



Third Party Protection Audit at the following Substaions of Resonia:

1. Nangalbibra- Bongaigaon Transmission Limited (Locations: Nangalbibra, Bongaigaon, Hatsingimari & Ampati)
2. Goa Tamnar Transmission Project Limited (Location: Goa)
3. Mumbai Urja Marg Limited (Location: Vapi)
4. Lakadia-Vadodara Transmission Project Limited (Locations: Lakadia & Vadodara)



CENTRAL BOARD OF IRRIGATION & POWER

Malcha Marg, Chanakyapuri, New Delhi - 110021

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Central Board of Irrigation and Power
Malcha Marg, Chanakyapuri, New Delhi-110021

Preface

Work Order Numbers 3370000016, 4530000033, 4840000094, and 4840000095, all dated 26.05.2025, were issued by Resonia, Gurugram to Central Board of Irrigation and Power for conducting Protection Audits at the following projects:

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4. Lakadia-Vadodara Transmission Project Limited (Locations: Lakadia & Vadodara)

S.N.	Description	Dates (Period) of Audit
1	Two (02) Nos 765 kV Vadodara Line Bays at 765/400 kV Lakadia Substation of LVTPL	17/06/2025 to 19/06/2025
2	Two (02) Nos 765 kV Lakadia Line Bays at 765/400/220 kV Vadodara Substation of LVTPL	24/06/2025 to 27/06/2025
3	220/ 132 kV Nangalbibra Substation of NBTL	30/06/2025 to 02/07/2025
4	Two Nos. 132 kV Hatsingimari Line Extension Bays at 132/ 33 kV Ampati Substation of NBTL	02/07/2025 to 03/07/2025
5	Two Nos. 132 kV Ampati Line Extension Bays at 132/ 33 kV Hatsingimari Substation of NBTL	04/07/2025 to 05/07/2025
6	Two Nos. 220 kV Nangalbibra Line Extension Bays at 400/ 220 kV Bongaigaon Substation of NBTL	06/07/2025 to 07/07/2025
7	400/ 220 kV Xeldem GIS Substation of GTTPL	08/07/2025 to 12/07/2025
8	400/ 220 kV Vapi GIS Substation of MUML	20/08/2025 to 24/08/2025

Auditing of all the assigned substations and bays was successfully completed on 24.08.2025. Consolidated report is being put up for information of Resonia, Gurugram.

During the course of the audit, the audit team's observations and recommendations were communicated directly to the respective Station In-charges to facilitate immediate action on critical findings.

Pradeep Kumar Gupta
Jt Advisor (BD)

220/ 132 kV Nangalbibra Substation

OBSERVATIONS DURING AUDIT OF 220 kV/ 132 kV NANGALBIBRA SUBSTATION OF RESONIA GROUP

220 kV / 132 kV Nangalbibra substation was established as a part of Transmission System associated with Nangalbibra- Bongaigaon Transmission Limited Project (NBTL) in North-Eastern Region.

The Substation was commissioned on 16.11.2024 with the energization of 220 kV Bongaigaon Line- 1 and Line-2, 160 MVA 220 kV/ 132kV/ 33 kV ICT- 1 and ICT- 2, 31.5 MVA 220 kV Bus Reactor-1 and Bus Reactor-2 and downward 132 kV line bays.

Dates of commissioning of various elements are as under:

S.N.	220 kV Lines	Line Length (KM)	Date of Commissioning
1	Bongaigaon Ckt-1	122.9	16/11/2024
2	Bongaigaon Ckt-2	122.9	16/11/2024

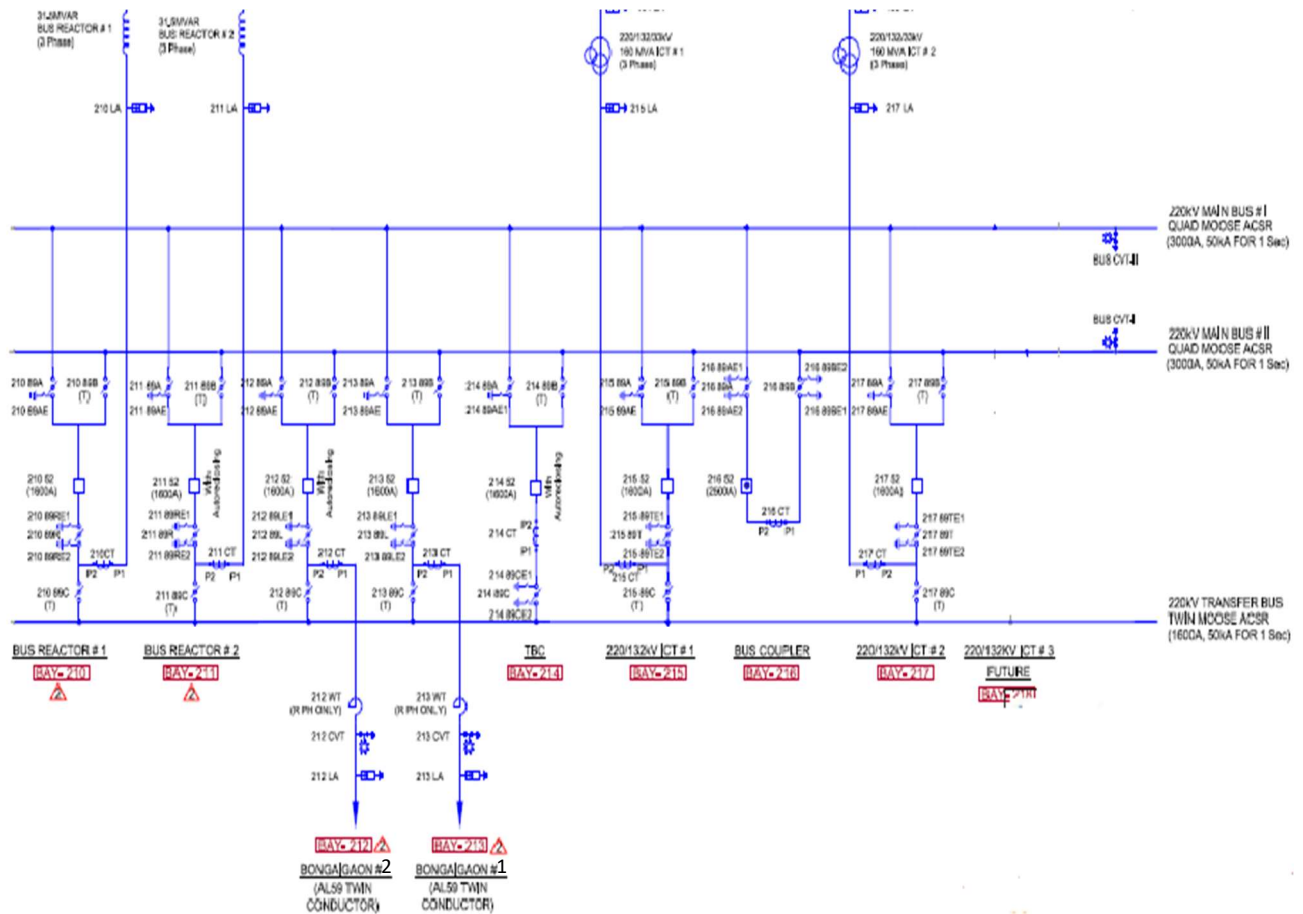
S.N.	Name of the Element	Capacity	Date of Commissioning
1	220 kV/ 132kV/ 33 kV ICT-1	160 MVA	17/11/2024
2	220 kV/ 132kV/ 33 kV ICT-2	160 MVA	16/11/2024
3	220 kV Bus Reactor-1	31.5 MVA	17/11/2024
4	220 kV Bus Reactor-2	31.5 MVA	17/11/2024

