

October 2006

## **TECHNICAL DESCRIPTION TD-85/1**

### **420 KV SF<sub>6</sub> GAS INSULATED METAL-ENCLOSED SWITCHGEAR (GIS)**

#### **1. Scope of Supply**

This technical description concerns the technical characteristics, design features and testing of 420 kV SF<sub>6</sub> Gas Insulated Switchgear (GIS) for installation indoors at PPC's 400/150/30 KV ehv substations control buildings. The installation of the switchgear shall be carried out in accordance with the IEC62271-203.

#### **2. Keywords**

Gas Insulated Switchgear (GIS), sulphur hexafluoride (SF<sub>6</sub>), Overhead Line (O.H.L.) bay, Cable feeder bay, Autotransformer (AT/F) bay, Bus Coupler bay, Unit Feeder bay, Bus Section bay, VTs and High Speed Earthing Switches bay.

#### **3. Operating Conditions**

The switchgear of this Technical Description is suitable for installation indoors with the following conditions:

- Ambient temperature indoors : -5 °C ÷ 40 °C
- Altitude : ≤ 1000 m
- Seismicity : As specified by the Purchaser (see para. 6)
- Relative humidity range : ≤ 95%
- Induced electromagnetic disturbances in secondary systems : 1,6KV

#### 4. **Equipment Electrical Rated Data**

All 420 kV Gas Insulated Switchgear equipment shall have the following rating characteristics :

Equipment Electrical Rated characteristics	
Rated voltage	400 kV
Maximum operating voltage	420kV
Minimum operating voltage	380kV
Rated frequency	50
Rated power frequency withstand voltage (1 min-50Hz) <ul style="list-style-type: none"> <li>- Phase to earth and between phases</li> <li>- Across open switching device and/or isolating distance</li> </ul>	650kV rms 815KV rms
Rated lightning impulse (1,2/50 $\mu$ s) Withstand voltage <ul style="list-style-type: none"> <li>- Phase to earth and between phases</li> <li>- Across open switching device and/or isolating distance</li> </ul>	1425KV peak 1425(+240)KV peak
Rated switching impulse withstand voltage <ul style="list-style-type: none"> <li>- Phase-to-earth and across open switching device:</li> <li>- Between phases :</li> <li>- Across isolating distance:</li> </ul>	1050KV,peak 1575KV, peak 900(+345)KV, peak
Permissible partial discharge intensity for cast resin at $1.2 \times U_R$ KV/ $\sqrt{3}$	<5pC
Rated normal current for busbars	3150 A
Rated normal current for feeders	3150 A
Rated normal current for bus coupler	3150 A
Rated short-time current,	40 kA
Rated peak withstand current	100KV peak
Rated duration of the short circuit	3 sec
Loss of gas (per year and compartment)	<1%
Auxiliary sources of supply D.C. A.C.	110 V 230/400, 50 Hz
Method of earthing of the 400KV system	Solidly earthed

## 5. **Standards**

IEC62271-203	:Gas insulated metal-enclosed switchgear for rated voltages above 52KV
IEC60694	:Common specifications for high-voltage switchgear and controlgear standards.
IEC60376	:Specification and acceptance of new sulphur hexafluoride.
IEC60480	:Guide to the checking of sulphur hexafluoride (SF <sub>6</sub> ) taken from electrical Equipment.
IEC62271-100	:High voltage alternating-current circuit-breakers.
IEC62271-101	:Synthetic testing of high-voltage alternating current circuit-breakers.
IEC62271-200	:High voltage alternating current disconnectors and earthing switches.
IEC60044-1	:Current transformers.
IEC60044-2	:Voltage transformers.
IEC60137	:Insulated bushings for alternating voltages above 1000V.
IEC60099-4	:Non-linear resistor type arresters for AC systems
IEC62271-305	:Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52KV.
IEC62271-306	:Direct connection between power transformers and gas-insulated metal-enclosed switchgear for rated voltages above 52KV.

## 6. **General Requirements for Gas Insulated Switchgear**

The design of the metalclad switchgear shall comply with IEC Publications 62271-203, 62271-100 and 60694.

Any components or assemblies that may require replacement during the normal life of the switchgear shall be of a common design for all circuits to permit these to be interchangeable and to reduce spare holdings. This requirement is particularly important for circuit breaker, disconnector and earth switch operating mechanisms.

The double busbar switchgear shall be designed such that it is possible to remove, repair or add any circuit bay whilst maintaining one busbar in service at all times.

The GIS switchgear shall be accompanied by supporting structures. Bidders should submit drawings of the suitable supporting structures subject to Purchaser approval.

The GIS switchgear shall be designed to withstand the seismic requirements of IEE 61166 with qualification level of AF5 (0,5g Horizontally). For vertical severity

the direction factor (D) shall be 0,5 (as per IEC60068-3-3). The qualification level shall be proved either by test certificates of a bay identical to the ones required by this hereby technical description or by combined test and mathematical analysis for the O.H.L bay of this hereby technical description.

The test certificates or the mathematical analysis must be submitted along with the technical offer. If neither is submitted, the eventual supplier shall carry out the test without any cost for PPC S.A.

### **6.1. Bushings**

All the bushings for connections of GIS with 420KV overhead lines (SF<sub>6</sub>-to-air bushings), 420kV cables (SF<sub>6</sub>-to-cable bushings) shall generally be in accordance with IEC 60137, IEC 62271-305 and IEC-62271-306 where applicable.

All air bushing whether they are intended for O.H.L or cable shall either be of porcelain of grey color or from silicon rubber.

Creepage distance shall be 10500mm.

### **6.2. Enclosures and Conductor Expansion**

Busbar and conductor connections and enclosures shall be designed to absorb the effects of thermal expansion and contraction and the agreed permissible movement of the foundations without impairing the guaranteed performance of the equipment.

Expansion joints of flexible connections shall be provided in the enclosures at suitable locations to directly absorb any differential movements and to ensure the installation will not be subjected to stresses leading to premature failures. In addition adjustable mountings shall be provided to accommodate reasonable tolerances with associated civil works and other plant to which the switchgear may be connected. Tolerances that can be accommodated shall be stated in the Technical Data Sheets.

Equipment foundation, floor and structure fixing to suit the switchgear design concept utilized by the manufacturer whereby movement can be absorbed within the switchgear expansion joints or is transmitted through the enclosure and sliding supports to flexible connections, shall be provided.

A flexible conductor and enclosure connection shall be provided at the coupling point and shall be capable of withstanding these conditions for the life of the equipment.

### **6.3. Gas Compartments**

The switchgear shall be divided into separate gas compartments by the use of gas tight barriers.

