PREVENTIVE MAINTENANCE AND CONDITION ASSESSMENT SOP & FORMAT FOR GIS (145kV & ABOVE)

Compiled & Circulated by BSPTCL

JULY,2025

INDEX

Standard Operating Procedure (SOP)

Preventive Maintenance and Condition Assessment of Gas Insulated Switchgear (GIS)

1. Objective

To define the steps required for carrying out preventive maintenance and condition assessment of GIS systems in a planned and safe manner, minimizing downtime and extending asset life.

2. Scope

Applicable to all medium and high-voltage GIS systems installed in substations under the maintenance purview.

3. Responsibilities

• Maintenance Engineer: Plan, schedule, and supervise maintenance activities.

• Technicians: Perform inspection, testing, and minor corrective actions.

• Safety Officer: Ensure all safety procedures are followed.

4. Safety Precautions

• Ensure complete isolation of the GIS from power sources.

• Discharge all capacitive charges.

• Use PPE: arc flash suit, gloves, face shield, etc.

• Display safety signage and lockout/tagout as per SOP.

• Verify absence of voltage before any maintenance.

5. Tools and Equipment Required

• Infrared Thermal Imager

• SF_6 Gas Analyzer (Moisture, Purity, Decomposition Products)

• Partial Discharge Measurement Equipment

• Insulation Resistance Tester

• Circuit Breaker Timing Test Kit

• Mechanical Tools for Inspection

• Torque Wrench

• Laptop with diagnostic software (OEM-specific)

6. Preventive Maintenance Schedule (Indicative)

Activity	Frequency	With/ without shutdown	As per format attached
Visual Inspection	Daily	W/O Shutdown	Annexure – 1
SF_6 Gas Density Monitor	Monthly	W/O Shutdown	Annexure – 2
Circuit Breaker Check	Monthly	W/O Shutdown	Annexure – 3
GIS Hall Maintenance	Monthly `	W/O Shutdown	Annexure – 4
EOT Crane Maintenance	Monthly	W/O Shutdown	Annexure – 5
Current Transformer Test	SOS	With Shutdown	Annexure – 6
Voltage Transformer	Half Yearly	W/O Shutdown	Annexure – 7

Partial Discharge Measurement	Annually	W/O Shutdown	Annexure- 8
GIS Hall Maintenance	Annually	W/O Shutdown	Annexure – 9
EOT Crane	Annually	W/O Shutdown	Annexure – 10
Circuit Breaker Test	Bi-annually	With Shutdown	Annexure – 11
SF6 Gas Quality Check	Four-Yearly	W/O Shutdown	Annexure – 12
Circuit Breaker Test	Four-Yearly	With Shutdown	Annexure -13
Density Monitor	Five- Yearly	With Shutdown	Annexure – 14
Complete Overhaul	Six-Ten Years (OEM Recommended)		

7. Detailed Procedure

7.1 Visual Inspection

- Check for oil/grease leaks, corrosion, cracks, and dirt.
- Verify cleanliness of insulators and enclosures.
- Ensure labels, signs, and earth connections are intact.

7.2 SF_6 Gas Analysis

- Measure SF_6 pressure using OEM-approved gauge.
- Analyze gas for:
  - Moisture content (dew point)
  - SF_6 purity (≥ 97%)
  - Decomposition products (SO_2, HF, etc.)
- Refill or replace gas if below threshold.

7.3 Partial Discharge (PD) Measurement

- Perform online or offline PD testing.
- Identify internal insulation issues, surface discharges, and voids.
- Record and trend PD activity over time.

7.4 Circuit Breaker Timing Test

- Measure opening, closing, and trip-free times.
- Compare with OEM limits.
- Lubricate and adjust mechanism if deviation found.

7.5 Infrared Thermography

- Scan for hot spots at joints, busbars, cable terminations.
- Compare with historical data and reference values.
- Investigate abnormal temperatures (>10°C above ambient).

7.6 Insulation Resistance Testing

- Apply 1kV to 5kV insulation test (as per voltage class).

- Record readings for busbar sections, CTs, PTs, etc.
- Megger value must be within acceptable limits (typically >1000 MΩ).

7.7 Mechanical & Functional Testing

- Test manual/remote operation of disconnects, earthing switches.
- Check alignment and torque settings.
- Ensure interlocks operate correctly.

8. Condition Assessment Criteria

• SF_6 quality within threshold → Healthy

• PD < OEM limits → Healthy

• No hot spots in IR scan → Healthy

• Breaker timing and insulation resistance acceptable → Healthy

If two or more parameters show abnormal results, schedule corrective maintenance or replacement.

9. Documentation

• Record all test results in GIS Maintenance Logbook.

• Tag abnormal components.

• Upload reports to centralized Asset Management System.

Annexure – 1

Format for Visual Inspection on Daily Basis

S. No.	Description	OK/Not OK
1	Check for oil/grease leaks, corrosion, cracks and dirt of all component	
2	Verify cleanliness of insulators and enclosures	
3	Ensure all labels, signs and earth connections are intact	
4	GD pressure monitoring-weekly noted down	
5	CB GD pressure reading-daily noted down	
6	CB Counter reading	
7	Locking of LCC- Panels- to avoid a unauthorized access	
8	Alarms in LCC & Relay Panels	
9	Cleaning of GIS Equipment	
10	Healthiness of DC supply	
11	Round the clock monitoring of Gas-SLD, Relay healthiness in SCADA & CRP – by Operation Shift Staff	

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure – 2

SF6 GAS DENSITY MONITOR – MONTHLY ACTIVITY (WITHOUT SHUTDOWN)

Bay Details:
Density Monitor Make: ***Ambient Temperature:**
Density Monitor Type:

Equipment Details	Gas Compartment-01			Gas Compartment-02			Gas Compartment-03			Gas Compartment-04			Gas Compartment-05		
	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B
Date of Commissioning															
Gas Compartment Details (Equipment)															
Date of Checking (DD/MM/YYYY)															
Actual Pressure in SF6 Density Monitor															
Design Pressure															
Remarks /Observations (Filling Done/Corrective Action if any)															

- Ambient Temperature to be recorded for GIS Hall/Outdoor based on location of installation of Density Monitor

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure – 3

CIRCUIT BREAKER – MONTHLY ACTIVITY (WITHOUT SHUTDOWN)

	Equipment Details	CB-I/	CB-II/	CB-III/	CB-IV/	CB-V/	CB-VI/	Remarks/Observations
	Date of Commissioning							
	Make							
	Rating							
	Sl. No.							
	Bay Loc							
	Date of Checking (DD/MM/YYYY)							
Sl	**Description Activity**							
1	**Oil leakage in Operating Mechanism**							
2	**Oil level in Operating Mechanism (Top-upif required)**							
3	**Visual Checks of MBs (for any defects)**							
4	**Healthiness of Controlled Switching Device**							
5	**Healthiness of heating/illumination circuit**							
6	**Healthiness of spring mechanism & position indication**							
7	**Actual Hydraulic pressure (in Mpa)**							

