kV</td>
<td>245 kV (rms)</td>
<td>145KV(rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 HZ</td>
<td>50 Hz</td>
<td>50Hz</td>
</tr>
<tr>
<td>c)</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Rated short time thermal</td>
<td>63 kA for 1Second.</td>
<td>50KA for 3Second.</td>
<td>50KAp for 3Second.</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>e)</td>
<td>Rated dynamic current</td>
<td>157.5 kAp.</td>
<td>157.5Kap</td>
<td>157.5KAp</td>
</tr>
<tr>
<td>f)</td>
<td>Rated insulation levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>1.2/50 micro second</td>
<td>1550 kVp</td>
<td>±1050 kVp</td>
<td>650KVp</td>
</tr>
<tr>
<td>ii)</td>
<td>1 Minute power</td>
<td>710 kV(rms)</td>
<td>460 kV (rms)</td>
<td>310KVp</td>
</tr>
<tr>
<td>iii)</td>
<td>250/2500 micro second</td>
<td>1175 kVp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g)</td>
<td>Maximum temperature rise over an ambient temperature of 400°C</td>
<td>As per IEC 60044-1</td>
<td>As per IEC 60044-1</td>
<td>As per IEC 60044-1</td>
</tr>
<tr>
<td>h)</td>
<td>Radio interference voltage at 1.1Un/√3and frequency range 0.5 to 2</td>
<td>1000 microvolts</td>
<td>1000 microvolts</td>
<td>1000 microvolts</td>
</tr>
<tr>
<td>i)</td>
<td>One minute power frequency</td>
<td>3 kV (rms)</td>
<td>3 kV (rms)</td>
<td>3 kV (rms)</td>
</tr>
<tr>
<td>j)</td>
<td>Partial discharge level</td>
<td>10 pico coulombs</td>
<td>5(10) pico coulombs</td>
<td>5 pico coulombs</td>
</tr>
</tbody>
</table>

11 VOLTAGE TRANSFORMERS

11.3 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. However, for 500 kV on the lines outdoor type Capacitive Voltage Transformers suitable for carrier coupling shall be provided.

11.4 Ratios and Characteristics
The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table II-A and Table II-B.

11.5 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.

11.6 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.

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

11.8 Constructional Details of Voltage Transformers:
Bus bar 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. Line
VT shall be provided on respective line bays. When one or two phases of PT are used for Line in place of all three phases, it shall be possible to fix the same in any phase.

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

Voltage transformers secondary’s 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.

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

The accuracy of 0.2S on secondary (metering core) should be maintained throughout the entire burden range up to 400 VA on all the three windings without any adjustments during operation.

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

It shall be possible to remove the VT without affecting the adjacent compartment.

Wherever any single phase PT is used, provision shall be given to mount the PT in any one phase (to be decided by site during commissioning).
11.9 TESTS

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.
## 11.10 TECHNICAL PARAMETERS

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Particular</th>
<th>500KV</th>
<th>230KV</th>
<th>110KV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated System voltage</td>
<td>550KV (rms)</td>
<td>245KV(rms)</td>
<td>145KV(rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated Frequency</td>
<td>50HZ</td>
<td>50HZ</td>
<td>50HZ</td>
</tr>
<tr>
<td>c)</td>
<td>System Neutral earthing</td>
<td>Eaffectedly earthed</td>
<td>Eaffectedly earthed</td>
<td>Eaffectedly earthed</td>
</tr>
<tr>
<td>d)</td>
<td>System Fault level</td>
<td>63KA for 1 sec</td>
<td>50 KA for 3 sec</td>
<td>50 KA 3 sec</td>
</tr>
<tr>
<td>e)</td>
<td>Rated insulation levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) 1.2/50 micro sec</td>
<td>+1550 KVp</td>
<td>±1050 KVp</td>
<td>650 KVP</td>
</tr>
<tr>
<td></td>
<td>ii) 1 minute power</td>
<td>710 KV (rms)</td>
<td>460 KV (rms)</td>
<td>310 KVP</td>
</tr>
<tr>
<td></td>
<td>iii) 250/2500 micro sec</td>
<td>1175 KVp for 500KV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>One minute power frequency withstand voltage for secondary winding</td>
<td>3 KV (rms)</td>
<td>3 KV (rms)</td>
<td>3 KV (rms)</td>
</tr>
<tr>
<td>g)</td>
<td>Radio interference voltage at 1.1 Un/√3 and frequency range 0.5 to 2 MHz</td>
<td>1000 micro volts</td>
<td>1000 micro volts</td>
<td>1000 micro volts</td>
</tr>
<tr>
<td>h)</td>
<td>Rated total thermal burden</td>
<td>400 VA</td>
<td>400 VA</td>
<td>400 VA</td>
</tr>
<tr>
<td>i)</td>
<td>Partial discharge level</td>
<td>10 pico coulombs</td>
<td>10 pico coulombs</td>
<td>10 pico coulombs</td>
</tr>
</tbody>
</table>
12 OUTDOOR BUSHINGS

12.3 General
Outdoor bushings, for the connection of conventional external conductors to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements as per relevant IEC.

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 publication IEC 60137 as applicable.

12.4 Insulation levels and creepage distances
All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS. The creepage distance over the external surface of outdoor bushings shall not be less than 25 or 31 mm/kV as per specific project requirement.

12.5 Bushing types and fitting
Condenser type bushings will be preferred but alternative types can also be considered. Liquid filled bushings shall be provided with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will only be accepted if specifically approved.

12.6 Mechanical forces on bushing terminals
Outdoor bushings must be capable of withstanding cantilever forces due to weight of bus duct and short circuit forces. Design calculations in support of the cantilever strength chosen shall be submitted for owners review and approval.
### 12.7 The major parameters of the bushings shall be as follows

<table>
<thead>
<tr>
<th></th>
<th>550kV</th>
<th>245kV</th>
<th>145kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage (kV)</td>
<td>550</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>Rated current</td>
<td>4000A</td>
<td>3150 (Amp)</td>
<td>2000A</td>
</tr>
<tr>
<td>(As applicable)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightning impulse</td>
<td>1550</td>
<td>1050</td>
<td>650</td>
</tr>
<tr>
<td>withstand voltage (kVp)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching impulse</td>
<td>1175</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Withstand voltage (kVp)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One minute power</td>
<td>710</td>
<td>460</td>
<td>310</td>
</tr>
<tr>
<td>Frequency withstand voltage kV (rms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum total</td>
<td>13750</td>
<td>6125</td>
<td>3400</td>
</tr>
<tr>
<td>creepage distances (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 13 SURGE ARRESTORS

#### 13.3 General

The surge arrestors shall confirm in general to latest IEC – 60099-4.