S.N.	132 kV Line Bays	Bay No.	Date of Commissioning
1	Nangalbibra MePTCL Ckt-1	101	17/11/2024
2	Nangalbibra MePTCL Ckt-2	102	17/11/2024

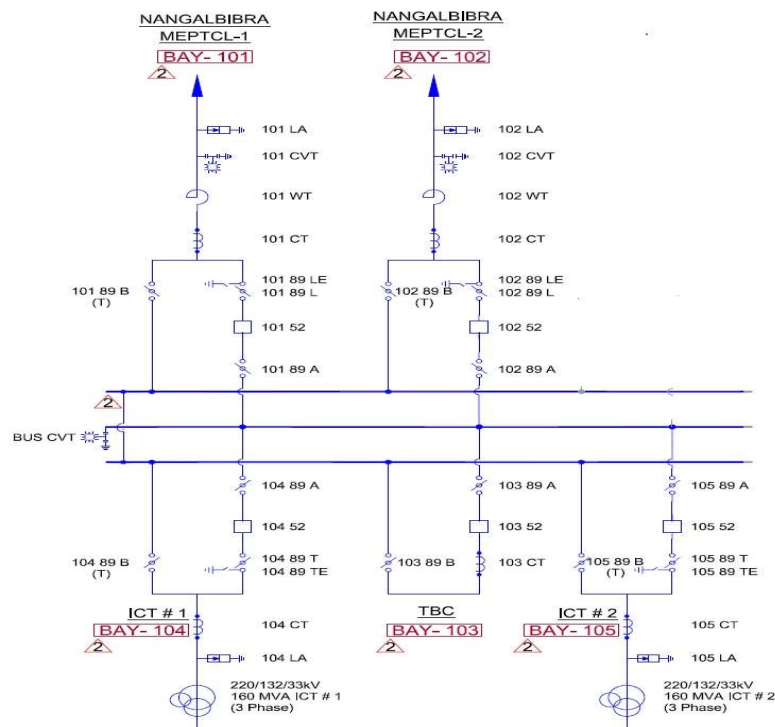
The system is presently charged on no-load as the downstream 132 kV lines are yet to be erected by Meghalaya Power Transmission Corporation Limited (MePTCL). All other elements under the scope of Resonia Group have been commissioned and charged at no-load with no power flow.

The 220 kV/ 132 kV system which is presently commissioned and in charged condition has been shown in the Single Line Diagram as attached below:

220 kV switchyard at Nangalbibra



132 kV switchyard at Nangalbibra



Observations and Suggestions by team of Auditors during visit to the Substation premises and during perusal of records placed before the team of Auditors are as under:

1.0 Operation and Maintenance

Voltage Profile during the period November 2024 to May 2025 was reviewed. Month wise Maximum and Minimum Voltage (**in kV**) Profile for 220 KV Bus is tabulated below:

Month	Year			
	Bus-1 Voltage (in kV)		Bus-2 Voltage (in kV)	
	Max	Min	Max	Min
Nov 2024	230.2	219.1	229.7	218.8
Dec 2024	230.19	218.03	230.29	219.83
Jan 2025	230.19	218.43	230.29	217.99
Feb 2025	229.9	218.9	229.6	218.6
Mar 2025	229.3	212.7	229.2	212.7
Apr 2025	229.00	211.76	228.9	217.46
May 2025	228.62	213.92	228.64	213.92

It is suggested that necessary direction be given to operating personnel to keep record of system parameters at the instant of any manual operation of the transmission element (including Bus Reactor) at the substation.

The Substation is being operated from remote. Trip Reports with Relay Flag details & PLCC Counter advancement details along with Trip Analysis need to be available at Substation level. It is to ensure that deficiencies are addressed at the earliest opportunity.

Readings of OTI and WTI of ICTs and Reactors at Local and Remote were compared and wide difference in WTI & OTI readings of Y phase Reactor of Line-1, as tabulated below, has been noted:

Transformers & Reactors	WTI HV (in °C)		WTI LV (in °C)		OTI (in °C)	
	Local	SCADA	Local	SCADA	Local	SCADA
ICT-1	47	33.2	45	33.59	48	41.40
ICT-2	47	31.9	46	32.40	47	40.40
Bus Reactor- 1	62	60.37	-	-	54	56.47
Bus Reactor-2	65	60.02	-	-	56	57.11

Necessary action needs to be taken to ensure consistency of readings (Local and SCADA) to the extent possible.