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

GIS HALL MAINTENANCE–MONTHLY ACTIVITY

i. GENERAL

S. No.	Description	Activity
1	Cleaning of GIS Hall	
2	Sealing of GIS Hall to prevent air leakage	
3	Condition of illumination & emergency light	

ii. AHU

S. No.	Description	Activity
1	Cleaning of AHU Filter (Quarterly)	
2	Abnormal sound and vibration from AHU if any	
3	Tightening check of fan belt	

iii. CABLETERMINATIONBOX

S. No.	Description	Activity
1	Checking of oil level in reservoir/ accumulator provided for cable termination box	

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure – 5

EOT CRANE–MONTHLY ACTIVITY

S. No.	Description	Activity
1	Movement of EOT Crane (Long travel, Cross travel, Hoist) without loading	
2	Limit Switch Operation	

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

CURRENT TRANSFORMER–SOS ACTIVITY (WITH SHUTDOWN)

Dt. of Commissioning..... **Make.....** **Rating.....** **S. No. .....** **Bay Loc.....**

PTW NO..... **Date.....**

(I) Measurement of CT Ratio **Details of Kit used:(Make, Rating & Sl. No) ….....** **Date of Last Calibration:……**

Primary Current	Secondary Current	Ratio	***Permissible ratio Error***	***Reference***
100Amp.			***Protection Core: +/-3%*** ***Metering Core: +/-1%***	***IS-2705***

(II) Measurement of Secondary Resistance **Details of Kit used:(Make, Rating & Sl. No)….....** **Date of Last Calibration:……**

Core	**Resistance Value**			**Remarks**
	RØ	**YØ**	**BØ**	
1				
2				
3				
4				
5				

(III) Magnetising Characteristics **Details of Kit used:(Make, Rating & Sl. No)….....** **Date of Last Calibration:……**

Applied Voltage in Secondary (Volts)	**Measured current (mA)**	**Primary Voltage (Volts)**

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

VOLTAGE TRANSFORMER–SIX MONTH LY ACTIVITY (WITHOUT SHUTDOWN)

Date of Commissioning..... **Make.....** **Rating.....** **Sr No.....** **Bay Loc .....**
PTW No..... **Date.....**

Name of Feeder/Bay	Measurement	Values Volts(forCore-3)		Voltage variation between Bus – I & Bus - II	Remarks/Observations &Action plan
		Bus-I	Bus-II		
	R-N				
	Y-N				
	B-N				

Note: Measurement to be carried out simultaneously for same phase of BusVTswith0.2classmulti-meter.
Readings to be taken from LCC Panel.

Drift in secondary Voltage (to be measuredby0.2/0.5classMultimeter)	*Condition*	*Measurement Frequency*	*Reference*
a)Upto±0.5volts	*Healthy*	*6 monthly*	*POWER GRID Practice*
b)+/-0.5to+/-0.8volts	*To be monitored*	*3 monthly*	
c)Beyond0.8 volts	*Case may be referred to CCA-AM*		

	Remarks Based on review of Test Results	Action to be taken on the remarks	Action taken for rectification	Closing of the Issue
Maintenance Engineer				
Substation Incharge				

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

PARTIAL DISCHARGE MEASUREMENT– YEARLY ACTIVITY (WITHOUT SHUTDOWN) (PORTABLE TEST KIT)

Details of testing kit used:
Make:

Type:

Principal of operation (UHF/Acoustic):

Equipment Details	Sensor No -/ Phase -	Sensor No -/ Phase -	Sensor No-/ Phase -	Sensor No-/ Phase -	Sensor No- /Phase-	Sensor No-/ Phase -
Date of Commissioning						
Location (Bay/Bus)						
Date of Checking (DD/MM/YYYY)						
System Voltage (in kV)						
Partial Discharge (%, mV, dB) $						
Remarks/Observations						

Note:

1. **To be carried out for GIS portion where Online Partial Discharge Monitoring System is not available.**
2. **During the first year after commissioning, Partial Discharge measurement is to be carried out every four months upto one year and thereafter on six monthly basis.**
3. **At the time of PD measurement all mobile devices, cutting & grinding tools, welding m/c etc to be switched off in and around the GIS hall/ GIS outdoor equipment to avoid interference and influence on the PD test system.**
4. **$: Measurement unit (mV, dB, %) to be mentioned as per the kit measurement unit system and in the remarks/ observations column, diagnostics done by kit (no PD, particle, corona, floating electrode, void, contamination etc) to be mentioned.**
5. **In case any partial discharge (even less than 5 pC) is detected at any location, partial discharge measurement to be repeated on weekly basis at those locations to monitor the trend.**

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

GIS HALL MAINTENANCE–YEARLYACTIVITY

I. AHU

S. No.	Description	Ok / Not Ok
1	Replacement of worn out filters	
2	Replacement of fan belts if required	
3	Lubrication and tightening of blower rotating mechanism and damper mechanism	

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure – 10

EOT CRANE–YEARLY ACTIVITY

S. No.	Description	Ok/ Not Ok
1	Greasing of pulley, sling, gear box and all other moving parts if required	
2	Functional test at rated load * or at least 110% of heaviest equipment installed in GIS	
3	Motor current to be measured at rated load (Long/Cross/Hoist Travel motor)	

***Load to be prepared by site either by casting of concrete block or any other compact weight**

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

CIRCUIT BREAKER - TWO YEARLY ACTIVITY (WITH SHUTDOWN)

PTWNO		**Make, Sl. No & Rating of Equip.**		**Date of commissioning**	
Bay Loc. No		**Date of Measurement**		**Ambient Temp**	

I. SF6CIRCUITBREAKER

(i) OIL PRESSURE DROP DURING DUTY CYCLE OPERATION-O-0.3 S-CO

	OILPRESSURE			
	Pre-commissioning value	**Previous value**	**Present value**	**Remarks/Observations**
Before Operation				
After Operation				
Drop in Pressure				

(a) Checking of Hydraulic Pump operation

	Set value	**Actual value**	**Remarks/Observations**
START(Pressure)			
STOP(Pressure)			

(b) Checkingofspringchargingmotor/hydrauliccompressormotoroperationtiming

	Pre-commissioning value	**Present value**	**Remarks/Observations**
Duration of running			

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

(c) Checking of Pole Discrepancy Relay

TRIP 'R' ph	Measure Tripping Time of Y & B pole	
	Set Value* in sec	Operating Value in sec
PREVIOUS VALUE		
PRESENT VALUE		
Note- 2.5 sec for CBs with Auto Reclose function & 0.5 sec for CBs without Auto Reclose Function		

Close any one pole and observe the tripping of same pole

CLOSE 'R' pole	Measure Tripping Time of R pole	
	Set Value* in sec	Operating Value in sec
PREVIOUS VALUE		
PRESENT VALUE		
Note- 2.5 Sec for CBs with Auto Reclose Function &0.5 Sec for CBs without Auto Reclose Function.		