#### 13.4 INSULATION CO-ORDINATION AND SELECTION OF SURGE ARRESTOR

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

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

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

13.5 Duty requirements

The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers, reactors and long lines.

Surge arresters for the 420 kV network shall be capable of discharging of severe re-energization switching surges on a 500 kV, 450 Km long line with surge impedance of 300 ohms and capacitance of 12 nF/Km and over voltage factor of 2.3 p.u at the arrestor terminals.

550 kV class arrester shall be capable of discharging energy equivalent to class 4 of IEC for a 550 kV system on two successive operation followed immediately by 50 HZ energisation with a sequential voltage profile as specified below:

a) 650 kVp for 3 peaks

b) 575 kVp for 0.1 Sec.
c) 550 kVp for 1 Sec.

d) 475 kVp for 10 Secs.

245 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV system on two successive operations.

The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

<table>
<thead>
<tr>
<th>Equipment to be protected</th>
<th>Lightning impulse (kVp) for 420 kV system</th>
<th>Switching surge (kVp) for 420 kV system</th>
<th>Lightning impulse (kVp) for 245 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Transformer</td>
<td>+ 1300</td>
<td>+ 1050</td>
<td>+ 950</td>
</tr>
<tr>
<td>Instrument Transformer</td>
<td>+ 1425</td>
<td>+ 1050</td>
<td>+ 1050</td>
</tr>
<tr>
<td>Reactor</td>
<td>+ 1300</td>
<td>+ 1050</td>
<td>-</td>
</tr>
<tr>
<td>CB/Isolator</td>
<td>+1425</td>
<td>+ 1050</td>
<td>+ 1050</td>
</tr>
<tr>
<td>Acrossopen contacts</td>
<td>+ 1425 (-/+240)</td>
<td>+ 900 (-/+345)</td>
<td>+ 1200</td>
</tr>
</tbody>
</table>

13.6 Constructional Features

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

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the supplier and each arrestor shall be fitted with a Online continuous resistive leakage current monitoring system. The system shall be provided with an interface to integrate with the substation automation system.

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

### 13.7 Tests

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

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

### 13.8 Test on Surge Monitors

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

**Parameters**

Following are the parameters for 500kV and 230 kV system generally adopted by Owner for their installations. These parameters are indicative and not binding. The actual
parameters required for the installation shall be evolved by Supplier.

### 13.9 Technical Parameters

<table>
<thead>
<tr>
<th>SL</th>
<th>Particulars</th>
<th>500 kV</th>
<th>230 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated system voltage</td>
<td>500 kV</td>
<td>245 kV</td>
</tr>
<tr>
<td>b)</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>c)</td>
<td>Rated arrestor voltage</td>
<td>490 kV</td>
<td>216 kV(196Kv)</td>
</tr>
<tr>
<td>d)</td>
<td>Nominal discharge current</td>
<td>10 kA of 8/20 microsecond wave</td>
<td>10 kA of 8/20 microsecond wave</td>
</tr>
<tr>
<td>e)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
<td>50 Hz</td>
</tr>
<tr>
<td>f)</td>
<td>Minimum discharge Capability voltage corresponding to minimum discharge characteristics</td>
<td>8 KJ / kV or corresponding to cl. 3.4.1 (d) to arrestor voltage &amp; at minimum discharge</td>
<td>5 KJ/kV (referred to rated arrestor)</td>
</tr>
<tr>
<td>g)</td>
<td>Continuous operating voltage at 500C</td>
<td>303 kV</td>
<td>168 kV</td>
</tr>
<tr>
<td>h)</td>
<td>Min.switching surge residual voltage (1 kA)</td>
<td>730 kVp</td>
<td>-</td>
</tr>
<tr>
<td>i)</td>
<td>Max. Residual voltage at</td>
<td>-</td>
<td>560 kVp</td>
</tr>
<tr>
<td>ii)</td>
<td>10 kA nominal discharge current</td>
<td>900 kVp</td>
<td>600 kVp</td>
</tr>
<tr>
<td>iii)</td>
<td>20 kA nominal discharge current</td>
<td>975 kVp</td>
<td>-</td>
</tr>
<tr>
<td>j)</td>
<td>Long duration discharge class</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>k)</td>
<td>High current short duration test</td>
<td>100 kA</td>
<td>100 kA</td>
</tr>
<tr>
<td>l)</td>
<td>Current for pressure relief test</td>
<td>63 kA rms</td>
<td>50 kA rms</td>
</tr>
<tr>
<td>m</td>
<td>Prospective symmetrical fault</td>
<td>40 kA rms for 0.2 Sec</td>
<td>40 kA rms for 0.2 Sec</td>
</tr>
<tr>
<td>n)</td>
<td>Pressure relief class:</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>o)</td>
<td>RIV at 1.1 Un/√3 kV rms (micro volts)</td>
<td>Less than 500</td>
<td>Less than 500</td>
</tr>
<tr>
<td>p)</td>
<td>Partial discharge at 1.05 COV</td>
<td>Not more than 50</td>
<td>Not more than 50</td>
</tr>
<tr>
<td>q)</td>
<td>Reference ambient temp.</td>
<td>50 °C</td>
<td>50 °C</td>
</tr>
</tbody>
</table>
14 500 KV & 230 KV GIS BUILDING

The buildings shall house 500 Kv, 230KV and 110 kV Gas Insulated Switchgear (GIS) separately and other associated equipments inside in each of the GIS building. Wherever 500 Kv, 230KV and 110 kV GIS hall already exists then the existing 500 Kv, 230KV and 110 kV GIS hall shall be suitably extended (wherever applicable) to accommodate the 500 Kv, 230KV and 110 kV GIS bays to be provided under the present scope.