The results of DGA and BDV tests conducted on transformer and reactor elements of the substation pre-charging are as under:

Name Of The Equipment	Date Of Commissioning	Date Of Sampling	BDV (kV)	CO (μl/l)	CO ₂ (μl/l)	C ₂ H ₂ (μl/l)	C ₂ H ₆ (μl/l)	C ₂ H ₄ (μl/l)	CH ₄ (μl/l)	H ₂ (μl/l)	O ₂ (μl/l)	N ₂ (μl/l)	TGC	Water (ppm)
ICT-1	17.11.2024	22.05.24	85.9, 92.6, 98.6	ND	555	ND	ND	ND	ND	ND	1580	2856	-	5
ICT-2	16.11.2024	11.06.24	79.9, 75.9, 88.1	1	214	ND	ND	ND	ND	ND	1492	2719	-	7
Bus-Reactor-1	17.11.2024	22.07.24	94.9, 82.6, 94.3	ND	346	ND	ND	ND	ND	ND	845	1910	-	4
Bus-Reactor-2	17.11.2024	11.07.24	88.9, 90.0, 85.0	ND	478	ND	ND	ND	ND	ND	895	2143	-	6

The results of DGA test conducted on transformer and reactor elements of the substation post charging (after 1 week) are as under:

Name Of The Equipment	Date Of Commissioning	Date Of Sampling	CO (μl/l)	CO ₂ (μl/l)	C ₂ H ₂ (μl/l)	C ₂ H ₆ (μl/l)	C ₂ H ₄ (μl/l)	CH ₄ (μl/l)	H ₂ (μl/l)	O ₂ (μl/l)	N ₂ (μl/l)	TGC	Water (ppm)
ICT-1	17.11.2024	26.11.24	ND	151	ND	ND	ND	ND	2	4226	10044	-	ND
ICT-2	16.11.2024	26.11.24	ND	106	ND	ND	ND	ND	5	2177	6246	-	ND
Bus-Reactor-1	17.11.2024	26.11.24	ND	93	ND	ND	ND	ND	3	2099	8228	-	ND
Bus-Reactor-2	17.11.2024	26.11.24	ND	86	ND	ND	ND	ND	3	489	3524	-	ND

The oil parameters and DGA results are well within the prescribed limit. The last oil sampling was carried out on 26.11.2024, therefore, oil sampling is due for all ICTs and Reactors (Half-yearly sampling). It may be taken up at the earliest opportunity.

Third Harmonic Resistive Current (THRC) of LAs was measured after charging of the system on 17.11.2024. The leakage current values reviewed were found to be within prescribed limit. It is suggested that the measurement of THRC be undertaken pre-monsoon and post-monsoon basis to ensure healthiness of the LAs.

Thermo-vision scanning of substation equipments has not been undertaken by NBTL personnel since charging of the substation. It is suggested that even though the substation is currently on no-load but one time thermo-vision scanning be undertaken to check for any loose connection/ hot-spots on any equipment in the substation.

2.0 Transformers and Reactors

During the site inspection, it has been observed that oil is coming in OLTC breather from OLTC conservator. Further investigation revealed that the transformer's main tank and OLTC tank are communicating with each other, leading to the mixing of main tank oil with OLTC oil. The site manager has informed that the matter has already been taken up with the

manufacturer. This needs to be addressed at the earliest opportunity to avoid the mixing of main tank oil and OLTC tank oil.



It was also observed that there was seepage of oil from oil headers and cooling accessories of the main tank of ICT-1 and ICT-2. This also need to be arrested in due course of time.



It is observed that Maximum Temperature of Winding Temperature Indicator (WTI) And Oil Temperature Indicator (OTI) of 160 MVA 220 / 132/ 33 ICT- 1 and ICT- 2, 31.5 MVAr 220 Bus Reactor-1 and Bus Reactor-2 have gone beyond 130°C. This seems to be erroneous. It may so happen that pointer was manually operated during maintenance checking of Alarm/ Trip circuit of respective device. Maintenance Engineer needs to reset the maximum temperature indicator after testing.



Pre-Commissioning test results of Transformers and Reactors were reviewed and it is observed that Polarization Index (PI) of ICT-2 varies from 1.36 to 2.38.

Transformers & Reactors	Testing Date	(HV+ IV) – LV	(HV+ IV) – E	LV - E	HV - E
ICT-1	08.06.2024	1.53	1.60	1.87	NA
ICT-2	08.06.2024	1.87	1.36	2.38	NA
Bus Reactor- 1	16.07.2024	NA	NA	NA	1.99
Bus Reactor-2	15.07.2024	NA	NA	NA	1.92

It is to be noted that Oil filled equipment having Polarization Index above 2.0 is considered to be dry. In view of the above, it can be inferred that complete dry out of ICTs was not undertaken prior to energisation.

Pre-commissioning core insulation values were reviewed and it is observed that core insulation were recorded as >1 GΩ. It indicates that the Megger used for the measurement

didn't have the capability to record values $>1 \text{ G}\Omega$. As such, it prevents the trend analysis of core insulation (C_C-C_L , C_C-E and C_L-E) resistance in future. Hence, it is recommended to conduct above test with a higher range Insulation Resistance Tester in future.

3.0 Control and Protection

The latest duly approved relay settings for all the protection relays was not available at site. It is advised to always keep it at the substation for verification/ inspection and analysis.

There needs to be a practice of maintaining detail Trip reports with Disturbance Recorder outputs & SCADA output and analysis of consolidated Trip events at site level in printed hard copy. Due to non-availability of printed consolidated reports performance of the Protection system examined during the audit process became cumbersome. Critical analysis of Trip Events by studying Disturbance Recorder output and Event Recorder output in association with Relay fault files be ensured for planning of remedial actions for improvement in System Operation.

Generation of reports by SCADA as required by management on time-to-time basis for system planning need to be feasible with least manual intervention.

Power Swing function

Upon analysing the protection philosophy of Nangalbibra substation, it was found that in 220 kV lines, Power Swing protection blocks all zones and OOS function is enabled whereas in 132 kV line protection, it blocks all zones except Zone-1 is enabled.