(d) **Checking of Anti Pumping relay**–by giving simultaneous s& continuous Close & Trip command, Hunting should not take place**.**
OK/NOTOK

(e) **Check of interlocks** (Local Closing Interlock): Earth Switch Interlocks with CB: Ok/Not Ok

(f) Check of Operating Lockouts

		Pressure Values					
Sl. No	Test-Description	A/R Lockout		Closing L/O		Operational Lockout	
		Set value	Actual	Set Value	Actual	Set Value	Actual
1.	Driving mechanism (Hydraulic)						

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

(g) Healthiness of Operation Counter

PHASE	ACTUALREADINGS		Remarks, Observation & Action Plan in case of Non-Conformance
	BEFOREOPERATION	AFTEROPERATION	
R			
Y			
B			

(i) Maintenance of Control Cabinets

1. Checking of tightness of all the terminations in MB.
2. Checking of Door Sealing gaskets and replacement thereof, if necessary
3. Check functioning of space heater /illumination

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure – 12

SF6GAS–FOUR YEARLY ACTIVITY (WITHOUT SHUTDOWN)

	Equipment Details	Gas Compartment Number -			Gas Compartment Number -			Gas Compartment Number -			Remarks/Observations
	Date of Commissioning										
	Bay Location										
	Date of Checking (DD/MM/YYYY)										
Sl	**Description of Activity**										
1	**Dew point in Deg C along with temperature and pressure at time of measurement**	**DP**	**Press**	**Temp**	**DP**	**Press**	**Temp**	**DP**	**Press**	**Temp**	
2	**Purity in %**										
3	***SO2 in ppm**										
4	***HF in ppm**										
5	***CF4 in ppm**										

***Where ever kit is available**

Note:

2. **During first year of commissioning, SF6 Gas testing is to be carried out for all compartments before completing one year service period. However, after first year, SF6 Gas testing is to be carried out every four years.**
3. **In case, SF6GasistoppedupinanyGasCompartmentthenSF6Gastestingistobecarriedoutforthat GasCompartmentafter SF6gas filling and also after one week of Gas topping.**

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

CIRCUIT BREAKER-FOUR YEARLY ACTIVITY (WITH SHUTDOWN)

I BREAKER OPERATION CHECKS–

PTWNO		**Make & Sl. No of Equip.**		**Rating**		**DOC**	
Date of Measurement		**Bay Loc. No)**	**Kit Details (Make & Sl. No)**		**Last Calibration Date**		**Ambient Temp**

(a)CB timings including PIR checks

PHASE	DETAILS	CLOSE TIME	OPEN TIME		CLOSE OPEN (CO) TIME		Close coil current	Trip coil current				REMARKS& OBSERVATIONS
								Factory Values		Present Values		
			TRIP-I	TRIP- II	TRIP-I	TRIP- II		T_{c1}	T_{c2}	T_{c1}	T_{c2}	
R	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											
Y	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											
B	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											

Above PIR opening times is to be noted wherever applicable.

CO Time is to be measured with simultaneous Close-Trip Commands. In case provision does not exist for simultaneous Close/Trip commands in kit, Trip command to be given at least 10ms prior to closing of CB contacts.

Circuit Breaker Timing is to be done only at time of feeder shutdown. Reference Procedure is attached as Annexure–A.

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

II DYNAMIC CONTACT RESISTANCE MEASUREMENT–

CB POLES	Remarks on DCRM Signature from RHQ/AM
R phase	
Y phase	
B Phase	

Dynamic Contact Resistance signature for CO operation of CB to be recorded and compared with the earlier signatures. Minimum delay (co time) should be 300ms.

Sampling frequency for DCRM and Contact Travel Measurement--- 10KHZ

CircuitBreakerDCRMistobedoneonlyattimeoffeedershutdown.ReferenceProcedureisattachedasAnnexure–A.

III CONTACTRESISTANCEMEASUREMENT(CRM)–

Contact Resistance to be measured across Circuit Breaker using Earth Switches located at both end of CBs

CB Pole	Present value of resistance (in micro-ohm)	Previous value of Resistance (in micro-ohm)	Pre-commissioning value of resistance (in micro-ohm)
R phase			
Y phase			
B phase			

Circuit Breaker CRM is to be done only at time of feeder shutdown. Reference Procedure is attached as Annexure–A.

During first year of commissioning. CB Condition Monitoring Tests such as Timing, CRM & DCRM to be carried out before completing one year of service period.
In addition to normal frequency (i.e. every 4 years), DCRM, CRM & TIMING Measurement tes is to be carried out in month of April of next financial year AMP cycle if any of following condition is met:

ii. More than 150 nos. switching operations are performed by CB since last contact resistance measurement test. For the purpose of counting switching operations, One no. Close & Open cumulatively shall be considered as One no. Switching Operation. Only, onload operations shall be considered as switching operation and off line operations shall not be considered as switching operations

iii. Summation of square of fault current cleared by any CB pole exceeds 200 kA sq since last contact resistance test.

Notifications in SAP shall be triggered for performing DCRM, CRM & Timing test upon meeting conditions specified above.

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

DENSITY MONTIOR – FIVE YEARLY ACTIVITY (WITH SHUTDOWN)

	Equipment Details	Gas Compartment Number-	Gas Compartment Number-	Remarks/ Observations
	Date of Commissioning			
	Bay Location			
	Make of Density Monitor			
	Serial Number of Density Monitor			
	Date of Checking (DD/MM/YYYY)			
Sl	**Description of Activity**			
1	**Checking the status of LowSF6 Alarm (stage-1) at BCU**	**Ok/ Not Ok**	**Ok/ Not Ok**	
2	**Checking the status of SF6 Signal for Lockout/zone tripping (stage-2A) at BCU**	**Ok/ Not Ok**	**Ok/ Not Ok**	
3	**Checking the status of SF6 Signal for Lockout/zone tripping (stage-2B) at BCU**	**Ok/ Not Ok**	**Ok /Not Ok**	

Note:

1. **To be done only with Feeder Shutdown (Line/ICT/Reactor).**
2. **Testing to be done by Isolating the Density Monitor from the Gas Compartment so that there is no release of SF6 gas from the Gas Compartment.**
3. **Bus Bar Tripping on Zone Tripping Logic due to SF6 Stage–2A/2B contact operation must be isolated at the time of Density Monitor Testing.**
4. **Precautions should also be taken to isolate Tripping of adjoining Bays (eg Tripping from Tie Bay to Main Bay in One Half Breaker Scheme, Feeder Bays to Auxiliary Bus etc) at the time of Density Monitor Testing.**

Signature of Maintenance Technician Signature of Operational Technician Signature of J.E.E/A.Ex.E

Annexure– A

Procedure–Measurement of Operational Timings, Contact Resistance & Dynamic Contact Resistance Measurement for Circuit Breakers

Testing on Circuit Breaker requires complete isolation of equipment by taking outage of bay. However, in case of One and Half Breaker scheme if CB is isolated by taking bay shutdown then Voltage shall be available on both side of isolators i.e. 89A & 89B. For GIS testing maintenance switch on either side of CB is used for connecting test equipment (Operational Analyzer, Static Contact Resistance kit, Dynamic Contact Resistance Measurement kit). But testing shall not be possible by keeping both maintenance switch (89AE & 89BE) in Close position. At least one Earth Switch needs to be isolated from ground for testing. However when GIS Earth Switch is dis-connected from ground there is risk of high induction voltage on ungrounded Earth Switch which is detrimental to human & testing equipment safety. In view of above, CB testing (Timing, CRM & DCRM) in GIS not recommended only with bay shutdown where voltage is present on either side of bay isolator i.e. 89A & 89B. Therefore in one & half breaker arrangement, CB testing is recommended only with Feeder shutdown when voltage will not be present at least on one side of bay isolator. It will then be possible to open earthing from Earth Switch without any risk of induction and safe testing condition. However in case of Double Bus scheme, shutdown of bay is always along with Feeder outage and one side dead condition is automatically fulfilled.