The bidder shall submit the design & construction proposal of the building along with necessary information, data, and drawings in the techno-commercial bid according to the complete requirements.

The area for 500 kV, 230 & 110 KV GIS hall is indicated in the enclosed General Arrangement drawing. The dimension given is for reference only and may vary according to requirement of the equipment to be installed inside. The bidder shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance. 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.

Following minimum requirement shall apply

2.5 clear space up to 3m height all around the GIS

Phase to Earth clearance to be maintained, when HV test bushing is installed on any bay for HV cable testing.

Seismic Design Criteria

The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic level Zone- IV, as per new IS-
1893, Year-2002 has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. If the equipment has not been type tested earlier, design calculations of simulated parameters should be furnished along with the offer.

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

14.3 PARTIAL DISCHARGE MONITORING SYSTEM & DEW POINT METER
Portable P.D meter & Dew point meter shall be offered, if required as per relevant schedule of BPS and shall be considered for evaluation of bid. The specifications are enclosed at Annex-I. Supplier shall provide adequate number of UHF sensors in the offered GIS for connection to the P.D. meter and the number and location of these sensors shall be subject to approval of the employer.
15 QUALITY OF SF6 GAS

15.3 General

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)

15.4 Test

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

The bidder shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.
The bidder shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

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

16 SF6 GAS MONITORING DEVICES AND ALARM CIRCUITS

Dial type temperature compensated gas density or density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of the state of the gas & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows:-

Compartments except circuit breaker

Gas Refill level (This will be used to annunciate the need for the gas refilling. The Supplier shall provide a contact for remote indication.

'Zone Trip' level - This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

Circuit Breaker

Gas Refill' level - This will be used to annunciate the need for gas refilling. The Supplier shall provide a contact for remote indication.

'Breaker Block' level - This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting
capability of the breaker. At this level the breaker block contact shall operate & the trip-ping & closing circuit shall be blocked.

'Zone Trip' level - This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

The bidder should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

16.3 Gas Leakage
The maximum gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately.

16.4 Gas Supply
The Supplier shall include the supply of all SF6 gas necessary for filing & putting into operation the complete switchgear installation being supplied. In addition 20% of total gas requirement shall be supplied in separate cylinders as spare requirement, over & above the requirement of gas for successful commissioning. Pl. refer list of mandatory spares in this connection.

17 GAS FILLING AND EVACUATING PLANT:-
All the plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied with the contract 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 when carrying out maintenance or repair work on the switchgear and associate equipment of at least one complete bay.

Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.

The capacity of evacuation plant will be as under:

Vacuum Pump: 40 M3/Hour (Nominal suction pressure)

Compressor: 15 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 gas compartments shall preferably be fitted with permanent non-return valves through which the gas is pumped into or evacuated from the compartments.

Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be provided along with the bid.

18 SF6 GIS TO XLPE CABLE TERMINATION

The 500/230/110kV underground cables are to be connected to 500/230/110 kV GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure for making connection 1CX2500 sq mm (for 400KV feeders & Transformer) / 1600 sq mm (for 230 feeders & Transformer) / 630 sq. Mm (for 110KV feeders & Transformer) XLPE cable. Cable termination kit shall be supplied by cable supplier. The ducts and the casing
shall be suitable for the requirements for which it is designed. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

The SF6 GIS to XLPE cable termination shall conform to IEC-60859 (latest edition).

The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

All supporting structures for the SF6 bus-duct connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.

The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The typical arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall also be submitted.

It shall also be possible to do the HV testing of cable by removing the termination to GIS.

GIS Termination arrangement

Outside SF6 bushing, for the connection between the GIS and overhead lines or conventional air insulated equipment shall be furnished where specified.
Bushing shall comply with the relevant IEC Standards. The bushing can be with composite insulators (Silicon rubber) or with the porcelain insulators with all surfaces free from imperfection. The internal and external electrical field of the bushings can be controlled by a capacitive grading body or by grading shields.

For SF6/Air bushing, the GIS manufacturer shall provide detailed drawings and information.

The design of cable end box shall fully comply with the IEC 60859 standard. All cable end moulds shall be suitable for connecting single core XLPE 400 kV & 230 kV copper cables in respective GIS as per the price schedule.

For cable end terminations, the supplier shall submit detailed drawings illustrating clearly the scope of supply boundaries.

19 ELECTRIC OVERHEAD CRANE

One EOT Crane each for 500kV, 230KV and 110kV GIS hall of suitable capacity (12T for 500KV, 10T for 230KV and 8T for 110KV) shall be provided for erection & maintenance of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipments.

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

The crane for 400kV GIS hall shall have capacity of minimum 12T safe working load & minimum height of crane have shall be 9.0 meters or as per actual requirement whichever is higher.
The crane for 230kV GIS hall shall have capacity of minimum 10T safe working load & minimum height of crane have shall be 8.0 meters or as per actual requirement whichever is higher.

The crane for 110kV GIS hall shall have capacity of minimum 8T safe working load & minimum height of crane have shall be 7.0 meters or as per actual requirement whichever is higher.

20 TRANSFORMER / REACTOR TERMINATION MODULE

The transformer / reactor termination module enables a direct transition from the SF6 gas insulation to the bushing of an oil-insulated transformer / reactor. For this purpose, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer’s/reactor’s foundations are absorbed by the expansion fitting.

OR

The oil filled transformers and reactors are as shown in the substation SLD. The oil to air bushings of the 400/230/33 kV autotransformers and 500 kV reactors shall be supplied by the respective supplier’s and the same shall be connected to the SF6 ducts thru air to SF6 bushings to be provided under present scope. Terminal connection arrangement to connect GIS duct to bushing and duct mounting arrangement details shall be submitted during detailed engineering for Employer’s approval and for co-ordination with transformer and reactor supplier. Any modification suggested by Autotransformer and reactor supplier shall have to be carried out by the supplier to facilitate proper connection with the bushings of the autotransformer and reactors.
21 PAINTING OF ENCLOSURE:

All enclosures shall be painted externally as per manufacturer’s painting procedure. The painting procedures as followed shall be enclosed with the bid.