Gas section volumes shall be as large as possible to minimise the effects of any internal overpressure and shall be consistent with the need to allow changes in the switching arrangements for maintenance, repair or extension whilst ensuring the remaining parts can remain energised.

Each gas compartment shall be provided with facilities for routine checking of gas moisture content and purity. Gas compartments shall be fitted with permanent connection points and valves for filling, emptying and gas treatment equipment without moving the switchgear.

All such valves shall have facilities for attaching two lead seals, one of which will be attached by the Owner and the other by the Contractor. This is to ensure that the gas system may only be opened in the presence of both parties. The seals will be fixed initially upon commissioning of the switchgear.

Busbar enclosures shall be segregated into gas tight compartments of such volumes so as to ensure the amount of time necessary for discharging the SF<sub>6</sub> and its subsequent vacuum treatment and refilling does not exceed the time stated in the Technical Data Sheets.

Where compartments are interconnected through external gas pipes, these pipes shall be provided with vacuum couplings to prevent the escape of gas during testing or maintenance.

Each gas compartment shall include the following.

- A pressure relief device to guard against excessive overpressure.
- An absorber to take up residual moisture.
- A density switch functioning as a temperature compensated - pressure monitor with a two level alarm.

### **6.4. Gas Filters**

Each gas compartment shall be fitted with gas filters, driers or desiccants for the absorption of moisture and the gaseous products of switching. It shall be possible to replace the active materials of the filter without extensive dismantling and preferably without taking disconnectors or circuit-breakers out of service.

## **6.5. Gas Barrier and Supporting Insulators**

All internal support insulators and gas barriers shall be of a high quality material designed to minimise internal and surface electrical stresses. The materials shall be free of voids and partial discharges at the maximum working voltages.

Gas barriers shall be gas tight and of sufficient strength to withstand short circuit forces and the maximum pressure differential that can occur under internal fault conditions.

## **6.6. Gas Seals**

All static and moving gas seals shall be designed to prevent gas leakages and moisture ingress under all normal conditions of service. The materials used for gas seals shall withstand exposure to SF<sub>6</sub> gas and its decomposition products without deterioration for the service life of the equipment.

Measures shall be incorporated to eliminate any deterioration of gas sealing surface finishes and fixings due to the influence of climatic conditions.

Seals between different insulating media, sliding or rotating surfaces and those exposed to the risk of deterioration due to their use outdoors shall preferably include multiple seals. Details of the materials used and methods of sealing shall be stated in the Technical Data Sheets.

## **6.7. SF<sub>6</sub> Gas Requirements**

All SF<sub>6</sub> gas supplied for use in the switchgear shall comply with the detailed requirements of IEC 62271-303 and IEC 60480 which are the minimum standards acceptable.

The gas system of the switchgear shall utilise low pressures to minimise leakages and eliminate any possibility of liquefaction at the lowest ambient temperatures. The equipment shall be designed such that no heating elements will be required for satisfactory operation within the range of ambient temperatures and pressures encountered under service conditions.

The minimum dew point temperatures in unheated SF<sub>6</sub> gas filled equipment shall not exceed -20°C at the working pressure.

## **6.8. Gas Monitors**

Temperature compensated gas density or pressure monitors shall be provided for each gas section.

The gas monitors shall be fitted with electrical contacts for alarm and automatic tripping purposes. These shall be set in two stages. The first stage shall operate an alarm to warn that the gas pressure/density is falling to a critical level. The

second stage shall initiate automatic isolation of the gas section concerned by tripping associated circuit-breakers and disconnectors as appropriate. Tripping shall be wired into the main protection circuits and shall only be initiated when both alarm and trip conditions exist.

Voltage free electrical contacts shall be provided for every alarm for remote and repeat alarm facilities in addition to alarm facias incorporated in the local control panel/marshalling kiosk associated with each primary circuit.

The philosophy of the automatic shut down sequence shall be agreed with the Purchaser during initial contract discussions.

A lockout feature with contacts for remote indication shall be provided for circuit-breakers whenever the SF<sub>6</sub> gas pressure is less than that permitted by the design for satisfactory operation.

## **6.9. Enclosures**

The enclosures for the SF<sub>6</sub> gas insulated switchgear shall be either of aluminium alloy, painted only in the outside or from welded steel painted inside and outside. and shall be designed to minimise losses and heating due to circulating currents.

Dimensioning of enclosure wall thickness and type of material shall be such as to safely withstand over-pressures caused by internal faults corresponding to maximum fault levels for a minimum time of 500 milliseconds then the arcing shall be contained for the longer time necessary for protection operation.

Bursting discs or equivalent shall be provided where necessary to protect the main enclosure from uncontrolled discharge of arced gases due to burn through of the enclosure or mechanical failure.

Bursting discs shall be directed away from personnel operating zones by suitable vents also designed to prevent accidental damage to discs.

Evidence shall be provided to verify that enclosures have been designed and tested in accordance with established pressure vessel codes without encroaching on internationally agreed safety factors for this type of equipment.

Each enclosure shall include facility for easy access to the circuit breaker, disconnector and earth switch contacts for inspection and repair and removal.

Each enclosure shall be provided with lifting points to facilitate maintenance or repair work.

The enclosures shall be connected to earth (effectively earthed). All metal parts which do not belong to a main or an auxiliary circuit shall be earthed.

## **6.10. Position Indicators**

Position indicators shall be provided for all circuit-breakers, disconnectors and earthing switches to show whether the main contacts of these switches are in the fully open or closed positions.

Indicators shall be of a reliable mechanical design and be positively driven in both directions by the final drive stage of the contact operating mechanism. Each indicator shall be clearly visible to operating staff at operating control points and access routes provided under this contract.

Inspection windows capable of withstanding internal faults and external damages may be considered as an alternative for visual checking of the contact positions of all three phases of each particular item.

## **6.11. Pressure relief devices**

Pressure relief devices shall be arranged so as to minimize the danger to an operator during the time that work is performed in the gas-insulated substation if gases or vapours are escaping under pressure.

## **6.12. Interconnecting componets**

The various componets of the GIS shall be assembled together by means of standardized bolted flanges.

Telescopic coupling elements (in busbars for example) shall be used to connect adjacent switchgear sections. Expansion elements with metal bellows shall be used where necessary to compensate for thermal expansion or contraction cycles.

## **7. Bay equipment**

### **7.1. Overhead line (O.H.L.) bay**

#### **7.1.1. Circuit Breakers**

##### **7.1.1.1.General**

1. Circuit breakers shall be of the puffer type or auto puffer type or self compression type (self blust) with operating mechanism of either spring type or hydraulic or type.