As regard Power Swing blocking function, Rama Krishna Committee had recommended two options, in brief, as under:

There are a number of options one can select in implementing power-swing protection in their system. Designing the power system protection to avoid or preclude cascade tripping is a requirement of modern day power system. Below we list two possible options:

- Block all Zones except Zone-1
- Block all Zones and Trip with Out of Step (OOS) Function

12.3. Placement of OOS trip Systems

Out of step tripping protection (Standalone relay or built-in function of Main relay) shall be provided on all the selected lines. The locations where it is desired to split the system on out of step condition shall be decided based on system studies. The selection of network locations for placement of OOS systems can best be obtained through transient stability studies covering many possible operating conditions.

Till such studies are carried out and Out-of-Step protection is enabled on all identified Lines, it is recommended to continue with the existing practice of Non- Blocking of Zone-I on Power Swing.

However, it should be remembered that with this practice the line might trip for a recoverable swing and it is not good to breakers.

Committee strongly recommends that required studies must be carried out at the earliest possible time (within a timeframe of one year) to exercise the options above.

In view of recommendation as above, NBTL may expedite Transient Stability study so that appropriate feature can be enabled in the Line Protection Relay.

Several Events which are not relevant for analysis of Disturbances may not be mapped in Disturbance Recorder. Proper designation of Events be undertaken. Analog and Digital Channels of Disturbance Recorder be configured as per standard guidelines.

Proper Functioning of Fault Locators at both ends of the Line needs to be ensured and any mismatch in readings with actual location of fault may be taken up with the Manufacturer of the Protection Relays for necessary modification of the Scheme. Accurate identification of fault location will minimize Outage duration as well.

Limited details of Trip instances of various elements were reviewed. Observations on available trip data are as under:

1. Remote end data is not available at the station. As such, co-ordinated functioning of Protection Relays at both ends of the Line Feeders could not be reviewed.
2. Tripping of 220 kV Bongaigaon Line-1 and 220 kV Bongaigaon Line-2 on 10.05.2025
 - Fault locator reading is not matching with the actual fault location distance. Hence, relay setting data and configuration is to be reviewed for their accuracy.
 - Z1 OPTD is to be configured in DR of Main- 1 Micom relay
 - Main-2 Protection operated is to be configured in Main-1 Protection and vice-versa.
 - DR PDF output report doesn't have the name of the line/ element in the header which should be programmed accordingly for retrieval of DR data
3. Tripping of 220 kV Bus Reactor- 2 on 04.02.2025
 - Tripped twice on operation of Backup Impedance protection. On site investigation by NBTL staff, it was found that there was a problem in voltage selection scheme for backup impedance relay due to which voltage was not extended to protection during changeover of the bus voltage. The scheme has now been modified and the voltage of Bus-1 and Bus- 2 to Backup Impedance relay is being extended whenever there is a change in bus voltage (1 or 2) during switching operation.

4. Tripping of ICT-1, ICT-2, Bus Reactor-1, Bus Reactor-2 on date 26.04.2025
 - During 220 Bus-1 fault, all the above-mentioned elements maloperated simultaneously. During the event, ICT-1 and ICT-2 tripped on differential protection while Bus Reactor-1 and Bus Reactor-2 tripped on REF protection.
 - On site investigation by NBTL staff, it was found that there was a problem in stabilizing resistor in differential relay of ICT-1 and ICT-2 and REF relay of Bus Reactor-1 and Bus Reactor-2. The same has been rectified and no further problem has been observed till date.
 - It is recommended that the settings of the differential protection and REF protection be reviewed to avoid maloperation of the above-mentioned elements for a through fault.

Fault Location data as provided by Main- 1 & 2 Distance Protection Relays at both ends of Lines vis- a- vis actual locations of Fault reported by Transmission Line Maintenance gang are as tabulated below:

Name of Line	Date	Time	Line Length (KM)	Fault Current fed from Nangalbibra (kA)	Fault Distance from Nangalbibra end (KM)		Actual Fault Distance from Nangalbibra end (KM)
					Main-1	Main-2	
Bongaigaon Line-1	10.05.2025	17:49:57	122	1.07 kA	118.4 KM	122.2 KM	82.97 KM
Bongaigaon Line-2	10.05.2025	17:49:57	122	0.87 kA	143.8 KM	141.0 KM	82.97 KM

From the above, it can be observed that there is wide difference in Fault Distances provided by Main-1 & 2 Distance Protection Relays in both 220 kV Lines. It is suggested that Protection Relay settings be reviewed once again to fine tune the distance measurement by Line Protection Relays. This will provide very valuable information to the Line Maintenance Crews to pin point the location of fault and rectification of defect in shortest possible time.

4.0 Auxiliary DC and AC System

Measurement of DC Auxiliary Voltage was undertaken; Source-I & II was found to be as under:

Description	Source- I	Source- II
Positive to Negative	244.6 V	243.7 V
Positive to Earth	129.5 V	128.9 V
Negative to Earth	-114.6 V	-114.4 V

Description	Voltage
Positive of Source-I to Negative of Source-II	243.7 V
Negative of Source-I to Positive of Source-II	244.1 V

Both the 220V DC Source-I and Source-II have DC earth fault leading to unbalance DC voltage. This has to be rectified by locating and removing the faults and thereby arresting the DC leakages.

Measurement of DC Auxiliary Voltage for communication equipment was undertaken and was found to be as under:

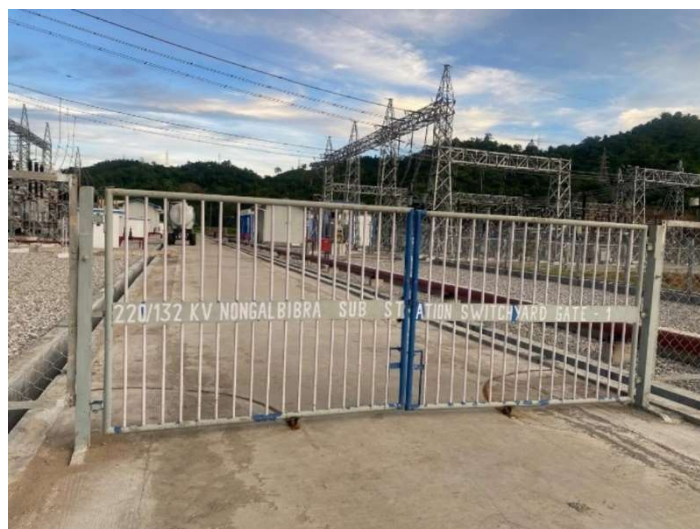
Description	Source- I	Source- II
Positive to Negative	53.12 V	52.27 V
Positive to Earth	0.78 V	0.77 V
Negative to Earth	-52.30 V	-51.47 V