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

22 HEATERS

Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed inside the main circuit.

23 IDENTIFICATION & RATING PLATE

Each bay shall have a nameplate showing

A listing of the basic equipment from air entrance bushing to air entrance bushing (such as a breaker, disconnectors grounding switches, current transformers, voltage transformers, and bushings).

A schematic diagram indicating their relative locations.

Each module will have its own Identification & rating plate.

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

24 ON SITE HV TESTING

After the switchgear has been completely installed on site and filled with Sf6 gas, the complete assembly shall be subjected to the site tests as per IEC – 62271-203.

25 TRANSPORT OF EQUIPMENT TO SITE

The Supplier 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 Supplier 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, earthswitches, surge arrestors and bus sections exceeding 3 metres length shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the Supplier 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 Supplier shall communicate the interpretation of the data.

26 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 metalclad 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 blanking 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 TANTRANSCO. 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 Supplier will be able to use the available storage areas at site.

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

27 DESCRIPTION OF THE TYPE TEST FOR 500KV, 230KV AND 110KV GIS

The offered 500/230/110kV GIS equipments shall conform to the type tests as per IEC-62271-203 in general and standards of respective component in particular. Supplier shall submit type test reports for the following type tests & additional type tests. Refer the annexure for list of type tests.

The test reports of the type tests for GIS as well as all type tests on 500/230/110kV SF6/Air bushing as per IEC 60137 shall be submitted for approval and the test reports shall be of tests conducted within 5 (five) years prior to the date of bid opening. In case the test reports for 500/230/110kV GIS equipments are older than 5 (five) years on the date of bid opening, the Supplier shall repeat those test(s) at no extra cost to the employer.

28 MISCELLANEOUS

28.3 Country of origin

There will be no restriction on the country and origin.
28.4 Type Test Report

The bidder shall submit Type test reports as per the relevant IEC standards for GIS obtained from any of the following laboratories.

KEMA, Holland
CESI, Italy
IPH, Germany
EDF, France
Keri, South Korea
CRIEPI, Japan.
CERDA, France
PHELA, Italy.

STRI, Sweden.
China national High Voltage apparatus Inspecting Centre, China
Xian High Voltage research institute, China
Test reports of other labs are subject to approval of the owner on applying with proper justification and credentials.

28.5 Routine tests

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

28.6 SERVICE REQUIREMENT

Supplier of the GIS should have a service network in India.

28.7 ACCESSORIES FOR 500KV GIS

a) SF6 Gas handling plant of adequate capacity - 1 Set

b) SF6 gas service cart with all accessories(portable) - 1 Set
c) Test Bushing for cable testing - 1 Set

d) Portable vaccum and filling cart with 3 outlet - 1 Set

**c.1.0 ESSENTIAL TOOLS AND SPARES FOR 500KV GIS**

Single phase voltage transformer - 1 Set

Single phase set of 5 cores current transformer including enclosure - 1 Set

Enclosure insulators (Breathing and non-Breathing type each) - 2 Set

Tripping and closing coils - 3 Sets (each)

SF6 Pressure gauges - 4 Sets

SF6 Pressure relief devices - 2 Sets

Oil pressure switch with micro switch - 2 Sets

Fixed and Moving current carrying contacts for circuit breaker - 2 Set

Fixed and Moving Arcing carrying contacts for circuit breaker - 2 Set

Main and auxiliary nozzle for circuit breaker - 2 Set

Insulated drive rod for circuit breaker - 1 Set

Buffer cylinder complete for breaker - 1 Set

Accumulator/Pr. Storage cylinder for breaker - 2 Set

Pilet value assembly for Hydraulic mechanism - 2 Set

Main value assembly for hydraulic mechanism - 2 Sets

Auxiliary contacts for circuit breaker - 2 Set
Fixed and Moving Arcing carrying contacts for DS and ES
- 2 Set (each)

Auxiliary contacts for DS and ES - 1 Set

SF6 gas in steel bottle 52 Kg / bottle - 4 Nos.

Hydraulic oil - 100 Ltrs

Hydraulic Pump for circuit breakers - 2 unit

Complete drive mechanism for DS and ES - 1Set (each)

Motor for disconnect switches and grounding switches - 1 unit (each)

Complete drive mechanism for fast acting grounding switches - 1 unit

Motor for fast acting grounding switches - 1 unit

Rupture disc for circuit breakers / potential transformer - 2 No.(each)

Set of spares for local control cabinet including mcb., fuses, time relays, auxiliary relay and terminals

Rupture disc for other compartments - 2 Nos.

O rings for all compartments and breaker-5 Sets (each)

Lifting hooks, belts of various size for GIS Equipment handling - 1 Set.

c.2.0 Special Tools

SF6 gas leak detector - 1 Set

Hygrometer - 1 Set

Mille volt drop measurement appliance with 5m long test prob - 1 Set
SF6 gas bottle locking, measuring and filling assembly with all hose for filling and top up - 1 Set

One set of pipe grooving tools for the hydraulic operating mechanism - 1 Set

Infra-red / Thermal imaging camera - 1 set

Spl. Tools dismantling, o/h and reassembling og breaker and other compartment - 1 Set

CT / PT Analyzer - 1 No.

Circuit Breaker Analyzer - 1 No.

Dynamic Contact Resistance Measuring (DCRM) all transduser, fixing features etc., with lap top and software - 1 No.

SF6 Gas Analyzer to measure dew point, purity of SF6, SO2 and air - 1 No

Portable Partial Discharge monitoring kit with lap top and software - 1 No.

Acoustic / Sound level measuring kit - 1 No.

Digital weighing machine - 1 No.

Industrial hot blower for treating gas pipe, monitors etc., - 1 No.

Micro wave oven for desicant reactivation - 1 No.

Torque Wrinch 0 – 50Nm - 1 No.

Torque Wrinch 40 – 200Nm - 1 No.