Unless otherwise specified herein, all material, equipment, fabrication and testing of the subject circuit breakers shall conform to the latest revision of IEC 62271-100 standard.



2. Each circuit breaker shall be capable of making and breaking short circuit faults in accordance with the quantities, factors and service operation, requirements specified and in addition to fulfill all the requirements specified hereafter in this specification under par. 6.1.1.3. "*Specific Requirements for Circuit Brakers*".
3. All equipment entering into the breakers shall be new, of first grade quality, as to material, workmanship and design. Material and apparatus furnished under this Specification shall be subject to inspection by Purchaser. Purchaser's Inspectors shall, during working hours, have access to all parts of shops where material is being manufactured and shall be provided by Seller with reasonable inspection facilities. Purchaser's representative may at any time inspect any or all test data. Release of material shall not relieve Seller from responsibility for furnishing material to conform to all requirements of Purchaser's order nor invalidate any claim which Purchaser may make because of defective or unsatisfactory material.
4. The circuit breaker shall not be strained when making or breaking the rated short circuit currents. Under these conditions there shall be no leakage of SF6.
5. Auxiliary arcing contacts shall be provided to protect the main contact during the operation of the circuit breakers. All contacts shall be readily and quickly replaceable.
6. All seals shall be sufficiently tight to hold pressures incident to temperature changes resulting from normal operation and changes in ambient temperatures without leakage or breathing of moisture.
7. The circuit-breakers operating mechanism shall be of the, spring operated or hydraulic type.  
The circuit breakers and operation mechanism shall be suitable for high speed three-pole and single-pole auto-reclosing (one shot).

Operating mechanism shall be of the mechanically and electrically trip-free type.

Electrical tripping devices shall operate between limits of 30 per cent below and 10 per cent above normal operating voltage with the coils at a temperature of 45°C.

The circuit-breaker operating mechanism shall be so designed that the circuit-breaker is free open immediately when the trip coil is energized.

The circuit-breaker shall consist of 3 separate single-phase units with three(3) operating mechanisms, they shall be so coupled that accurate alignment of the units is not necessary and so that any unit can readily be replaced by a spare unit. It shall be possible to make independent adjustments on each unit.

Means shall be provided for the manual operation of all circuit breakers for maintenance purpose.

8. An approved design of handling equipment shall be provided for each type of circuit-breaker.
9. Padlocks or other approved means shall be provided to lock the circuit breaker local manual operating handle in the "neutral" position.
10. In addition to the accessories specified hereabove, each circuit breaker shall be equipped with a central control cabinet which shall contain the following:
  - Weatherproof housing for the operating mechanism fixed on the base frame of the breaker (class of IP 44 as per IEC 60529) .
  - Space heater element or elements automatically controlled by thermostat, inside the weatherproof housing of the operating mechanism.
  - Operation counter.
  - Wiring diagram mounted inside the main door of the mechanism housing.
  - Position indicator to show clearly from the vicinity of the mechanism the open and closed positions of the circuit-breaker.
  - Copper grounding pads.
  - Name plate of non-corrosive material giving Manufacturer's name and address and apparatus type, year of manufacture, serial number and main characteristics of the breaker's operating mechanism.
  - Manual-local-remote control switch with as many stages as needed for the control circuits of the breaker. In the "manual" position ,the CB shall be operated by a hand crank. The "local" position and in conjunction with two (2) push-buttons or a control switch, will be used to control the CB from the operating mechanism's housing ,for maintenance purpose only. When the CB is under local control, the CB bay will be out of service. The "remote" position will be used to control the CB from a remote place and for tripping purposes. Furthermore, the "manual-local-remote" switch shall be equipped with an additional number of stages beyond those need for the control circuits which shall be used to be inserted to both positive (+) and negative (-) 110V DC buses of the control circuits.
  - Two push-buttons for local closing and opening of breaker.
  - Auxiliary contacts readily changeable to normally open or normally closed as follows :
    - 10 free N.O. contacts (at least)
    - 10 free N.C. contacts (at least)
11. Each pole of the circuit breaker shall be equipped with an operating mechanism cabinet; which among other things, it shall contain:
  - an SF6 density monitor

### **7.1.1.2. Operating Duty and Performance**

- (i) The requirements of IEC62271-100 in respect of service, operation and the making and breaking of fault currents shall apply to the specified circuit breakers.
- (iii) Rated of Rise of Restriking Voltage: Attention is drawn to the requirements of Schedule of Tests wherein the minimum inherent rates of rise of restriking voltage of test plant arrangements are stated. Where not specifically stated in the test certificates submitted with the Tender, the Tenderer shall certify that the R.R.R.V. to which the circuit breaker was subjected during the short circuit tests was not less than the inherent values of the test plant stated in the Schedule of Tests for the first phase to clear factor of 1.3. Any device incorporated in a circuit breaker to limit or control the rate of restriking voltage across the circuit breaker contacts shall likewise be to the Engineer's approval and full descriptions of any such device shall be given.
- (iv) Reclosure Duty: Circuit breakers controlling transmission lines shall be suitable for high speed auto reclosure. Circuit breakers must be capable of coping with the interrupting duties produced by out of synchronism conditions associated with auto reclosure.
- (v) Interrupting Duty: Circuit breakers must be capable of coping with the interrupting duties produced by the switching of transformer magnetizing currents, line charging currents, cable charging currents, capacitor banks, short-line faults and out-of-phase switching duties.
- (vi) Fault Clearance Time: The overall fault clearance time including relay operating time shall not exceed 80 ms.

### **7.1.1.3. Specific Requirements for Circuit Breakers**

1. The circuit breakers shall have two interrupting chamber per phase. All units shall be suitable for high speed three-pole and single-pole auto-reclosing (one shot).
2. Rated voltage (according to IEC) : 420 kV
3. Lightning impulse withstand voltage, (1,2/50 $\mu$ s)
  - between phase and ground and between phases: 1425kV crest
  - across breaker's open contacts : 1425 (+240)
4. Rated frequency : 50 Hz
5. Switching impulse withstand voltage
  - phase to earth and across open contacts : 1050KV, peak
  - between phases : 1575KV, peak