Sequence of Operation of Bay equipment's for testing GIS CBs for different scheme (One and Half Breaker scheme, Double Bus Scheme) is given below.

One and Half Breaker Scheme

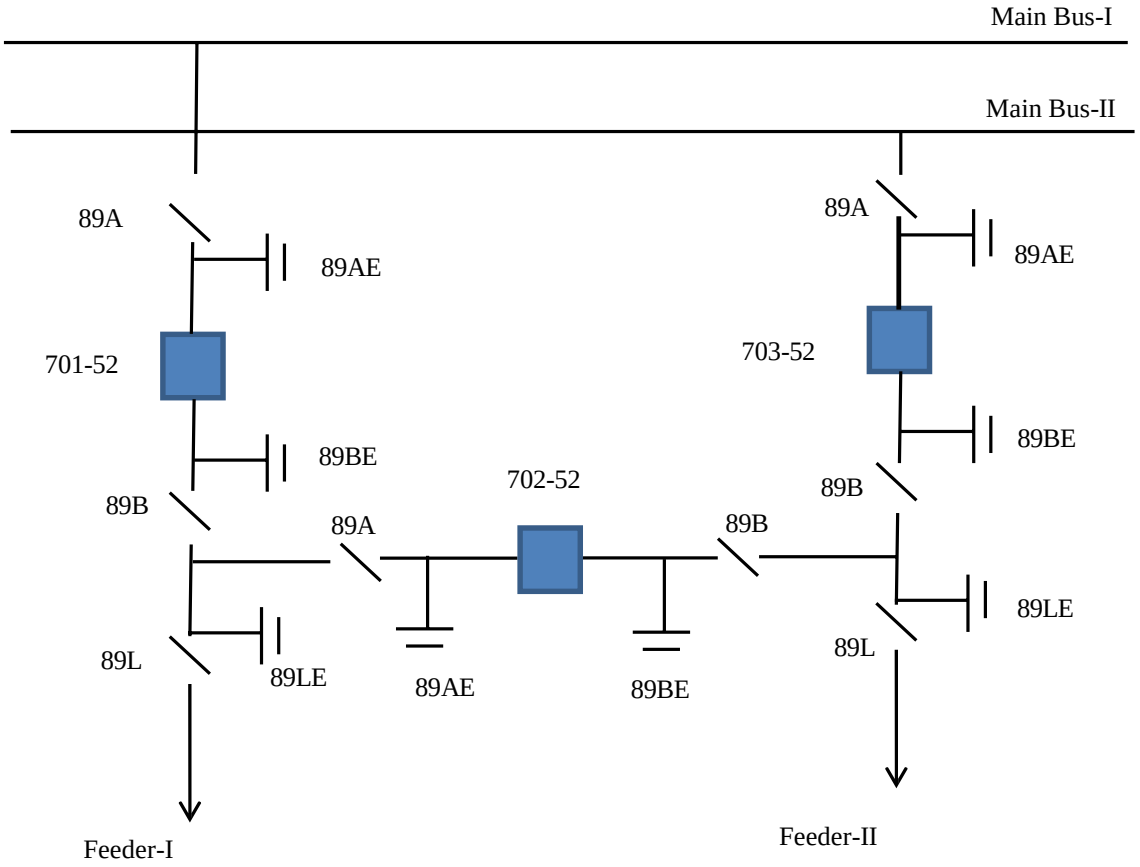


Figure-01

1. **Main Bay CB (701) (Refer Figure–01)**

    a. First take shut down of Feeder–I by Opening both 701 (Main) & 702 (Tie Bay)

    b. Then Open 701 & 702 Bay Isolators i.e.701 –89A,701–89B,702–89A,702–89B and Feeder Isolator i.e. 701 – 89L.

    c. Then Close both Earth Switches across subject CB i.e701–89AE & 701–89BE

    d. Dis-connect earth/ground connection with 701-89BE E/S.

    e. Connect Measurement kit across 701CB using E/S 89AE & 89BE

    f. Carry out test (Operational Timing/Contact Resistance/Dynamic Contact Resistance Measurement) with one Earth Switch (89A) connected with ground.

    g. After completion of test, connecting of 701 -89BE E/S with ground should be restored and same should be tightened properly by applying torque as per manufacturer guidelines.

h. In case grounding for maintenance on Feeder is required during shutdown then safety guidelines & PTW procedure as applicable for working on Line/ICT/Reactor should be followed prior to taking up any maintenance works.

Note: Due care needs to be taken while dis-connecting/re-connecting earthing connection with E/S before & after test to avoid any damage to E/S outcoming point on GIS. Clarification from GIS manufacturer may be taken if required.

2. <u>Tie Bay CB (702) (Refer Figure–01)</u>

a. First take shutdown atleast one of the Feeders of the Dia i.e. either Feeder – I or Feeder – II. In this case, we have formed procedure by considering shutdown of Feeder – I.

b. First take shutdown of Feeder–I by Opening both701(Main) & 702(Tie Bay)

c. Then Open 701 & 702 Bay Isolators i.e. 701 –89A,701–89B,702–89A,702–89B and Feeder Isolator i.e. 701 – 89L.

d. Then Close both Earth Switches across subject CB i.e702–89AE&702–89BE

e. Dis-connect earth/ground connection with 702-89AE.