Torque Wrinch 100 – 500Nm - 1 No.

Rachat spanner set (box spanner) 10 – 36 mm - 1 Set

Ring spanner 10 – 41 mm - 2 Set

Double End spanner 10 – 41 mm - 2 Set
Align key 1 – 12 mm - 2 Set
Multimeter (reputed make) - 2 No
Clamp on meter (0 – 20A, 20 – 200A, 200 – 2000A) - 2 No
Clamp on leakage meter (0 – 20 mA, 20 – 200 mA, 0.2 – 2A) -1No
LCR Meter - 1No
10KV Digital Power Insulation Tester - 1No
Earth resistance measuring kit - 1No

**c.3.0 ACCESSORIES FOR 230KV GIS**

Spare bushing for cable / HV test - 1 No.

**c.4.0 ESSENTIAL TOOLS AND SPARES FOR 500KV GIS**

Single phase voltage transformer - 1 Set
Single phase set of 5 cores current transformer including enclosure - 1 Set
Enclosure insulators (Breathing and non-Breathing type each) - 2 Set
Tripping and closing coils - 3 Sets (each)
SF6 Pressure gauges - 4 Sets
SF6 Pressure relief devices - 2 Sets
Oil pressure switch with micro switch - 2 Sets
Fixed and Moving current carrying contacts for circuit breaker - 2 Set
Fixed and Moving Arcing carrying contacts for circuit breaker - 2 Set
Main and auxiliary nozzle for circuit breaker - 2 Set
Insulated drive rod for circuit breaker - 1 Set
Buffer cylinder complete for breaker - 1 Set
Accumlator/Pr. Storage cylinder for breaker- 2 Set
Pilet value assembly for Hydraulic mechanism- 2 Set
Main value assembly for hydraulic mechanism- 2 Sets
Auxiliary contacts for circuit breaker - 2 Set
Fixed and Moving Arcing carrying contacts for DS and ES - 2 Set (each)
Auxiliary contacts for DS and ES - 1 Set
SF6 gas in steel bottle 52 Kg / bottle - 2 Nos.
Hydraulic oil - 75 Ltrs
Hydraulic Pump for circuit breakers - 2 unit
Complete drive mechanism for DS and ES - 1 Set (each)
Motor for disconnect switches and grounding switches - 1 unit (each)
Complete drive mechanism for fast acting grounding switches - 1 unit
Motor for fast acting grounding switches - 1 unit
Rupture disc for circuit breakers / potential transformer - 2 No. (each)
Set of spares for local control cabinet including mcb., fuses, time relays, auxiliary relay and terminals
Rupture disc for other compartments - 2 Nos.
O rings for all compartments and breaker - 5 Sets (each)
Lifting hooks, belts of various size for GIS Equipment handling - 1 Set.

c.5.0 Special Tools
SF6 gas leak detector - 1 Set
Hygrometer - 1 Set

Mille volt drop measurement appliance with 5m long test prob - 1 Set

SF6 gas bottle locking, measuring and filling assembly with all hose for filling and top up - 1 Set

One set of pipe grooving tools for the hydraulic operating mechanism - 1 Set

Spl. Tools dismantling, o/h and reassembling og breaker and other compartment - 1 Set

CT / PT Analyzer - 1 No.

Circuit Breaker Analyzer - 1 No.

SF6 Gas Analyzer to measure dew point, purity of SF6, SO2 and air - 1 No

Rachat spanner set (box spanner) 10 – 36 mm - 1 Set

Ring spanner 10 – 41 mm - 1 Set

Double End spanner 10 – 41 mm - 1 Set

Align key 1 – 12 mm - 1 Set

c.6.0 ACCESSORIES FOR 110KV GIS

Test Bushing for cable testing - 1 Set

c.7.0 ESSENTIAL TOOLS AND SPARES FOR 110KV GIS

Single phase voltage transformer - 1 Set

Three phase voltage transformer - 1 Set

Single phase set of 5 cores current transformer including enclosure - 1 Set
Enclosure insulators (Breathing and non-Breathing type each)
- 2 Set

Tripping and closing coils
- 3 Sets (each)

SF6 Pressure gauges
- 4 Sets

SF6 Pressure relief devices
- 2 Sets

Limit switch with micro switch for spring mechanism
- 2 Sets

Fixed and Moving current carrying contacts for circuit breaker
- 2 Set

Fixed and Moving Arcing carrying contacts for circuit breaker
- 2 Set

Main and auxiliary nozzle for circuit breaker
- 2 Set

Insulated drive rod for circuit breaker
- 1 Set

Buffer cylinder complete for breaker
- 1 Set

Closing and tripping spring for breaker
- 1 Set (each)

Auxiliary contacts for circuit breaker
- 2 Set

Fixed and Moving Arcing carrying contacts for DS and ES
- 2 Set (each)

Auxiliary contacts for DS and ES
- 1 Set

SF6 gas in steel bottle 52 Kg / bottle
- 4 Nos.

Spring charging motor for circuit breakers
- 2 unit

Complete drive mechanism for DS and ES
- 1 Set (each)

Motor for disconnect switches and grounding switches
- 1 unit (each)

Complete drive mechanism for fast acting grounding switches
- 1 unit
Motor for fast acting grounding switches - 1 unit

Rupture disc for circuit breakers / potential transformer - 2 No. (each)

Set of spares for local control cabinet including mcb., fuses, time relays, auxiliary relay and terminals

Rupture disc for other compartments - 2 Nos.

O rings for all compartments and breaker - 5 Sets (each)

Lifting hooks, belts of various size for GIS Equipment handling - 1 Set.