6. Power frequency withstand  
Voltage, 50Hz, for 1 minute, phase to earth  
and between phases : 650KV rms  
-across breaker's open contacts : 815KV rms
7. Rated normal current : 3150 A
8. Rated short-circuit breaking current  
(at 420 kV)  
-r.m.s. value of A.C. component, : 40kA rms.  
-percentage of D.C. component : in accordance with  
IEC62271-100
9. Rated transient recovery characteristics for terminal faults corresponding  
to 100% rated short-circuit breaking current :  
- First-pole-to-clear factor (phase factor): 1.3  
- Rated transient recovery voltage : 624KV peak  
- Rate of rise of recovery voltage : 2KV
10. Rated short-circuit making current,  
in KA. It will be equal to 2.5  
times the rms. value of the A.C.  
component of the rated short circuit  
breaking current, i.e. : 100kA peak
11. Rated short circuit duration : 3 sec
12. Rated operation cycle, : O-0.3sec-CO-3min-CO
13. First pole to clear factor : 1,3
14. Interruption of transformer magnetizing current  
The circuit breaker shall be able to interrupt transformer magnetizing current  
of autotransformers of 400/150/30KV, 280MVA.
15. Interruption of unloaded lines  
The breaker shall be able to interrupt overhead line charging currents of  
400A, without restrike .
16. Interruption of unloaded underground cables  
The breaker shall be able to interrupt capacitive cable charging currents of  
400A without restrike .
17. Rated transient recovery characteristics for short-line faults  
-Rated transient recovery voltage : 480KV peak  
-First pole to clear factor : 1  
-RRRV : 2KV/ $\mu$ s

18. Mechanical endurance class: M1 (2000 operations)
19. Interrupting time  
The maximum interval between energization of the tripping coil and interruption of the main circuit in all poles of the breaker must not be greater than 50ms, at 100% of the rated breaking capacity, and 70 ms at 10%, 30%, 60% of the rated breaking capacity.
20. Operating time diversion  
The operating time diversion between breaker poles and between breaks of each pole, on closing or tripping shall not exceed 5msec (shorter times will be preferred).
21. Number of tripping coils : two(2)
22. Number of closing coils : One(1)
23. Supply voltage of tripping and closing coils : 110V dc
24. Tolerances of the supply voltage of the tripping coils :-30%,+10%
25. Tolerances of the supply voltage of the closing coil :-15%,+10%
26. Rated short-time withstand current :40KA,rms
27. Rated peak withstand current :100KA,peak

#### **7.1.1.4.General Arrangement and pressure withstand**

Evidence shall be provided that enclosures subject to pressures in excess of normal atmospheric pressures can have withstand these pressures, without leakage, permanent distortion or any temporary distortion such as might cause malfunction of the circuit- breaker.

Means shall be provided to allow access for the inspection and maintenance of fixed and moving contacts and other enclosed components.

#### **7.1.1.5.CB' s operating mechanism additional requirements**

Circuit-breaker mechanisms shall be "trip free" as defined in IEC Publication 60050 (441).

Each part of the operating mechanisms shall be of substantial construction, utilising such materials as stainless steel, brass or gunmetal where necessary to prevent sticking due to rust or corrosion. The overall designs shall be such as to reduce mechanical shock due to fault current stresses, vibration or other causes.

An approved mechanically operated indication shall be provided on each circuit-breaker operating mechanism to show whether the circuit-breaker is open or closed.

Since the circuit breaker is comprised of three independent units it shall be possible to make independent adjustments to each unit and or to the three units so that make and break the circuits simultaneously, if it is so required. In the event of any phase failing to complete a closing operation, provision shall be made for automatic tripping of all three phases of the circuit- breaker(pole discrepancy).

Anti-pumping relays shall be provided to prevent reclosing if the closing coil remains energised and the circuit- breaker fails to latch in the closed position or is tripped during closing.

Approved means for manual operation of the circuit breaker shall be provided.

#### 7.1.2. **Busbars**

Double busbars shall be extensible bothsides. The three phases of each busbar shall be placed in common or in separate compartments filled with SF<sub>6</sub>. Each busbar shall be earthed through maintenance earthing switch. The bus bar current rating shall be 3150A.

#### 7.1.3 **Disconnectors**

Disconnectors shall comply with the requirements of IEC62271-101 and IEC62271-203.

Disconnecting switches shall be designed for live operations and will not be required to switch current other than bus charging currents .

1.The lightning impulse withstand voltage shall be :

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- Phase to earth and between phases : 1425KV peak
- Across the isolating distance : 1425 (+240)

2.The switching impulse withstand voltage

- Phase to earth :1050 KV peak
- Between phases :1575 KV peak
- Across isolating distance :900(+345) KV,peak

3.The power frequency withstand voltage shall be

- phase to earth and between phases : 650KV rms
- Across the isolating distance : 815KV rms

4.The rated current shall be : 3150A

5.The rated short-time withstand current shall be : 40KA

6.The rated peak withstand current shall be : 100KA peak

- 7.The rated duration of short circuit shall be : 3 sec  
8.The mechanical endurance class shall be :M1 (2000operations)  
9.The operating mechanism of the disconnectors must be equipped with a selector (control) switch of three (3) positions. In position No.1 only manual operation shall be allowed via hand crank. In position No. 2 only local electrical operation shall be allowed. The local electrical operation shall be achieved via local push-buttons or control switch for opening and closing. In position No. 3 only remote electrical operation shall be allowed.

Lockings in both open and close positions shall be provided for the manual hand crank, with mechanical couplings to ensure all three phases open and close simultaneously. Means for emergency manual operation shall be provided.

Disconnectors of a metalclad and approved type design shall be arranged to permit safe maintenance of any section of the equipment when the remainder is alive.

The position of the disconnector contacts is to be indicated by a reliable indicating device.

The lightning and power frequency withstand voltages shall apply at the minimum operating density of the insulating medium.

The disconnectors shall be equipped with auxiliary contacts as follows:

- 7 voltage free N.O. contacts (at least)
- 7 voltage free N.C. contacts (at least)

#### 7.1.4. **Busbar Disconnectors**

For on load changeover of busbars in duplicate busbar stations the disconnectors shall be interlocked so that it is not possible to parallel or disconnect two sections of busbars by means of the busbar disconnectors unless a paralleled bus-coupler circuit is already closed.

In all other circumstances busbar disconnectors shall be interlocked so that their respective circuit-breakers can only be connected to one set of busbars at a time.

The busbar disconnectors shall be equipped with auxiliary contacts as follows:

- 7 voltage free N.O. contacts (at least)
- 7 voltage free N.C. contacts (at least)

#### 7.1.5. **Earthing Switches of low speed (maintenance earthing switches)**

Earthing switches without making capacity, integral with disconnectors or separately mounted shall function in such a manner as to provide an earthed zone, permitting access for maintenance to circuit breakers, busbars, and all parts of the main circuits. Earthing switches shall be electrically operated. They

will be used in conjunction with the circuit breaker, one at each side of the breaker.

The earthing switch, when in the closed position, shall be capable of carrying the rated short time current (40KA) for three seconds without the contacts to be burned or to be melted.

Facilities integral with the earthing switch for primary current injection or low voltage checks shall be insulated from earth and incorporate a disconnectable earth strap.