f. Connect Measurement kit across 702 CB using702 Bay E/S 89AE & 89BE

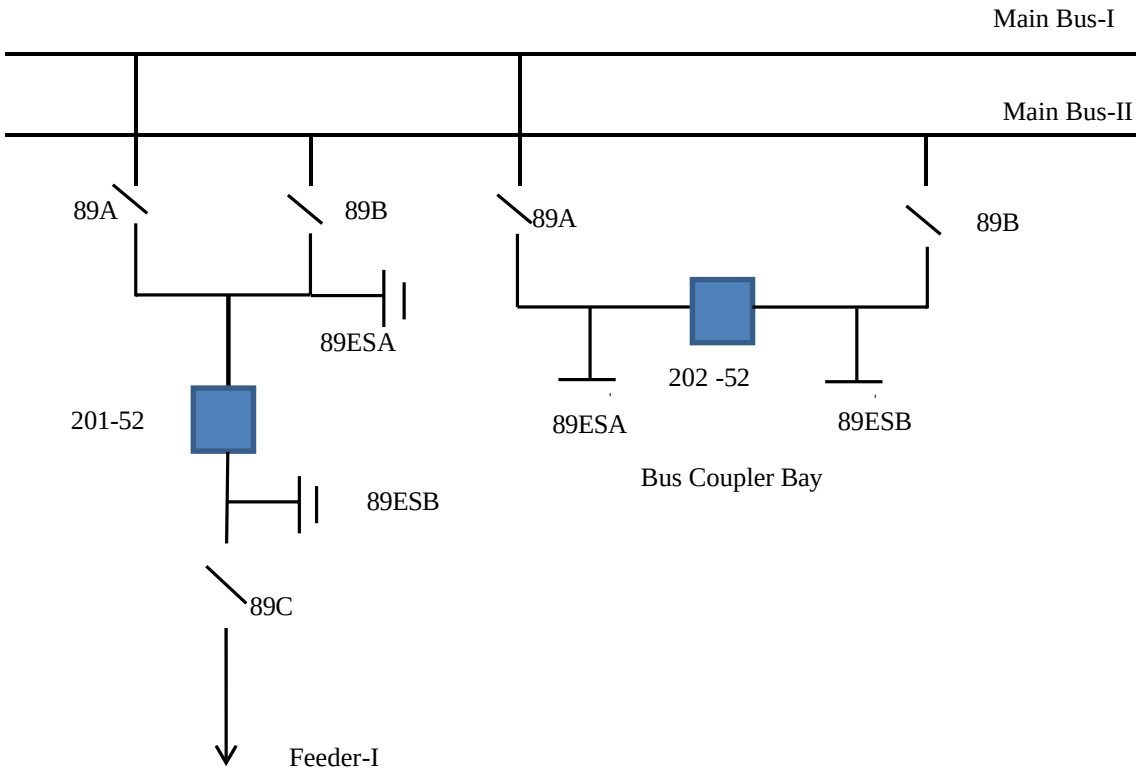
g. Carry out test (Operational Timing/Contact Resistance/Dynamic Contact Resistance Measurement) with one Earth Switch (89B) connected with ground.

h. After completion of test, connection of 702 - 89AE E/S with ground should be restored and same should be tightened properly by applying torque as per manufacturer guidelines.

i. In case grounding for maintenance on Feeder is required during shutdown then safety guidelines & PTW procedure as applicable for working on Line/ICT/Reactor should be followed prior to taking up any maintenance works.

Note: Due care needs to be taken while dis-connecting/re-connecting earthing connection with E/S before & after test to avoid any damage to E/S outcoming point on GIS. Clarification from GIS manufacturer may be taken if required.

Double Main Bus Scheme



Figure– 02

1. **Bay CB (201) (Refer Figure –02)**

   a. First take shutdown of Feeder–I by Opening 201 Bay CB.

   b. Then Open 201 Bay Isolators i.e. 201–89A,201–89B and Feeder Isolator i.e.201–89C.

   c. Then Close both Earth Switches across subject CB i.e 201–89ESA & 201–89ESB

   d. Dis-connect earth/ground connection with 201-89ESB E/S.

   e. Connect Measurement kit across 201 CB using E/S 89ESA & 89ESB

   f. Carry out test (Operational Timing/Contact Resistance/Dynamic Contact Resistance Measurement) with one Earth Switch (89A) in ground mode.

   g. After completion of test, connection of 201 - 89ESB E/S with ground should be restored and same should be tightened properly by applying torque as per manufacturer guidelines.

   h. In case grounding for maintenance on Feeder is required during shutdown then safety guidelines & PTW procedure as applicable for working on Line/ICT/Reactor should be followed prior to taking up any maintenance works.

Note: Due care needs to be taken while dis-connecting/re-connecting earthing connection with E/S before & after test to avoid any damage to E/S outcoming point on GIS. Clarification from GIS manufacturer may be taken if required.

2. <u>Bus Coupler Bay CB (202)(Refer Figure–02)</u>

a. First take shutdown of any one bus out of two buses i.e. either Bus –I or Bus–II. In this case, we have formed procedure by considering shutdown of Bus – I.

b. Open 202 Bay CB.

c. Then Open 202 Bay Isolators i.e. 202–89A, 202–89B.

d. Then Close both Earth Switches across subject CB i.e202–89ESA & 202–89ESB

e. Dis-connected earth/ground connection with 202-89ESA E/S.

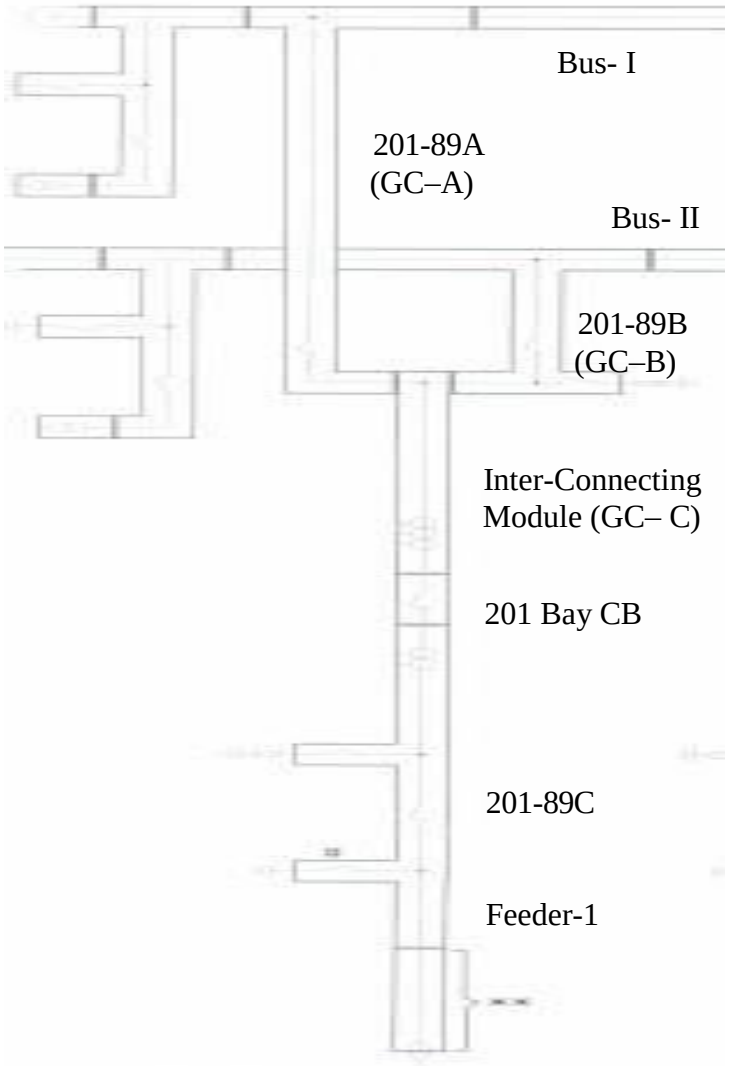
f. Connect Measurement kit across 202 CB using E/S 89ES A& 89ESB

g. Carry out test (Operational Timing/Contact Resistance/Dynamic Contact Resistance Measurement) with one Earth Switch (89B) in ground mode.

h. After completion of test, connection of 202 -89ESAE/S with ground should be restored and same should be tightened properly by applying torque as per manufacturer guidelines.