**c.8.0 Special Tools**

SF6 gas leak detector - 1 Set

Hygrometer - 1 Set

SF6 gas bottle locking, measuring and filling assembly with all hose for filling and top up - 1 Set

Spl. Tools dismantling, o/h and reassembling og breaker and other compartment - 1 Set

Rachat spanner set (box spanner) 10 – 36 mm - 1Set

Ring spanner 10 – 41 mm - 2 Set

Double End spanner 10 – 41 mm - 2 Set

Aglign key 1 – 12 mm - 2 Set

Multimeter (reputed make) - 1 No

**c.9.0 Language**

Language of communication and drawings will be in English only. However, Name plate details and Caution plates shall also be provided in Local Language (Tamil)
c.10.0 Training

Training in maintenance for 2 Engineers from TNEB/Chennai for 4 weeks at manufacture’s site. Training in operation for 4 Engineers from TNEB/Chennai for 6 weeks at site.
### TABLE I-A-I

**REQUIREMENTS FOR 500 kV CURRENT TRANSFORMER RATED FOR 4000 AMPS.**

<table>
<thead>
<tr>
<th>No. of core(s)</th>
<th>Core no.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output Burden (VA)</th>
<th>Accuracy Class</th>
<th>Min. Knee point. Voltage Vk</th>
<th>Max. CT Sec. Wdg Resistance (ohm)</th>
<th>Max. Excitation current at Vk (in mA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>4000-3000-2000/-1</td>
<td>-</td>
<td>TPS*</td>
<td>4000 3000/2000</td>
<td>16/12/8</td>
<td>15 on 4000/1tap 20 on 3000/1tap 30 on 2000/1tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>4000-3000-2000-</td>
<td>-</td>
<td>TPS*</td>
<td>4000 3000/2000</td>
<td>16/12/8</td>
<td>15 on 4000/1tap 20 on 3000/1tap 30 on 2000/1tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>METEERING</td>
<td>4000-3000-2000-</td>
<td>20 20 20</td>
<td>0.2S 0.2S 0.2S</td>
<td>- - -</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>TRANS BACK UP/ LINE</td>
<td>4000-3000-2000/-1</td>
<td>-</td>
<td>TPS*</td>
<td>4000 3000/2000</td>
<td>16/12/8</td>
<td>15 on 4000/1tap 20 on 3000/1tap 30 on 2000/1tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>TRANS DIFF/ LINE</td>
<td>4000-3000-2000-</td>
<td>-</td>
<td>TPS*</td>
<td>4000 3000/2000</td>
<td>16/12/8</td>
<td>15 on 4000/1tap 20 on 3000/1tap 30 on 2000/1tap</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

a. *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.

b. Metering core shall be of accuracy class 0.2S as per IEC: 60044-1.
### TABLE-IA-II

**REQUIREMENTS FOR 500 kV CURRENT TRANSFORMER RATED FOR 3000 AMPS.**

<table>
<thead>
<tr>
<th>No. of Core(s)</th>
<th>Core no.</th>
<th>Application</th>
<th>Current ratio (VA)</th>
<th>Output Burden (VA)</th>
<th>Accuracy Class</th>
<th>Min. Knee pt. Voltage Vk</th>
<th>Max. CT</th>
<th>Max. Excitation current at Vk (in mA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHE</td>
<td>3000-2000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/2000/500</td>
<td>12/8/2</td>
<td>20 on 3000/1tap. 30 on 2000/1tap. 120 on 500/1 tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>3000-2000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/2000/500</td>
<td>12/8/2</td>
<td>20 on 3000/1tap. 30 on 2000/1tap. 120 on 500/1 tap</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>METERING</td>
<td>3000-2000-2000</td>
<td>20 20</td>
<td>0.2S</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>TRANS BACK UP/ LINE</td>
<td>3000-2000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/2000/500</td>
<td>12/8/2</td>
<td>20 on 3000/1tap. 30 on 2000/1tap. 120 on 500/1 tap</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>TRANS DIFF/ LINE PRTN</td>
<td>3000-2000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/2000/500</td>
<td>12/8/2</td>
<td>20 on 3000/1tap. 30 on 2000/1tap. 120 on 500/1 tap</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

c. *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.*

d. *Metering core shall be of accuracy class 0.2S as per IEC: 60044-1.*
### TABLE-IA-III

**REQUIREMENTS FOR 500 KV CURRENT TRANSFORMER RATED FOR 2000 AMPS.**

<table>
<thead>
<tr>
<th>No. of cores</th>
<th>Core no.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output Burden (VA)</th>
<th>Accuracy Class</th>
<th>Min.Knee pt. Voltage Vk</th>
<th>Max.CT Sec.Wg Resistance</th>
<th>Max. Excitation current at Vk (in mA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>2000-1000/1</td>
<td>-</td>
<td>TPS*</td>
<td>2000/1000</td>
<td>8/4</td>
<td>30 on 2000/1tap 60 on 1000/1 tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>2000-1000/1</td>
<td>-</td>
<td>TPS*</td>
<td>2000/1000</td>
<td>8/4</td>
<td>30 on 2000/1tap. 60 on 1000/1 tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>METEERING</td>
<td>2000-1000-20</td>
<td>20</td>
<td>0.2S</td>
<td>0.2S</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>TRANS BACK UP/ LINE PRTN.</td>
<td>2000-1000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>2000/1000/500</td>
<td>8/4/2</td>
<td>30 on 2000/1tap 60 on 1000/1Tap 120 on 500/1 tap</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>TRANS DIFF/ LINE PRTN.</td>
<td>2000-1000-500/1</td>
<td>-</td>
<td>TPS*</td>
<td>2000/1000/500</td>
<td>8/4/2</td>
<td>30 on 2000/1tap 60 on 1000/1Tap 120 on 500/1 tap</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

1. *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.