Description	Voltage
Positive of Source-I to Negative of Source-II	53.1 V
Negative of Source-I to Positive of Source-II	52.28 V

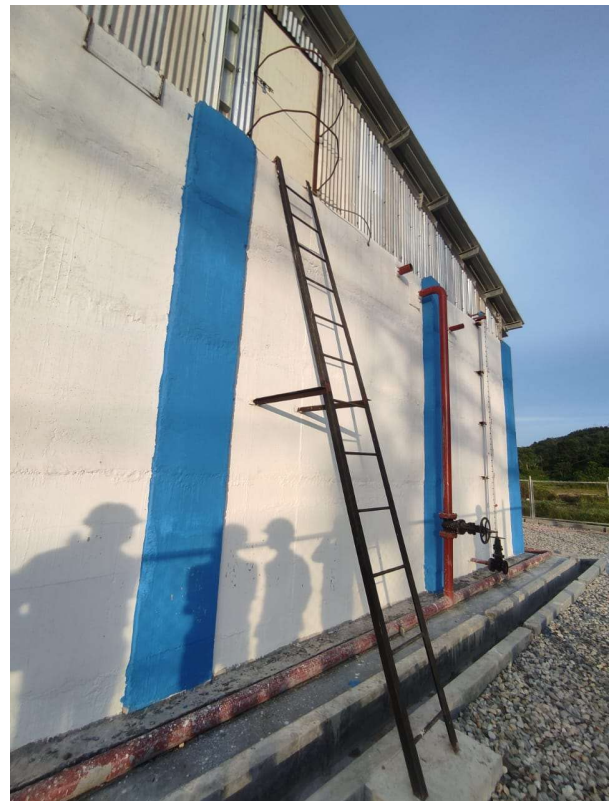
5.0 Earthing

Proper Earthing of Switchyard Gates has to be provided. In this regard IEEE 80 recommends as under:

“The ground grid should extend to cover the swing of all substation gates. Gate posts should be securely bonded utilizing a flexible connection”.



Earthing of ladders in the substation needs to be ensured. All metallic structure/ enclosure/ non-current carrying parts need to be earthed. The ladders should also anchored properly on the supporting walls.



For safety, compliance of recommendations provided in IEEE 80-2013 be ensured.

8.2 Typical shock situations During a fault, the earth conducts currents that emanate from the grid and other permanent ground electrodes buried below the earth's surface. In the case of conventional substations, the typical case of metal-to-metal touch voltage occurs when metallic objects or structures within the substation site are not bonded to the ground grid. **Objects such as pipes, rails, or fences** that are located within or near the substation ground grid area, and not bonded to the ground grid, meet this criterion. Substantial metal-to-metal touch voltages may be present when a person standing on or touching a grounded object or structure comes into contact with a metallic object or structure within the substation site that is not bonded to the ground grid. In practice, hazards resulting from metal-to-metal contact may best be avoided by bonding potential danger points to the substation grid.

Report of measurement of Earth resistance as was undertaken on 12.09.2024 was reviewed. It is observed that Earth grid resistance is varying from 0.2 Ω to 0.4 Ω .

6.0 General

It was observed that the smoke and heat detection of the substation is yet to be commissioned. Since the substation is in charged state, it is recommended to get all the fire safety equipments commissioned and fit for use.

The substation is present in Meghalaya which is a very heavy rainfall inundated state. As such, the audit team observed that the outer periphery wall of the substation was damaged due to the soil erosion caused by the rain water getting collected and consequent loss of soil strength. Temporary restoration for security of the site has been taken up by the site management. However, for permanent solution this needs to be taken up at the management at the earliest as the erosion was seen adjacent to the foundation of gantry tower.



During the site visit, it was observed that switchyard equipment identification is existing but the operating box of CB may also be suitably marked for easy identification of the particular bay CB.



7.0 Statutory Warnings

Danger Notice Boards need to be fixed in Switchyard area as a statutory requirement. In this regard Indian Electricity Rules (1956) stipulates as under:

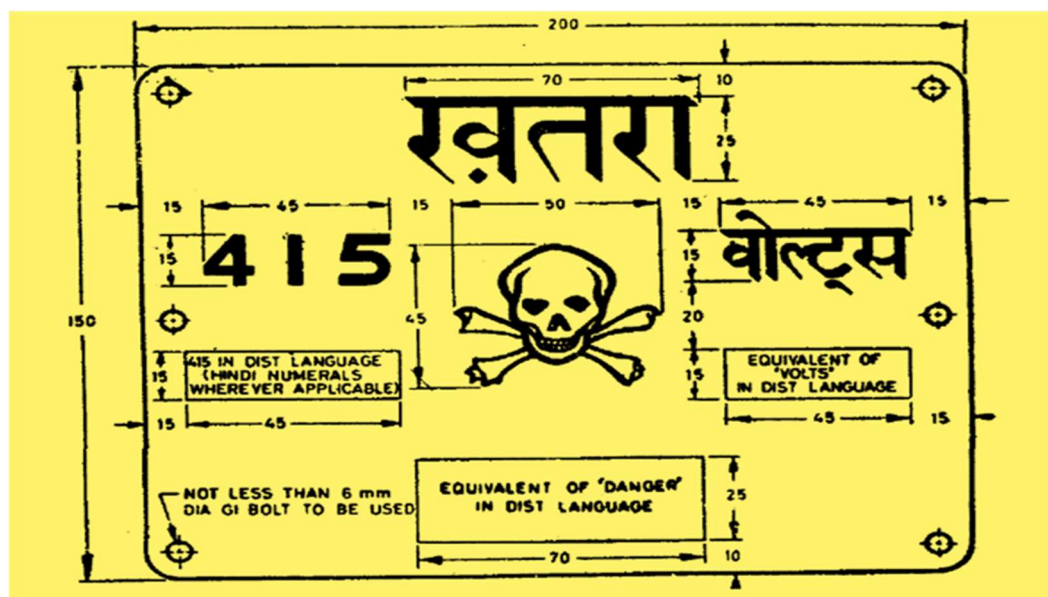
35.Danger Notices:- The owner of every medium, high and extra-high voltage installation shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the district, with a sign of skull and bones 1[of a design as per the relevant IS No.2551]....