Annexure– B

Gas Handling Works (Removing/Filling)–Double Main Bus Scheme (Bus Side Gas Compartments)



Figure– 03

In Double Main Bus arrangement, both bus side isolators are connected through an interconnecting module and interconnecting is connected bay Circuit Breaker. Under normal operating condition, only one Bus side isolator is closed and bus isolator remains closed. Due to this configuration/ position of bus side isolators under normal operating condition, voltage is always extended in both isolator irrespective of OPEN or CLOSE position. In most of the GIS Zone Tripping logic of Bus side isolators and interconnecting module, tripping is given to both Bus Bar.

In order to overcome risk of flashover due to loss of SF6 and unwanted tripping of Bus Bar on zone trip logic following precautions to be taken while gas handling of Bus side isolators and interconnecting module,

Whenever SF6 Gas Handling (removing/filling) is carried out in any Bus side Gas Compartments (i.e. GC–A/B/C refer Figure – 03) pertaining to bus side isolators and interconnecting module, then Zone tripping logic comes into picture. Therefore, before commencing any Gas Handling works, Zone tripping

logic for that relevant Gas Compartment is to be thoroughly understood to avoid the unwanted tripping of connected system. Precautions as per following are to be taken while handling SF6 Gas in any Bus side compartment during maintenance/ breakdown works,

1. **Gas Handling (GC–A)**
   a. Take shutdown of Feeder –1 by Opening 201 Bay CB.
   b. Take shutdown of Bus–I.
   c. Open 201 Bay Isolators i.e.201 –89A,201– 89B.
   d. Ensure that tripping going to Bus – II (as applicable) as per Zone tripping logic of Gas Compartment GC–A is disconnected before commencement of SF6 Gas Handling works for GC – A.
   e. After normalization of Gas Compartment GC –A upto rated pressure, Zone tripping logic to be normalized.

2. **Gas Handling(GC– B)**
   a. Take shutdown of Feeder –1 by Opening 201 Bay CB.
   b. Take shutdown of Bus–II.
   c. Open 201 Bay Isolators i.e. 201 –89A,201– 89B.
   d. Ensure that tripping going to Bus – I (as applicable) as per Zone tripping logic of Gas Compartment GC–B is disconnected before commencement of SF6 Gas Handling works for GC – B.
   e. After normalization of Gas Compartment GC –B upto rated pressure, Zone tripping logic to be normalized.

3. **Gas Handling(GC–C)**
   a. First take shutdown of Feeder–1 by Opening 201 Bay CB.
   b. Then Open 201 Bay Isolators i.e. 201–89A,201–89B.
   c. Ensure that tripping going to Bus –I& II(as applicable) as per Zone tripping logic of Gas Compartment GC – C is disconnected before commencement of SF6 Gas Handling works for GC – C.
   d. After normalization of Gas Compartment GC–C upto rated pressure, Zone tripping logic to be normalized.

Annexure–C

General Guidelines, Safeguards & Precautions during O&M of GIS

1. All preventive maintenance tests/checks such as CB Timing, DCRM, CRM, General Checks such as PD relay, anit pumping relay checking etc and SF6 Gas Testing to be carried out within 1st year of commissioning. Thereafter, tests to be carried out as per frequency defined in Index.
2. In case of SF6 gas leakage resulting due to internal flashover/arc, SF6 by-products also comes out and spreads in GIS hall. In such situation, working persons must avoid entering in GIS hall. Leaked SF6 gas and by-products from faulty equipment need to be diffused and escaped from GIS hall by opening doors, windows & other available ventilation methods before entering GIS hall for further monitoring & operation activities.
3. While dismantling of faulty GIS modules due to internal flashover, following steps are necessary for environmental and personal safety
    a) SF6 gas contaminated as results of internal flashover needs to be evacuated safely in spare empty cylinders using recovery pump before starting the dismantling activity. Cylinders used for storage of contaminated SF6 gas is to be marked/ colored for clear identification. Stored contaminated SF6 gas to be disposed to the available authorized agency.
    b) Persons working in the dismantling of faulty module should wear mask, eye glasses & hand gloves and avoid touching internal parts of GIS contaminated with SF6 by-products and solid residues by bare hand or any other part of body.
4. In case of GIS internal inspection/maintenance/repair work which has not faced internal flashover but require dismantling of GIS module in part/full, SF6 gas is expected to be good & usable. SF6 gas should be evacuated from the affected section of GIS and stored in SF6 gas handling plant's storage tanks or separate storage cylinder before opening/dismantling of affected GIS equipment. The SF6 gas need to be measured for SF6 gas quality (% purity, Dew point & SO2) before and after the evacuation and to be reused if parameters are found within limit as per IEC 60480 (standard for reuse of SF6 gas). In case of violation of SF6 gas quality parameters w.r.t to above standard, attempt to be made to bring the parameters within limit by circulating/passing the recovered SF6 gas through SF6 gas handling plant filter which absorbs the moisture and impurities to some extent.

Annexure – 1

Format for Visual Inspection on Daily Basis

S. No.	Description	OK/Not OK
1	Check for oil/grease leaks, corrosion, cracks and dirt of all component	
2	Verify cleanliness of insulators and enclosures	
3	Ensure all labels, signs and earth connections are intact	
4	GD pressure monitoring-weekly noted down	
5	CB GD pressure reading-daily noted down	
6	CB Counter reading	
7	Locking of LCC- Panels- to avoid a unauthorized access	
8	Alarms in LCC & Relay Panels	
9	Cleaning of GIS Equipment	
10	Healthiness of DC supply	
11	Round the clock monitoring of Gas-SLD, Relay healthiness in SCADA & CRP – by Operation Shift Staff	

Annexure – 2

SF6 GAS DENSITY MONITOR – MONTHLY ACTIVITY (WITHOUT SHUTDOWN)

Bay Details:
Density Monitor Make: ***Ambient Temperature:**
Density Monitor Type:

Equipment Details	Gas Compartment-01			Gas Compartment-02			Gas Compartment-03			Gas Compartment-04			Gas Compartment-05		
	R	Y	B	R	Y	B	R	Y	B	R	Y	B	R	Y	B
Date of Commissioning															
Gas Compartment Details (Equipment)															
Date of Checking (DD/MM/YYYY)															
Actual Pressure in SF6 Density Monitor															
Design Pressure															
Remarks /Observations (Filling Done/Corrective Action if any)															

- Ambient Temperature to be recorded for GIS Hall/Outdoor based on location of installation of Density Monitor

Annexure – 3

CIRCUIT BREAKER – MONTHLY ACTIVITY (WITHOUT SHUTDOWN)