2) Metering core shall be of accuracy class 0.2S as per IEC: 60044-1.
<table>
<thead>
<tr>
<th>No. of cores</th>
<th>Core no.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output Burden (VA)</th>
<th>Accuracy Class as Per IEC: 44-1</th>
<th>Min. Knee pt. Voltage Vk</th>
<th>Max. CT Sec. Wdg. Resist-</th>
<th>Max. Excitation current at Vk (in mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>3000-1600-800/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/1600/800</td>
<td>15/8/4</td>
<td>13.3 on 3000/1 25 on 1600/1 50 on 800/1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>BUS DIFF MAIN</td>
<td>3000-1600-800/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/1600/800</td>
<td>15/8/4</td>
<td>13.3 on 3000/1 25 on 1600/1 50 on 800/1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>METEERING</td>
<td>3000-1600</td>
<td>20</td>
<td>0.2S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>TRANS BACK UP/ LINE PRTN.</td>
<td>3000-1600-800/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/1600/800</td>
<td>15/8/4</td>
<td>13.3 on 3000/1 25 on 1600/1 50 on 800/1</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>TRANS DIFF/ LINE PRTN.</td>
<td>3000-1600-800/1</td>
<td>-</td>
<td>TPS*</td>
<td>3000/1600/800</td>
<td>15/8/4</td>
<td>13.3 on 3000/1 25 on 1600/1 50 on 800/1</td>
</tr>
</tbody>
</table>

**Note:**

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

2. Metering core shall be of accuracy class 0.2S as per IEC: 60044-1.
(c) REQUIREMENT FOR 132 K CTs For 2000-1200-800-400/1A (5Core)

<table>
<thead>
<tr>
<th>No. of Cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current Ratio</th>
<th>Output Burden</th>
<th>Accuracy class as per IEC-185</th>
<th>Min. Knee point voltage (Volts) ( V_k )</th>
<th>Max. CT.sec. winding resistance (ohms)</th>
<th>Max. Exciting current (mA)</th>
<th>Instrument security factor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>Metering</td>
<td>2000-1200-800-400/1A</td>
<td>20VA</td>
<td>0.2S @ ALL ratios</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>5 or less</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Main-I Protection</td>
<td>2000-1200-800-400/1A</td>
<td>N.A</td>
<td>PS</td>
<td>2000V @2000/1A</td>
<td>12 Ohms @ 2000/1A</td>
<td>30 mA @ 2000/1A</td>
<td>N.A</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Main-II Protection</td>
<td>2000-1200-800-400/1A</td>
<td>N.A</td>
<td>PS</td>
<td>2000V @2000/1A</td>
<td>12 Ohms @ 2000/1A</td>
<td>30 mA @ 2000/1A</td>
<td>N.A</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Bus Diff. Main</td>
<td>2000-1200/1A</td>
<td>N.A</td>
<td>PS</td>
<td>2000V @2000/1A</td>
<td>12 Ohms @ 2000/1A</td>
<td>30 mA @ 2000/1A</td>
<td>N.A</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Bus Diff. Check</td>
<td>2000-1200/1A</td>
<td>N.A</td>
<td>PS</td>
<td>2000V @2000/1A</td>
<td>12 Ohms @ 2000/1A</td>
<td>30 mA @ 2000/1A</td>
<td>N.A</td>
</tr>
</tbody>
</table>

NOTE: (i) The parameters like \( V_k \), RCT., I'm specified shall be proportional to ratios.

(ii) All the ratios shall be made available with secondary tapping only so that the same can be adopted simultaneously in different course.
### TABLE-IIA

**REQUIREMENT OF VOLTAGE TRANSFORMERS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>PARTICULARS</th>
<th>500 kV</th>
<th>230 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage</td>
<td>500/$\sqrt{3}$ kV</td>
<td>230/$\sqrt{3}$ kV</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td>Electromagnetic, or Single phase capacitor</td>
<td>Electromagnetic</td>
</tr>
<tr>
<td>3.</td>
<td>No. of</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage</td>
<td>1.2 continuous</td>
<td>1.2 continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5-30 seconds</td>
<td>1.5-30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error</td>
<td>±20 minutes</td>
<td>±20 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sec I</td>
<td>Sec II</td>
</tr>
<tr>
<td>6.</td>
<td>Rated voltage (V)</td>
<td>110/$\sqrt{3}$</td>
<td>110/$\sqrt{3}$</td>
</tr>
<tr>
<td>8.</td>
<td>Accuracy</td>
<td>3P</td>
<td>3P</td>
</tr>
<tr>
<td>9.</td>
<td>Output burden</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
**TABLE-IIA**  
**REQUIREMENT OF VOLTAGE TRANSFORMERS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>PARTICULARS SS</th>
<th>110 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rated primary voltage</td>
<td>110/√3 kV</td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td>Electromagnetic, or Single phase capacitor</td>
</tr>
<tr>
<td>3.</td>
<td>No. of</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Rated voltage</td>
<td>1.2 continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5-30 seconds</td>
</tr>
<tr>
<td>5.</td>
<td>Phase angle error</td>
<td>±20 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sec I</th>
<th>Sec II</th>
<th>Sec III</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Rated voltage (V)</td>
<td>110/√3</td>
<td>110/√3</td>
</tr>
<tr>
<td>7.</td>
<td>Application</td>
<td>Protection</td>
<td>Protection</td>
</tr>
<tr>
<td>8.</td>
<td>Accuracy</td>
<td>3P</td>
<td>3P</td>
</tr>
<tr>
<td>9.</td>
<td>Output burden</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
Technical Specification for Dew Point Meter

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

1. Measuring range : Upto -50 degree C Dew Point
2. Accuracy: $\pm 2$ degree C.
3. Display: $3^{1/2}$ digit LCD, 0.5 inch. High.
SECTION - IV
Outline Specification for Partial Discharge (PD) monitoring system for
Online Monitoring of PD in GIS

1. General

Partial Discharge monitoring system (PDM) will be supplied for UHF online monitoring of Partial Discharge (PD) in GIS.

The contractor shall be responsible for the design, supply, delivery, installation, site testing and commissioning of the complete PDM System. The contractor shall arrange for PDM manufacturer to be present throughout the commissioning of the PDM system and HV testing of HV equipment.

On the GIS, a partial discharge monitoring system (PDM System) will continuously collect partial discharge data using UHF technique from the monitored couplers (sensors). The partial discharge data shall be stored locally and transferred automatically to the end user control room (either local or remote) at intervals. The users must be able to access the data through web and client-server interfaces.

The System shall indicate to the operator control room at the local or remote (eg SMS, EMAIL) when the transferred data indicates partial discharge behaviour which requires his attention. On receiving such an indication, the operator will be able to retrieve and display partial discharge data from the coupler concerned to enable him to decide on action to be taken.

The partial discharge data shall be displayed in a way that allows the operator to recognise the type of defect present and indicate an increase in severity (trend analysis). It shall be necessary to be able to recognise signals from partial discharges, switching operations and external sources of interference.