Relevant provision in IS2551 is as under



3. MATERIAL AND FINISH

The plate shall be made from mild steel, atleast 1.6 mm thick and vitreous enamelled white, with letters, figures and the conventional skull and cross-bones in signal red colour [see IS:5-1978t] on the front side. The rear side of the plate shall also be enamelled.



- NOTE 1 — All letterings should be centrally spaced.
- NOTE 2 — The dimensions for the words in district language are mainly for guidance, however, care should be taken to space them centrally between the edges and the area of the skull and bones.
- NOTE 3 — The location of the fixing holes shall be left to the choice of the user.
- NOTE 4 — The corners of the plates should be rounded off.

All dimensions in millimetres.

NBTL to ensure compliance in the above stipulation in the statute.

**220 kV Nangalbibra Line
Bays at 400/ 220 kV
Bongaigaon Substation**

OBSERVATIONS DURING AUDIT OF 2 NO. 220 kV BAYS OF RESONIA GROUP

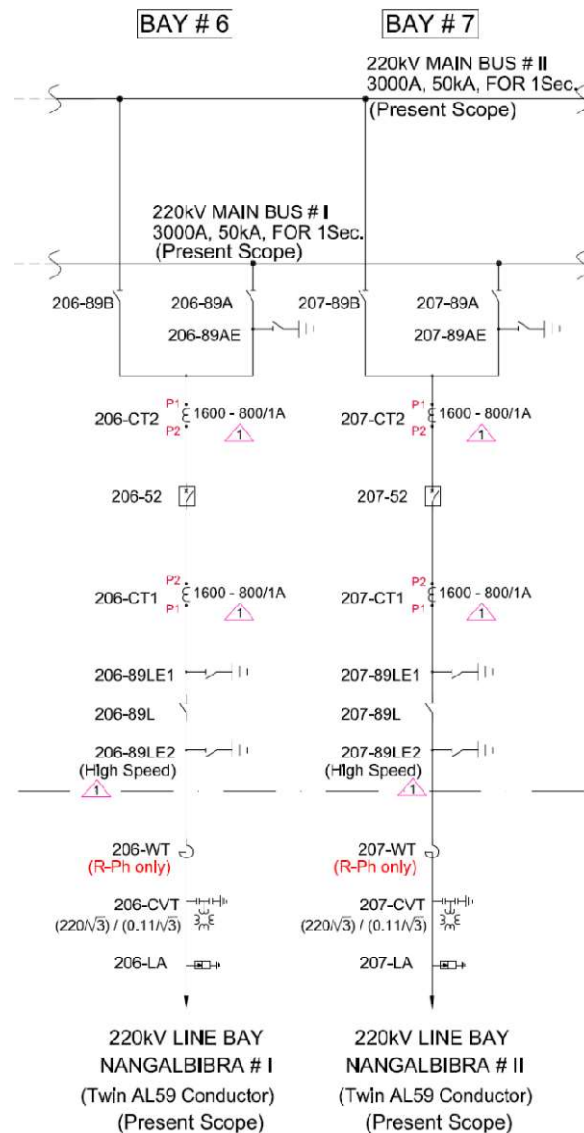
AT 400/ 220 kV PGCIL BONGAIGAON SUBSTATION

As part of NBTL project, 2 no. 220 kV bays pertaining to 220 kV Bongaigaon- Nangalbibra Double circuit lines were commissioned on 16.11.2024 by Resonia Group at 400/ 220 kV Bongaigaon substation of POWERGRID Corporation of India Limited (PGCIL).

Dates of commissioning of various elements are as under:

S.N.	220 kV Lines	Line Length (KM)	Date of Commissioning
1	Nangalbibra Ckt-1	122.9	16/11/2024
2	Nangalbibra Ckt-2	122.9	16/11/2024

The 220 kV system of Resonia Group at Bongaigaon 220 KV GIS substation of PGCIL has been shown in the Single Line Diagram as attached below:



Observations and Suggestions by team of Auditors during visit to the Substation premises and during perusal of records placed before the team of Auditors are as under:

1.0 Operation and Maintenance

The line bays are installed in PGCIL Bongaigaon substation and the O&M of NBTL equipments is being done by PGCIL on chargeable basis.

Third Harmonic Resistive Current (THRC) of LAs was measured after charging of the system on 16.11.2024. The leakage current values reviewed were found to be within prescribed limit. It is suggested that the measurement of THRC be undertaken pre-monsoon and post-monsoon basis to ensure healthiness of the LAs.

Thermo-vision scanning of substation equipments has not been undertaken by NBTL personnel since charging of the line bays at the substation. It is suggested that even though the bays are currently charged on no-load but one time thermo-vision scanning be undertaken to check for any loose connection/ hot-spots on any equipment in the substation.

During switchyard visit, it was observed that chipping has occurred (damaged petticoat) on porcelain insulator housing of R phase CVT. It is advised to repair it to avoid ingress of moisture so as to ensure healthiness of CVT.



2.0 Control and Protection

The relay setting recommendation Rev. 1 dated 09/11/2024 for Main-1 and Main-2 protection provided by GE Vernova T&D India Ltd. to Sterlite Power Transmission Ltd. were verified through DR PC. Although, most of the settings recommended were matching with the settings incorporated in the relay of Main-1 and Main-2, but some settings were not matching with the provided settings which would result in under-protected system, unwanted tripping or inaccurate trip reports. It is suggested to get the relay settings matched to duly approved settings (signed and stamped) from SPTL.