	Equipment Details	CB-I/	CB-II/	CB-III/	CB-IV/	CB-V/	CB-VI/	Remarks/Observations
	Date of Commissioning							
	Make							
	Rating							
	Sl. No.							
	Bay Loc							
	Date of Checking (DD/MM/YYYY)							
Sl	**Description Activity**							
1	**Oil leakage in Operating Mechanism**							
2	**Oil level in Operating Mechanism (Top-upif required)**							
3	**Visual Checks of MBs (for any defects)**							
4	**Healthiness of Controlled Switching Device**							
5	**Healthiness of heating/illumination circuit**							
6	**Healthiness of spring mechanism & position indication**							
7	**Actual Hydraulic pressure (in Mpa)**							

Annexure – 4

GIS HALL MAINTENANCE–MONTHLY ACTIVITY

i. GENERAL

S. No.	Description	Activity
1	Cleaning of GIS Hall	
2	Sealing of GIS Hall to prevent air leakage	
3	Condition of illumination & emergency light	

ii. AHU

S. No.	Description	Activity
1	Cleaning of AHU Filter (Quarterly)	
2	Abnormal sound and vibration from AHU if any	
3	Tightening check of fan belt	

iii. CABLETERMINATIONBOX

S. No.	Description	Activity
1	Checking of oil level in reservoir/ accumulator provided for cable termination box	

Annexure – 5

EOT CRANE–MONTHLY ACTIVITY

S. No.	Description	Activity
1	Movement of EOT Crane (Long travel, Cross travel, Hoist) without loading	
2	Limit Switch Operation	

CURRENT TRANSFORMER–SOS ACTIVITY (WITH SHUTDOWN)

Dt. of Commissioning..... **Make.....** **Rating.....** **S. No. .....** **Bay Loc.....**

PTW NO..... **Date.....**

(I) Measurement of CT Ratio **Details of Kit used:(Make, Rating & Sl. No) ….....** **Date of Last Calibration:……**

Primary Current	Secondary Current	Ratio	***Permissible ratio Error***	***Reference***
100Amp.			***Protection Core: +/-3%*** ***Metering Core: +/-1%***	***IS-2705***

(II) Measurement of Secondary Resistance **Details of Kit used:(Make, Rating & Sl. No)….....** **Date of Last Calibration:……**

Core	**Resistance Value**			**Remarks**
	RØ	**YØ**	**BØ**	
1				
2				
3				
4				
5				

(III) Magnetising Characteristics **Details of Kit used:(Make, Rating & Sl. No)….....** **Date of Last Calibration:……**

Applied Voltage in Secondary (Volts)	**Measured current (mA)**	**Primary Voltage (Volts)**

Annexure – 7

VOLTAGE TRANSFORMER–SIX MONTH LY ACTIVITY (WITHOUT SHUTDOWN)

Date of Commissioning..... **Make.....** **Rating.....** **Sr No.....** **Bay Loc .....**
PTW No..... **Date.....**

Name of Feeder/Bay	Measurement	Values Volts(forCore-3)		Voltage variation between Bus – I & Bus - II	Remarks/Observations &Action plan
		Bus-I	Bus-II		
	R-N				
	Y-N				
	B-N				

Note: Measurement to be carried out simultaneously for same phase of BusVTswith0.2classmulti-meter.
Readings to be taken from LCC Panel.

Drift in secondary Voltage (to be measuredby0.2/0.5classMultimeter)	*Condition*	*Measurement Frequency*	*Reference*
a)Upto±0.5volts	*Healthy*	*6 monthly*	*POWER GRID Practice*
b)+/-0.5to+/-0.8volts	*To be monitored*	*3 monthly*	
c)Beyond0.8 volts	*Case may be referred to CCA-AM*		

	Remarks Based on review of Test Results	Action to be taken on the remarks	Action taken for rectification	Closing of the Issue
Maintenance Engineer				
Substation Incharge				

PARTIAL DISCHARGE MEASUREMENT– YEARLY ACTIVITY (WITHOUT SHUTDOWN) (PORTABLE TEST KIT)

Details of testing kit used:
Make:

Type:

Principal of operation (UHF/Acoustic):

Equipment Details	Sensor No -/ Phase -	Sensor No -/ Phase -	Sensor No-/ Phase -	Sensor No-/ Phase -	Sensor No- /Phase-	Sensor No-/ Phase -
Date of Commissioning						
Location (Bay/Bus)						
Date of Checking (DD/MM/YYYY)						
System Voltage (in kV)						
Partial Discharge (%, mV, dB) $						
Remarks/Observations						

Note:

1. **To be carried out for GIS portion where Online Partial Discharge Monitoring System is not available.**
2. **During the first year after commissioning, Partial Discharge measurement is to be carried out every four months upto one year and thereafter on six monthly basis.**
3. **At the time of PD measurement all mobile devices, cutting & grinding tools, welding m/c etc to be switched off in and around the GIS hall/ GIS outdoor equipment to avoid interference and influence on the PD test system.**
4. **$: Measurement unit (mV, dB, %) to be mentioned as per the kit measurement unit system and in the remarks/ observations column, diagnostics done by kit (no PD, particle, corona, floating electrode, void, contamination etc) to be mentioned.**
5. **In case any partial discharge (even less than 5 pC) is detected at any location, partial discharge measurement to be repeated on weekly basis at those locations to monitor the trend.**

Annexure – 9

GIS HALL MAINTENANCE–YEARLYACTIVITY

I. AHU

S. No.	Description	Ok / Not Ok
1	Replacement of worn out filters	
2	Replacement of fan belts if required	
3	Lubrication and tightening of blower rotating mechanism and damper mechanism	

Annexure – 10

EOT CRANE–YEARLY ACTIVITY

S. No.	Description	Ok/ Not Ok
1	Greasing of pulley, sling, gear box and all other moving parts if required	
2	Functional test at rated load * or at least 110% of heaviest equipment installed in GIS	
3	Motor current to be measured at rated load (Long/Cross/Hoist Travel motor)	

***Load to be prepared by site either by casting of concrete block or any other compact weight**

Annexure – 11

CIRCUIT BREAKER - TWO YEARLY ACTIVITY (WITH SHUTDOWN)

PTWNO		**Make, Sl. No & Rating of Equip.**		**Date of commissioning**	
Bay Loc. No		**Date of Measurement**		**Ambient Temp**	

I. SF6CIRCUITBREAKER

(i) OIL PRESSURE DROP DURING DUTY CYCLE OPERATION-O-0.3 S-CO

	OILPRESSURE			
	Pre-commissioning value	**Previous value**	**Present value**	**Remarks/Observations**
Before Operation				
After Operation				
Drop in Pressure				

(a) Checking of Hydraulic Pump operation

	Set value	**Actual value**	**Remarks/Observations**
START(Pressure)			
STOP(Pressure)			

(b) Checkingofspringchargingmotor/hydraliccompressormotoroperationtiming

	Pre-commissioning value	**Present value**	**Remarks/Observations**
Duration of running			

(c) Checking of Pole Discrepancy Relay

TRIP 'R' ph	Measure Tripping Time of Y & B pole	
	Set Value* in sec	Operating Value in sec
PREVIOUS VALUE		
PRESENT VALUE		
Note- 2.5 sec for CBs with Auto Reclose function & 0.5 sec for CBs without Auto Reclose Function		

Close any one pole and observe the tripping of same pole

CLOSE 'R' pole	Measure Tripping Time of R pole	
	Set Value* in sec	Operating Value in sec
PREVIOUS VALUE		
PRESENT VALUE		
Note- 2.5 Sec for CBs with Auto Reclose Function &0.5 Sec for CBs without Auto Reclose Function.		