Automatic classification of PD through expert system shall be provided. This shall include multiphase analysis.

PDM system shall have the provision for external noise antenna for assisting in removal of external interfering signals (radar, radio, telecommunications, etc..), which are not associated with partial discharges in the GIS. Such signals are to be filtered out or suppressed completely in the PD detection/measurement system.

Access to partial discharge data and System administration functions shall be protected by password.

2. Specification for Partial Discharge Monitoring System

The online PD monitoring must be equipped with following key features:
- Meet sensitivity according to **CIGRE TF15/33.03.05 1998** at every place in the GIS (5pC or better) will be verified as part of site sensitivity tests.
- Continuous real-time measurement and PD analysis & not just multiplexed data collection.
- The system shall have individual channel control.
- Support KEMA Certified, IEC61850 standard for communications within substations.
- Node data connection must support both Copper Ethernet and Multi Mode Fibre Optic.
- Node communication must be by Ethernet, scalable, industrial standard between data nodes central server.
- PDM System should be able accept sufficient number of sensor inputs as derived from the CIGRE TF15/33.03.05 1998 with a provision for at least 30% more additional sensors at a later date as the new bays are added on one PDM system.
- Each UHF node will support a minimum of 6 continuously active input UHF Channels and 1 UHF noise channel.
- Support Simple Network Time Protocol (SNTP) for time sync.
- Fixed broadband monitoring (bandwidth >=1 GHz)
- Historical Phase Refered Partial Discharge (PRPD) over 5, 10 or 15 minute recording period (which may be software/hardware selectable).
- Minimum noise detection and suppression facilities:
  - Smart Gating with external type noise antenna.
  - Smart Coincidence Filter.
  - Artificial Intelligence Software detection package.
- UHF Signal classification (5 types or better) for GIS by Multiple Hybrid Expert System and the analysis result shall be clearly indicated to the operator. The PDM System shall, combine Artificial Neural Networks (ANNs), Genetic Algorithms (GAs) and Fuzzy logic for easy interpretation.
- 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.
- PD Alarm Wizard for configuration of all PD alarms within substations.
- PDM system must support both Web and Client-Server Interfaces including Alarms, Reports and Configuration options.
- Automatic report generator, configurable by end user.
- Ability to call and display, within application software, 2 Dimensional GIS schematics showing spatial relationship between couplers in the GIS.
- Display 3 Dimensional GIS models (Optional) showing spatial relationship between couplers.
- Ability to select standard and high resolution sampling, 8 or 10 bits and 64 or 256 samples per 50 Hz power cycle.
- 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 designed to operate from substation auxiliary supplies. Failure / non availability of auxiliary supply to the PDM System shall be sensed and alarmed by the System.

All UHF channels shall be monitored continuously and simultaneously to ensure no PD pulses are missed.

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 a PC at a headquarters/central location with remote application software which can automatically support remote accessing for up to 50 substations.

The PDM Supplier will have a proven history of operation at a minimum of ten (10) independent substations, each for a minimum of five (5) years. In the tender proposal the tenderer shall provide following information history and be prepared to support those claims with reference from the respective:
- Complete List of same PDM system type installations indicating for each installation:
  - Year of installation
  - Country and End-user
  - GIS Voltage level
  - Quantity of installed couplers
- Total number of monitored bay years
- End-user Reference letters

The PD couplers shall be of passive, maintenance free antenna type.

The PD couplers shall meet the following minimum specifications:
- Approved for in-service, permanent, continuous monitoring use.
- Detection spectra range: 250 MHz to 1.5 GHz.
- Average sensitivity of >6mm from 500MHz to 1500MHz.
- The coupler and GIS shall be adequately shielded to ensure that its operation and performance shall not be influenced by external interference.

Pre-amplifier installed as part of the coupler is not acceptable. UHF amplification or conditioning is only allowed at electronic node unit.

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.

The System shall have a signal sensitivity of -75dBm.

History data shall be recorded every 5, 10 or 15 minutes (software / hardware selectable). 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
- Microsoft ODBC (Open Database Connectivity) specification compliant
- ANSI 92 SQL (Structured Query Language) compliant
- Allow remote database access for LabVIEW application
- Examples of ODBC compliant RDBMS that provide remote access are Microsoft SQL Server, Oracle and IBM DB2.

- Both the local substation and central control room / headquarters shall allow the data from no less than six coupling devices to be displayed simultaneously, such that data from different couplers at different times may be displayed.

- Data shall be displayed in the following formats:
  - 3 dimensional oblique, snapshot and real time
  - 2 dimensional point on wave; both amplitude and discharge rate
  - Phase Refered Partial Discharge (PRPD) online and historical
  - Short term trents (STT)
  - 24 hour summary

- Both the local substation and central control room / headquarters shall be designed to operate in multiple languages and as such, shall be fully UNICODE compatible.

- The Headquarters shall include a data synchronization function that shall allow any missing data to be downloaded from any substation for a period of up to one year.

- System shall record switching transient generated by CBs and disconnectors. (Optional analysis of switching patterns)

- The System shall be type tested by independent accredited test house to following IEC standards for EMC & Environmental for use within EHV substations.

  ES BN 55022 (CISPR22) Conducted emissions
  IEC 60068-2-1  Low temperature
  IEC 60068-2-2  Dry heat
  IEC 60068-2-6  Vibration
  IEC 60068-2-27 Shock
  IEC 60068-2-56 Damp heat
  IEC 60255-5  Dielectric withstand
  IEC 61000-4-2 Electrostatic discharge
  IEC 61000-4-3 Radiated immunity
  IEC 61000-4-4 Fast transient
  IEC 61000-4-5 Surge
  IEC 61000-4-6 Conducted immunity
  IEC 61000-4-8 Power frequency magnetic field
  IEC 61000-4-9 Pulsed magnetic field
  IEC 61000-4-10 Damped oscillatory magnetic field
  IEC 61000-4-12 Damped oscillatory wave
TECHNICAL SPECIFICATIONS FOR SF6 GAS LEAKAGE DETECTOR.

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