The position of the earthing switch is to be indicated by a reliable indicating device.

The maintenance earthing switches shall be equipped with auxiliary contacts as follows:

- 7 voltage free N.O. contacts (at least)
- 7 voltage free N.C. contacts (at least)

#### 7.1.6. **High Speed Earthing Switches**

High speed earthing switches shall be capable of sustaining for three seconds the rated short circuit current (40KA) of the switchgear. They shall be used in conjunction with bus coupler (tie) disconnectors and the disconnectors of the line or cable feeder. They shall also be used in conjunction with the O.H Line disconnector . Power operated mechanisms shall be self locking in both open and closed position.

High speed earthing switches shall be capable of interrupting induced currents as may be necessary when used for grounding one out of two or more parallel circuits.

Facilities integral with the earthing switch for primary current injection or low voltage checks shall be insulated from earth and incorporate a disconnectable earth strap.

The position of the earthing switch is to be indicated by a reliable indicating device.

The high speed earthing switches shall be electrically operated.

The high Speed earthing switches shall be equipped with auxiliary contacts as follows:

- 7 voltage free N.O. contacts (at least)
- 7 voltage free N.C. contacts (at least)



#### 7.1.7. **Earthing Switch Operating Mechanisms.**

High speed and normal speed earthing switch operating mechanisms shall be of robust construction, carefully fitted to ensure free action and shall be unaffected by the climatic conditions at site. Mechanisms shall be as simple as possible and comprise a minimum of bearing and wearing parts.

The motor operated mechanism shall be equipped with selector control switch which shall allow the following three (3) modes of operation:

Position 1 : Manual operation only via a hand crank

Position 2 : Local operation-Local electrical control

Position 3 : Tele operation. Electrical operation from a remote place

All power driven earth switches shall be fitted with capability for hand operation in case of emergency (Manual operation).

#### 7.1.8. **SF<sub>6</sub> -to-air bushings**

Outdoor bushings for connections to external conductors shall be provided where needed. Bushings shall be in accordance with IEC 60137 where applicable.

Creepage distances for the insulators of outdoor bushings fitted to the SF<sub>6</sub> switchgear and for insulators for other external equipment shall be at least 4250mm.

Outdoor bushings must be capable of withstanding cantilever pull due to the external connection. Factors of safety of 2.5 minimum shall be applied.

#### 7.1.9. **Current Transformers**

Current transformers shall be included in the SF<sub>6</sub> switchgear for the various circuits and shall comply with IEC60044-1.

Current transformers (CTs) for TL bay shall be single phase with one (1) primary winding with two (2) sections and with two (2) secondary windings, each with its own magnetic core. The ratio of the CTs and the power output and accuracy class of the secondary windings shall be as follows:

Ratio : 800-1600/1-1A installed before the breaker.

winding 1 for distance protection, No1 30VA , 5P20

winding 2 for distance protection No2 30VA, class 5P20

Ratio: 800-1600/1-1A installed after the breaker

winding 1 for bus-bar differential protection, 30VA, 5P20

winding 2 for metering, 30VA, accuracy class 0.5, FS ≤ 5

Where separate terminal boxes are used for current transformer secondary wiring, the identifying labels shall be fitted to the terminal boxes in a conspicuous position but not on removable covers.

Current transformers shall have a short time thermal primary current rating not less than that of the associated switchgear (40KA). The dynamic current rating shall be 2,5X the rated short time thermal current. Secondary windings of each current transformer shall be earthed at one point only through a link and wired through the terminal blocks.

Magnetisation and core loss curves shall be provided for each type and rating of current transformer.

The power frequency voltage withstand of the secondary windings shall be:  
3KV rms

All secondary winding connections shall be brought out and connected by means of separately insulated leads to a terminal board mounted in an accessible position.

Current transformers for indication or metering shall have their secondary winding earthed at the switchgear.

Secondary windings which are not loaded must be short circuited before the transformer is energized.

The rated continuous thermal current of the current transformers shall be 1,2X rated current.

The terminal designation of the primary and secondary windings shall be in accordance with IEC60044-1.

#### 7.1.10. **Voltage Transformers**

Voltage transformers (VTs) shall comply with IEC60044-2 and shall be included in the SF<sub>6</sub> switchgear .

VTs shall be single phase of the inductive type, with the following :

Ratio : 400000 :  $\sqrt{3}/100$  :  $\sqrt{3}-100$  :  $\sqrt{3}-100$  :  $\sqrt{3}$  V

winding 1 - For metering purposes

- Rated power output : 25VA
- Accuracy class : 0,5
- Percentage voltage error :  $\pm 0,5$
- Phase displacement :  $\pm 20$  minutes

winding 2 - For protection purposes

- 
- Rated power output : 10VA
- Accuracy class : 3P
- Percentage voltage error:  $\pm 3,0$
- Phase displacement :  $\pm 120$  minutes

winding 3 - For metering purposes

- Rated power output : 25VA
- Accuracy class : 0,5
- Percentage voltage error :  $\pm 0,5$
- Phase displacement :  $\pm 20$  minutes

Voltage transformer secondary windings shall be earthed at the switchgear through a link, which can be removed for insulation testing.

The rated voltage factors of the VTs shall be : 1,2 continuous  
1,5 for 30sec

The power frequency withstand voltage of secondary windings shall be: 3KV rms

A label shall be provided at the secondary terminal boards (boxes) clearly indicating the connection required for each winding and/or ratio.

All secondary terminals shall be suitable to be wired with 4mm<sup>2</sup> size conductors furthermore, all secondary phase leads shall be protected by appropriate explosion type fuses and the neutral leads by links.

#### 7.1.11. **Surge arresters**

If GIS surge arresters are requested to be installed in the GIS, these arresters shall have the following characteristics.

The surge arresters shall be in accordance with IEC 60094-4, second edition:

- a. Continuous Operating voltage,  $U_c: 267 \leq U_c \leq 272 \text{KVrms}$
- b. Rated voltage as defined in IEC60094-4,  $U_r: 342 \text{KVrms}$
- c. Nominal discharge current (8/20 $\mu\text{s}$ ) : 20KA, peak
- d. High current impulse withstand : 100KA, peak
- e. Short circuit withstand capability : 40 KA rms
- f. Energy capability
  - Line discharge class : 4
  - Energy withstand :  $\geq 8 \text{KJ/KV}(U_r)$
- g. Maximum residual voltages at switching impulse (30/60 $\mu\text{s}$ )
  - at 1KA(protective level) :  $\leq 700 \text{KV, peak}$
  - at 2KA :  $\leq 715 \text{KV, peak}$

- h. Maximum residual voltages of lighting impulse (8/20 $\mu$ s)
- at 10KA (protective level) : $\leq$ 825KV,peak
  - at 20KA : $\leq$ 890KV,peak

The surge arresters shall be equipped with a surge counter and a leakage current meter.