(d) **Checking of Anti Pumping relay**–by giving simultaneous s& continuous Close & Trip command, Hunting should not take place**.**
OK/NOTOK

(e) **Check of interlocks** (Local Closing Interlock): Earth Switch Interlocks with CB: Ok/Not Ok

(f) Check of Operating Lockouts

		Pressure Values					
Sl. No	Test-Description	A/R Lockout		Closing L/O		Operational Lockout	
		Set value	Actual	Set Value	Actual	Set Value	Actual
1.	Driving mechanism (Hydraulic)						

(g) Healthiness of Operation Counter

PHASE	ACTUALREADINGS		Remarks, Observation & Action Plan in case of Non-Conformance
	BEFOREOPERATION	AFTEROPERATION	
R			
Y			
B			

(i) Maintenance of Control Cabinets

1. Checking of tightness of all the terminations in MB.
2. Checking of Door Sealing gaskets and replacement thereof, if necessary
3. Check functioning of space heater /illumination

Annexure – 12

SF6GAS–FOUR YEARLY ACTIVITY (WITHOUT SHUTDOWN)

	Equipment Details	Gas Compartment Number -			Gas Compartment Number -			Gas Compartment Number -			Remarks/Observations
	Date of Commissioning										
	Bay Location										
	Date of Checking (DD/MM/YYYY)										
Sl	**Description of Activity**										
1	**Dew point in Deg C along with temperature and pressure at time of measurement**	**DP**	**Press**	**Temp**	**DP**	**Press**	**Temp**	**DP**	**Press**	**Temp**	
2	**Purity in %**										
3	***SO2 in ppm**										
4	***HF in ppm**										
5	***CF4 in ppm**										

***Where ever kit is available**

Note:

2. **During first year of commissioning, SF6 Gas testing is to be carried out for all compartments before completing one year service period. However, after first year, SF6 Gas testing is to be carried out every four years.**
3. **In case, SF6GasistoppedupinanyGasCompartmentthenSF6GastestingistobecarriedoutforthatGasCompartmentafter SF6gas filling and also after one week of Gas topping.**

Annexure – 13

CIRCUIT BREAKER-FOUR YEARLY ACTIVITY (WITH SHUTDOWN)

I BREAKER OPERATION CHECKS–

PTWNO		**Make & Sl. No of Equip.**		**Rating**		**DOC**	
Date of Measurement		**Bay Loc. No)**	**Kit Details (Make & Sl. No)**		**Last Calibration Date**		**Ambient Temp**

(a)CB timings including PIR checks

PHASE	DETAILS	CLOSE TIME	OPEN TIME		CLOSE OPEN (CO) TIME		Close coil current	Trip coil current				REMARKS& OBSERVATIONS
								Factory Values		Present Values		
			TRIP-I	TRIP- II	TRIP-I	TRIP- II		T_{c1}	T_{c2}	T_{c1}	T_{c2}	
R	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											
Y	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											
B	**PIR CONTACT**											
	MAIN CONTACT											
	PIR INSERTION TIME											
	AUXILIARY CONTACT (NC)											

Above PIR opening times is to be noted wherever applicable.

CO Time is to be measured with simultaneous Close-Trip Commands. In case provision does not exist for simultaneous Close/Trip commands in kit, Trip command to be given at least 10ms prior to closing of CB contacts.

Circuit Breaker Timing is to be done only at time of feeder shutdown. Reference Procedure is attached as Annexure–A.

II DYNAMIC CONTACT RESISTANCE MEASUREMENT–

CB POLES	Remarks on DCRM Signature from RHQ/AM
R phase	
Y phase	
B Phase	

Dynamic Contact Resistance signature for CO operation of CB to be recorded and compared with the earlier signatures. Minimum delay (co time) should be 300ms.

Sampling frequency for DCRM and Contact Travel Measurement--- 10KHZ

CircuitBreakerDCRMistobedoneonlyattimeoffeedershutdown.ReferenceProcedureisattachedasAnnexure–A.

III CONTACTRESISTANCEMEASUREMENT(CRM)–

Contact Resistance to be measured across Circuit Breaker using Earth Switches located at both end of CBs

CB Pole	Present value of resistance (in micro-ohm)	Previous value of Resistance (in micro-ohm)	Pre-commissioning value of resistance (in micro-ohm)
R phase			
Y phase			
B phase			

Circuit Breaker CRM is to be done only at time of feeder shutdown. Reference Procedure is attached as Annexure–A.

During first year of commissioning. CB Condition Monitoring Tests such as Timing, CRM & DCRM to be carried out before completing one year of service period.
In addition to normal frequency (i.e. every 4 years), DCRM, CRM & TIMING Measurement tes is to be carried out in month of April of next financial year AMP cycle if any of following condition is met:

ii. More than 150 nos. switching operations are performed by CB since last contact resistance measurement test. For the purpose of counting switching operations, One no. Close & Open cumulatively shall be considered as One no. Switching Operation. Only, onload operations shall be considered as switching operation and off line operations shall not be considered as switching operations

iii. Summation of square of fault current cleared by any CB pole exceeds 200 kA sq since last contact resistance test.

Notifications in SAP shall be triggered for performing DCRM, CRM & Timing test upon meeting conditions specified above.

Annexure – 14

DENSITY MONTIOR – FIVE YEARLY ACTIVITY (WITH SHUTDOWN)

	Equipment Details	Gas Compartment Number-	Gas Compartment Number-	Remarks/ Observations
	Date of Commissioning			
	Bay Location			
	Make of Density Monitor			
	Serial Number of Density Monitor			
	Date of Checking (DD/MM/YYYY)			
Sl	**Description of Activity**			
1	**Checking the status of LowSF6 Alarm (stage-1) at BCU**	**Ok/ Not Ok**	**Ok/ Not Ok**	
2	**Checking the status of SF6 Signal for Lockout/zone tripping (stage-2A) at BCU**	**Ok/ Not Ok**	**Ok/ Not Ok**	
3	**Checking the status of SF6 Signal for Lockout/zone tripping (stage-2B) at BCU**	**Ok/ Not Ok**	**Ok /Not Ok**	

Note:

1. **To be done only with Feeder Shutdown (Line/ICT/Reactor).**
2. **Testing to be done by Isolating the Density Monitor from the Gas Compartment so that there is no release of SF6 gas from the Gas Compartment.**
3. **Bus Bar Tripping on Zone Tripping Logic due to SF6 Stage–2A/2B contact operation must be isolated at the time of Density Monitor Testing.**
4. **Precautions should also be taken to isolate Tripping of adjoining Bays (eg Tripping from Tie Bay to Main Bay in One Half Breaker Scheme, Feeder Bays to Auxiliary Bus etc) at the time of Density Monitor Testing.**