Main-1 Protection Mismatches

GROUP 1 DISTANCE SETUP	
31.01: Dist.Earth Mode:	Standard
31.0C: Setting Mode:	Advanced
31.10: PHASE DISTANCE:	
31.11: Phase Chars.:	Quad
31.20: Zone 1 Ph Status:	Enabled
31.22: Zone 1 Ph Dir.:	Forward
31.30: Zone 2 Ph Status:	Enabled
31.32: Zone 2 Ph Dir.:	Forward
31.40: Zone 3 Ph Status:	Enabled
31.42: Zone 3 Ph Dir.:	Forward
31.50: Zone P Ph Status:	Disabled
31.58: Zone Q Ph Status:	Disabled
31.60: Zone 4 Ph Status:	Enabled
31.62: Zone 4 Ph Dir.:	Reverse
31.70: GROUND DISTANCE:	
31.71: Ground Chars.:	Quad
31.80: Zone 1 Gnd Stat.:	Enabled
31.82: Zone 1 Gnd Dir.:	Forward
31.90: Zone 2 Gnd Stat.:	Enabled
31.92: Zone 2 Gnd Dir.:	Forward
31.A0: Zone 3 Gnd Stat.:	Enabled
31.A2: Zone 3 Gnd Dir.:	Forward
31.B0: Zone P Gnd Stat.:	Disabled
31.B8: Zone Q Gnd Stat.:	Disabled
31.C0: Zone 4 Gnd Stat.:	Enabled
31.C2: Zone 4 Gnd Dir.:	Reverse
31.D0: Digital Filter:	Standard
31.D1: CVT Filters:	Active
31.D3: Load Blinders:	Enabled
31.D4: Z< Blinder Imp:	14.64 Ohm
31.D5: Load/B Angle:	30.00 deg
31.D6: Load Blinder V<:	47.50 V
31.D7: Dist. Polarizing:	1.000
31.E0: DELTADIRECTIONAL:	
31.E1: Dir. Status:	Enabled
31.E2: AidedDeltaStatus:	Disabled
31.E3: Dir. Char Angle:	60.00 deg
31.F0: DIST STUB BUS:	
31.F1: Dist Stub Bus:	Disabled

DISTANCE SETUP		
Setting Mode	Advanced	
PHASE DISTANCE		
Phase Chars	Quad	
Zone 1 Ph Status	Enabled	
Zone 2 Ph Status	Enabled	
Zone 3 Ph Status	Enabled	
Zone 3 Ph Dir	Forward	

For M/S STERLITE POWER TRANSMISSION LTD.
220KV BONGAIGAON - NANGALIBRA LINE PROTECTION
REV 1

M/S. GE VERNOVA T&D INDIA LTD.
19/1, G.S.T.ROAD,PALLAVARAM,
CHENNAI- 43.



Zone P Ph Status	Disabled	
Zone 4 Ph Status	Enabled	
GROUND DISTANCE		
Ground Chars	Quad	
Zone 1 Gnd Stat	Enabled	
Zone 2 Gnd Stat	Enabled	
Zone 3 Gnd Stat	Enabled	
Zone 3 Gnd Dir	Forward	
Zone P Gnd Stat	Disabled	
Zone 4 Gnd Stat	Enabled	
Digital Filter	Standard	
CVT Filters	Disabled	
Load Blinders	Enabled	
Maximum full load current in Amps	CT Ratio	
	800	
Max.current in Amps in secondary I max	1.0	
In general the relay setting must allow for a level of overloading, typically a maximum current of 120% of I _{max} prevailing on the system transmission lines.		
With such a heavy load flow, the system voltage may be dipped, typically with phase voltages down to 80% of V _n nominal.		
Considering CT, PT, relay errors with tolerance and safety margin the load impedance may be 150% the expected rating. To avoid the load enochromment condition, the blinder impedance needs to be set as follows,		
Z< Blinder Imp in Ohms	(0.8*Rated voltage)/(I _{max} *1.5)	
	(0.8*63.52)/(1*1.5)	
	33.88	
Load Blinder V< in Volts	0.85*63.5	
	53.975	
Load/Blinder Angle		
Angle setting for the two blinder lines boundary with the gradient of the rise or fall with respect to the resistive axis.		
β in degrees	Arc Cos (0.85) + 15°	
	46.78°	
Dist Polarizing	1.00	
DELTA DIRECTIONAL		
Dir Status	Enabled	
Aided Delta Status	Ph & Gnd	
Dir. Char Angle	30.00	Degree
Dir. V Fwd	5.00	Volts
Dir. V Rev	4.00	Volts
Dir. I Fwd	100.0	mA
Dir. I Rev	80.0	mA

Note: The Delta directional settings are given as per general practice. However it can be modified according to

GROUP 1 DIST. ELEMENTS		
32.01:	PHASE DISTANCE:	
32.02:	Z1 Ph. Reach:	6.090 Ohm
32.03:	Z1 Ph. Angle:	84.00 deg
32.07:	R1 Ph. Resistive:	12.00 Ohm
32.08:	Z1 Tilt Top Line:	-5.000 deg
32.09:	Z1 Sensit. Iph>1:	80.00 mA
32.10:	Z2 Ph. Reach:	11.42 Ohm
32.11:	Z2 Ph. Angle:	84.00 deg
32.15:	R2 Ph. Resistive:	24.00 Ohm
32.16:	Z2 Tilt Top Line:	0 deg
32.17:	Z2 Sensit. Iph>2:	80.00 mA
32.20:	Z3 Ph. Reach:	18.27 Ohm
32.21:	Z3 Ph. Angle:	84.00 deg

DIST ELEMENTS		
Z1 Ph. Reach	6.089	Ohm
Z1 Ph. Angle	83.998	Degree
R1 Ph. Resistive	43.190	Ohm
Z1 Tilt Top Line	-3.0	Degree
Z1 Sensit. Iph>1	75.0	mA
Z2 Ph. Reach	11.416	Ohm
Z2 Ph. Angle	83.998	Degree
R2 Ph. Resistive	43.190	Ohm
Z2 Tilt Top Line	-3.0	Degree
Z2 Sensit. Iph>1	75.0	mA
Z3 Ph. Reach	18.266	Ohm
Z3 Ph. Angle	83.998	Degree
R3 Ph. Resistive	43.190	Ohm
Z3 Tilt Top Line	-3.0	Degree
Z3 Sensit. Iph>1	75.0	mA
Z4 Ph. Reach	0.761	Ohm
Z4 Ph. Angle	83.998	Degree
R4 Ph. Resistive	43.190	Ohm
Z4 Tilt Top Line	-3.0	Degree
Z4 Sensit. Iph>1	75.0	mA