#### 7.1.12. **Interlocking Facilities**

Disconnecting devices, earthing switches, circuit breakers etc., shall be provided with an interlocking system, which ensures safe operation of the equipment under all service conditions.

Where mechanical interlocks are employed, they shall be effective at the point where handpower is applied so that stresses cannot be transferred to parts remote from that point.

Auxiliary control switches used in the electrical interlocking schemes shall be arranged to ensure that the associated switching device is either in the fully open or fully closed position ( as appropriate ) before the interlocking circuit is completed.

Circuit breakers shall be interlocked so that, except under maintenance conditions, it is not possible to close a circuit breaker unless its associated disconnector or disconnectors is/are closed.

Disconnecting switches shall be so interlocked that they cannot be operated unless the associated circuit-breaker is open except where on load transfer of feeder circuits from one busbar to another where in this case the bus-tie disconnectors can be closed providing the bus-tie breaker is closed and the disconnector of the other bus-bar is also closed.

Earthing switches shall be interlocked such that they cannot be operated unless their associated disconnecting switches are open.

#### 7.1.13. **Padlocks**

Padlocks shall be provided on each item of substation equipment as detailed below and shall be additional to any mechanical interlocking devices specified in Chapter 6.1.12.

The following padlocks shall be provided:

- (A) On the circuit breaker's and disconnector's manual hand crank
- (B) On operating mechanism cubicle access doors.
- (C) On air or gas system isolating valves in open or closed positions.

Locks shall be designed, constructed and located on the equipment so that they will remain serviceable in the climatic conditions specified without operation or maintenance.

#### 7.1.14. **Operating mechanisms Cubicles**

Circuit breakers, disconnectors and earthing switches operating mechanisms, which contain auxiliary control switches and associated relays, control cable terminal blocks, and other ancillary equipment shall be accommodated in sheet steel vermin proof cubicles. The cubicles shall free-standing with front access, and shall be equipped with anti condensation heaters controlled by thermostat and interior lighting.

Cubicles shall be of rigid construction. Access to all compartments shall be provided by either removable panels or doors. All fastening shall be integral with the panel or door and provision shall be available for locking. Doors and panels shall be fitted with weatherproof sealing material suitable for the climatic conditions specified. Cubicles shall be well ventilated through vermin-proof louvres. Enclosure classification shall be a minimum of IP44 as per IEC 60529.

The arrangement of equipment within cubicles shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance of the associated apparatus.

#### 7.1.15. **Control and Indications**

The GIS switchgear shall be capable of being controlled from the following positions:

- From operating mechanisms cubicles located nearby the equipment such as CB, D/S and E/S and with indications and mimic diagrams.
- From the HMI center located in the substation control room - control of circuit breakers, disconnectors and earthing switches where power operated, with position indication in each instance.
- Remote PPC's transmission dispatching center - control of circuit breakers and disconnectors and position of earthing switches.
- Remote PPC's distribution dispatching center, (if applicable)-Control of 150/20KV transformers and 20KV equipment.

#### 7.1.16. **Auxiliary Switches and Contactors**

Circuit breakers, disconnectors and earthing devices and circuit selector disconnectors shall be provided with suitably rated auxiliary switches and contactors, where necessary, to relay circuit information for the purpose of control and circuit supervision at the substation control room and protection, indication, metering as required. In addition, two normally open and two normally closed auxiliary switches of the same type and rating as those specified above shall be provided as spare items on each equipment.

## **7.2. Cable feeder bay**

7.2.1. The cable feeder bay shall have the same equipment as the O.H.L. bay, as described in para. 7.1. above, except that the SF<sub>6</sub> -to-air bushing will be substituted by SF<sub>6</sub> -to-cable bushings and the CTs shall have different characteristics.

### **7.2.2. SF<sub>6</sub> -to-cable bushings**

The SF<sub>6</sub> -to-cable bushings shall be suitable for vertical or horizontal or under angle connection to single-phase 400 kV cables. Bushings shall generally be in accordance with IEC 60137 where applicable. The connection of the terminations with the bays shall be designed in such way so that if a malfunction of a 400 kV cable/ termination occurs, it won't create any other problems to the neighboring terminations (sealing-ends) or cables. All the necessary equipment for the connection of the 150 kV cables to the GIS bay must be part of the supply. The remaining technical data of the cables will be given in the inquiry.

CTs shall have the following characteristics :

- Three (3) single phase CTs with ratio 800-1600/1-1A

winding 1 : -For cable differential protection  
- Rated power output :30VA  
- Accuracy class : 5P  
- Accuracy limit factor :20

winding 2 : - For distance protection  
- Rated power output :30VA  
- Accuracy class : 5P  
- Accuracy limit factor :20

- Three (3) single phase CTs with ratio 800-1600/1-1A

winding 1 : - For metering purposes  
- Rated power output :30VA  
- Accuracy class : 0,5  
- Instrument security factor :FS≤ 5

winding 2 : - For bus-bar differential  
- Rated power output :30VA  
- Accuracy class : 5P  
- Accuracy limit factor :20

### **7.3. Bus Coupler Bay**

The bus coupler bay shall have the same components as the O.H.L. bay, as described in para. 7.1. above, but without the SF<sub>6</sub>-to-air bushing and without high speed earthing switches.

The current transformers shall be installed at both sides of the CB. The current transformers (CTs) before the CB shall be of a primary with two sections and two(2) secondary windings, with the following characteristics:

Three (3) CTs single-phase for busbar protection, 1200-2400/1-1A, class 5P20,30VA and class 0,5,30VA, FS ≤ 5

Three (3) single-phase current transformers (CTs) located after the CB shall be of a primary with two sections and have one(1) secondary winding, with the following output and class:

winding 1 for busbar protection, 1200-2400/1A , class 5P20,30VA.

### **7.4. Bus Section Bay**

The bus section bay shall include only disconnectors, four (4) high speed earthing switches and four (4) sets of VTs with each VT having the following characteristics :

- Ratio:  $400.000 : \sqrt{3}/100 : \sqrt{3} - 100 : \sqrt{3} \text{ V}$
- Number of secondary windings: 2`
- Power output of each secondary winding: 25VA
- Accuracy of each secondary winding: 0,5, used for metering purposes.

## **8. Tests**

### **8.1. Type tests**

The following type tests shall be carried out on a complete single-pole or three pole functional unit of an OHL switchgear bay (including at least the Circuit Breaker, the Disconnectors and the Earthing Switches) :

- a) Tests to verify the insulation level of the equipment and dielectric tests on auxiliary circuits.
- b) Tests to prove the radio interference voltage (RIV) level (if applicable)
- c) Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit

- d) Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short-time withstand current
- e) Tests to verify the making and breaking capacity of the included switching devices
- f) Tests to prove the satisfactory operation of the included switching devices
- g) Tests to prove the strength of enclosures
- h) Verification of the degree of the enclosure
- i) Gas tightness tests
- j) Electromagnetic compatibility tests (EMC) (If applicable)
- k) Additional tests on auxiliary and control circuits
- l) Tests on partitions
- m) Tests to prove the satisfactory operation at limit temperatures
- n) Tests to prove performance under thermal cycling and gas tightness on insulators
- o) Corrosion test on earthing connections (if applicable)

Concerning the VTs of an OHL switchgear bay, the following type tests shall be carried out in accordance with IEC 60044-2 standard:

1. Temperature rise test
2. Short – circuit withstand capability test
3. Radio interference voltage measurement
4. Determination of errors.

Concerning the CTs of an OHL switchgear bay, the following type tests shall be carried out in accordance with IEC 60044 – 1 standard:

1. Short – time current tests
2. Temperature rise test
3. Determination of errors

Type test certificates for all type tests of this hereby technical description for a complete OHL bay can be accepted instead of actual testing. For this reason, test certificates can be submitted along with the technical offer. If the submitted type tests certificates are found not to be satisfactory, or test certificates are not submitted then the eventual supplier shall carry out these tests without any cost for PPC S.A.



## 8.2 Routine tests

For routine tests new SF<sub>6</sub> in accordance with IEC60376, or used SF<sub>6</sub> in accordance with IEC60480, can be used.

The routine tests shall be performed on all components of a substation. Depending on the nature of tests, some tests may be performed on components, transport units or on the complete installation. The routine tests ensure that the product is in accordance with the equipment on which the type test has been carried out.

On a complete single-pole or three pole functional unit of an OHL switchgear bay (including at least the Circuit Breaker, the Disconnectors and the Earthing Switches), the following routine tests shall be carried out:

- a) Dielectric test on the main circuit
- b) Tests on auxiliary and control circuits
- c) Measurement of the resistance of the main circuit
- d) Tightness test
- e) Design and visual checks
- f) Pressure tests of enclosures
- g) Mechanical operation tests
- h) Tests on auxiliary circuits, equipment and interlocks in the control mechanism
- i) Pressure test on partitions

On the VTs of an OHL switchgear bay, the following routine tests shall be carried out in accordance with IEC 60044-2 standard:

1. Verification of terminal markings
2. Power – frequency withstand tests on primary winding
3. Partial discharge measurement
4. Power – frequency withstand test on secondary winding
5. Power – frequency withstand tests between sections of secondary winding.
6. Determination of errors.

On the CTs of an OHL switchgear bay, the following routine tests shall be carried out in accordance with IEC 60044-1 standard:

1. Verification of terminal markings
2. Power-frequency withstand test on primary winding
3. Partial discharge measurement
4. Power-frequency withstand test on secondary windings
5. Power- frequency withstand tests between sections of primary and secondary windings
6. Inter-turn overvoltage test
7. Determination of errors (This test shall be performed after the previous six tests)

## 8.3 Tests at site

After installation, and before being put into service, the GIS shall be tested in order to check the correct operation and the dielectric integrity of the equipment.

These tests and verifications comprise

- a) dielectric tests on the main circuits
- b) dielectric tests on auxiliary circuits
- c) measurement of the resistance of the main circuit
- d) gas tightness tests
- e) checks and verifications
- f) gas quality verifications

To ensure minimum disturbance, and to reduce the risk of moisture and dust entering enclosures and thus preventing correct operation of the switchgear, no obligatory periodic inspections or pressure tests concerning the enclosures are specified or recommended when the gas-insulated substation is in service. Reference shall be made in any case, to the manufacturer's instruction book.

## **9. Nameplates and Markings**

The GIS and all its operating devices shall bear legible and easily accessible nameplates which shall contain at least the following data (according to IEC 62271-203):

- Name of manufacturer
- Year of manufacture
- Type and serial number
- Rated voltage (kV)
- Rated lightning impulse withstand voltage (kV)
- Rated switching impulse withstand voltage (kV)
- Rated power frequency withstand voltage (kV)
- Rated frequency (Hz)
- Rated current of equipment (A)
- Rated current of busbars (A)
- Rated short-time withstand current (kA)
- Rated peak current (KIA)
- Rated duration of short-circuit (s)
- Rated short-circuit breaking current of circuit breaker (A)
- Rated duty cycle of circuit breaker
- SF<sub>6</sub> pressure at 20° C (bar) for all modules
- Weight of required SF<sub>6</sub> for the bay
- Weight of bay including SF<sub>6</sub>
- Standards according to which the bay has been manufactured

After placement of the order the respective texts shall be submitted for approval.

At the front of the bay a removable plate shall be placed whereon the Seller will engrave the name of the bay (e.g. overhead line ... ); .

Plates shall be also placed near the handles showing the positions ON-OFF as well as their respective direction of movement.

## **10. Maintenance and Accessibility Requirements**

The contractor will guarantee the following:

1. For routine inspections, all elements shall be accessible without removal of supporting structures. The removal of individual enclosure parts or complete switchgear bays shall be possible without disturbing the neighbouring bays.
2. Routine maintenance of external parts of the switchgear including instrument transformers shall not be necessary at intervals of less than 5 years.
3. The maintenance intervals of the circuit breaker shall not be less than 15 rated short circuit current interruptions, or 3000 rated current interruptions or 20 years operation whichever ever is earlier. Maintenance activities shall comprise only simple inspections and no exchange of parts or complex adjustments.
4. Checking the contact condition of the interrupter unit of the circuit breaker shall be possible without disturbing any other gas compartment and without interrupting any hydraulic piping. It shall be possible to safely replace the interrupter contacts of the circuit breaker even while the remaining switchgear is "live". The circuit breaker enclosure shall have provisions for easy withdrawal of the contact assembly. This procedure shall not involve the removal or dislocation for neighbouring bay enclosure parts. The removed interrupter assembly shall be easily and safely accessible for inspections and possible repairs.

## **11. Packing and Transport**

### **11.1. General Packing**

The equipment shall be delivered as completely assembled as possible. The packing shall include at least the following :

- a. Wooden frames protecting all the edges from blows and impacts during transport and shipping. Each side shall be also protected by  $\chi$ -planks.
- b. Plastic wrapping shall protect the equipment from moisture, dust etc.
- c. The flat surfaces shall be protected from mechanical stresses by means of corrugated cardboard lining or plastic lining with air inclusions or sheets of volume expanded polystyrene placed inside the plastic wrapping.

The delivery shall be complete. All the components, devices, endboxes, wirings etc. as well as every removable element must be fitted on the respective bay or packed with it, taking care that no damage or injury would arise during transport.

## **11.2. Impact Recorders for Transport**

One impact recorder shall be rigidly attached to each major switchgear assembly or part when packed, in order to record all horizontal and vertical impacts suffered during transport from factory to site. The recorder is to be operative from time of packing to unpacking on site in order to provide an uninterrupted record of all registered data. The recorder is to be suitably sealed, and the seal shall only be broken by PPC authorized personnel on arrival at site in order to release the registered data. An appropriate instruction book shall be supplied to the Purchaser.

In addition, one shock indicator shall be rigidly attached at least on each circuit breaker and current transformer. The G-range of the shock indicator shall be at least 20g. These indicators will be attached until the installation of the equipment is completed and shall give a "flag" for impacts equal or greater than the set point.

## **12. Documents**

### **12.1. Documents to be submitted by the bidder**

The Supplier shall, together with his offer, submit in three copies all documents with information necessary for the evaluation of the bids, such as certificates, drawings, technical leaflets etc. The information shall indispensably comprise the following:

1. Drawings of the switchgear complete with the components (circuit breakers, isolators, earthing switches, current transformers etc.), outline dimensions, weights and other data which may be needed for the installation of the switchgear under the given service conditions.
2. Technical leaflets for all types of bays, modules and accessories (circuit breakers etc.).
3. Preliminary outline drawings of the offered GIS
4. One-line diagram of the offered GIS
5. Complete description of all interlocks employed
6. Complete description of all high speed earthing switches used and their location in the GIS.
7. A table comprising all technical data of the individual devices of the bays offered. Such particulars shall be supported by corresponding information prospectuses of the manufacturer of these devices or by relevant test certificates.
8. Detailed information on the constructional characteristics of the switchgear.
9. Finally the Manufacturer shall furnish detailed information of any deviation of the material offered from the requirements of this technical description, if not mentioned in the above paragraphs.

10. Bidders are required to answer all items of "Attachment A" . Failure to comply will result in ejection of the offer.

Furnishing the above information is mandatory for the Manufacturer. It is recommended that the data requested shall be given clearly, a mere affirmative or negative reply will not be sufficient. Bids not comprising all the foregoing data will be rejected.

In case of no mentioning of any differences, the material will be considered to comply with the Technical Description.

## **12.2. Documents submitted by the contractor**

1. After placement of the order, the Seller shall submit for approval four (4) sets of detailed outline, schematic and wiring drawings.
2. The Seller shall submit, at least one month before the inspection notice, four (4) sets of detailed instructions for installation, operation and maintenance of the equipment.
3. Any delay in submitting the above drawings and instructions owing to the Seller will be regarded as a delay in execution of the contract.

## **13. Spare Parts**

- a. The spare parts included in the Table of Essential Spare Parts shall be delivered together with the bays. The cost of these spare parts shall included in the economic offer.
- b. If the Seller considers some additional spare parts should be offered, he should include them in a separate list. The Purchaser shall determine during the contract signature which of these spare parts, if any, and in what amount will be included in the order.
- c. The Purchaser is entitled to reduce the recommended quantities to complete refusal or to increase them up to twice the recommended amount with the same unit prices.

#### **d. Table of Essential Spare Parts**

<u>Essential Spare Parts</u>	<u>Unit</u>	<u>Qty</u>
Circuit breaker	pcs	1
One current (single phase) transformer of each type	pcs	1
One voltage (single pole) transformer of each type	pcs	1
Sets of breaker contacts, closing and tripping coils and contactors	sets	1
Sets of valves, gas filters, gas seals	sets	2
Disconnectors & earthing switches of each type	pcs	1
Disconnectors & earthing switches contacts set and operating mechanism of each type	pc	1
Gas monitor for switchgear	pc	1
SF <sub>6</sub> -Sealings	pc	2
SF <sub>6</sub> –to-air bushings	pc	1
SF <sub>6</sub> –to-Cable bushings	pc	1
Bursting disks	pc	2
Operating mechanism of the circuit breaker	pc	1

#### **14. Warranty**

The contractor must provide a warranty of the three (3) years beginning from the date of delivery of the GIS for any damages by faulty design or by unreliable components or by combination of the two

## " ATTACHMENT A "

### Rating of 400KV GIS

1. Rated voltage : .....
2. Rated lightning impulse level : .....
3. Rated switching impulse level : .....
4. Power frequency voltage withstand level : .....
5. Rated frequency : .....
6. Rated normal current
  - O.H line bays : .....
  - cable feeder bays : .....
  - buses : .....
7. Rated short-time withstand current for main and earthing circuits : .....
8. Rated peak withstand current for main and earthing circuits : .....
9. Rated duration of short circuit : .....
10. Anticipated loss of SF6 per year : .....
11. Total weight of the offered GIS : .....
12. Total weight of the SF6 in the offered GIS:.....
13. Weight of each bay of the GIS : .....  
 .....  
 .....
14. Are any high speed earthing switches used in the offered GIS? : .....  
 .....

.....

**15.** If the answer to question No.14 is yes,  
then indicate location of these high  
speed E/S within the GIS

:.....

.....

.....

.....

**16.** Design pressure of the enclosures

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....

**17.** Operating pressure of the pressure relief devices

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....

**18.** Type test pressure of the enclosures

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....

**19.** Routine test pressure of the enclosures

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....

**20.** Alarm pressure

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....

**21.** Minimum functional pressure

**a.** Circuit breaker

:.....

**b.** Other compartments

:.....



**22.** Is each gas compactmen equipt with:

- Pressure relief device? :.....
- Absorber of moisture? :.....
- Density switch? :.....

**23.** Type of material of the enclosures :.....

.....  
.....

**24.** Type of material of the air bushings :.....

.....  
.....

**25.** Length of O.H.L. bay, cable bay,  
autotransformer bay, bus coupler bay  
reactor bay and bus section bay, :.....  
unit feeder bay, VT's and high speed  
earthing switches bay :.....

.....  
.....  
.....

**26.** Width of O.H.L. bay, cable bay,  
autotransformer bay, bus coupler bay  
reactor bay and bus section bay :.....  
unit feeder bay, VT's and high speed  
earthing switches bay :.....

.....  
.....  
.....

**27.** For each bay indicate clearly where are  
high speed earthing switches needed :.....  
  
.....  
  
.....  
  
.....  
  
.....  
  
.....