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32.25:	R3 Ph. Resistive:	24.91 Ohm
32.27:	Z3 Tilt Top Line:	0 deg
32.28:	Z3 Sensit. Iph>3:	80.00 mA
32.40:	Z4 Ph. Reach:	400.0 mOhm
32.41:	Z4 Ph. Angle:	84.00 deg
32.42:	R4 Ph. Resistive:	24.00 Ohm
32.45:	Z4 Tilt Top Line:	0 deg
32.46:	Z4 Sensit. Iph>4:	80.00 mA

GROUP 1 BROKEN CONDUCTOR	
37.01:	Broken Conductor: Enabled
37.02:	I2/I1 Setting: 200.0e-3
37.03:	I2/I1 Time Delay: 15.00 s

BROKEN CONDUCTOR PROTECTION:	
Broken conductor	Enabled
I2/I1 setting	0.20
I2/I1 Time Delay (As per NERPC philosophy)	5

GROUP 1 SUPERVISION	
46.01:	VTS Mode: Measured Only
46.02:	VTS Status: Blocking
46.03:	VTS Reset Mode: Auto
46.04:	VTS Time Delay: 5.000 s
46.05:	VTS I> Inhibit: 10.00 A
46.06:	VTS I2> Inhibit: 200.0 mA
46.0E:	Inrush Detection: Disabled

VT SUPERVISION: VTS	
VTS Mode	Measured Only
VTS Status	Blocking
VTS Reset Mode	Auto
VTS Time Delay	5 sec
VTS I> Inhibit	2.0 A
VTS I2> Inhibit	50.0 mA
Inrush Detection	Disabled

32.50: GROUND DISTANCE:

32.51: Z1 Gnd. Reach: 6.090 Ohm

32.52: Z1 Gnd. Angle: 84.00 deg

32.53: Z1 Dynamic Tilt: Enabled

32.54: Z1 Tilt Top Line: -5.000 deg

32.55: kZN1 Res. Comp.: 1.070

32.56: kZN1 Res. Angle: -6.000 deg

32.57: kZm1 Mut. Comp.: 1.420

32.58: kZm1 Mut. Angle: -16.00 deg

32.59: R1 Gnd Resistive: 14.64 Ohm

32.5B: Z1 Sensit Ignd>1: 80.00 mA

32.60: Z2 Gnd. Reach: 11.42 Ohm

32.61: Z2 Gnd. Angle: 84.00 deg

32.63: Z2 Dynamic Tilt: Disabled

32.64: Z2 Tilt Top Line: 0 deg

32.65: kZN2 Res. Comp.: 1.070

32.66: kZN2 Res. Angle: -6.000 deg

32.67: kZm2 Mut. Comp.: 1.420

32.68: kZm2 Mut. Angle: -16.00 deg

32.69: R2 Gnd Resistive: 14.64 Ohm

32.6B: Z2 Sensit Ignd>2: 80.00 mA

32.70: Z3 Gnd. Reach: 18.27 Ohm

32.71: Z3 Gnd. Angle: 84.00 deg

32.73: Z3 Dynamic Tilt: Disabled

32.74: Z3 Tilt Top Line: 0 deg

32.75: kZN3 Res. Comp.: 1.070

32.76: kZN3 Res. Angle: -6.000 deg

32.77: kZm3 Mut. Comp.: 1.420

32.78: kZm3 Mut. Angle: 16.00 deg

32.79: R3 Gnd Resistive: 14.64 Ohm

32.7C: Z3 Sensit Ignd>3: 80.00 mA

32.90: Z4 Gnd. Reach: 400.0 mOhm

32.91: Z4 Gnd. Angle: 84.00 deg

32.93: Z4 Dynamic Tilt: Disabled

32.94: Z4 Tilt Top Line: 0 deg

32.95: kZN4 Res. Comp.: 1.070

32.96: kZN4 Res. Angle: -6.000 deg

32.97: kZm4 Mut. Comp.: 1.420

32.98: kZm4 Mut. Angle: 16.00 deg

32.99: R4 Gnd Resistive: 14.64 Ohm

32.9B: Z4 Sensit Ignd>4: 80.00 mA

32.B0: Mem Volt Dura: 16

GROUND DISTANCE		
Z1 Gnd. Reach	6.089	Ohm
Z1 Gnd. Angle	83.998	Degree
Z1 Dynamic Tilt	Enabled	
Z1 Tilt Top Line	-3.0	Degree
kZN1 Res. Comp.	1.070	
kZN1 Res. Angle	-6.097	Degree
R1 Gnd. Resistive	28.791	Ohm
Z1 Sensit. Ignd>1	75.0	mA
Z2 Gnd. Reach	11.416	Ohm
Z2 Gnd. Angle	83.998	Degree
Z2 Dynamic Tilt	Enabled	
Z2 Tilt Top Line	-3.0	Degree
kZN2 Res. Comp.	1.070	
kZN2 Res. Angle	-6.097	Degree
R2 Gnd. Resistive	28.791	Ohm
Z2 Sensit. Ignd>1	75.0	mA
Z3 Gnd. Reach	18.266	Ohm
Z3 Gnd. Angle	83.998	Degree
Z3 Dynamic Tilt	Enabled	
Z3 Tilt Top Line	-3.0	Degree
kZN3 Res. Comp.	1.070	
kZN3 Res. Angle	-6.097	Degree

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R3 Gnd. Resistive	28.791	Ohm
Z3 Sensit. Ignd>1	75.0	mA
Z4 Gnd. Reach	0.761	Ohm
Z4 Gnd. Angle	83.998	Degree
Z4 Dynamic Tilt	Enabled	
Z4 Tilt Top Line	-3.0	Degree
kZN4 Res. Comp.	1.070	
kZN4 Res. Angle	-6.097	Degree
R4 Gnd. Resistive	28.791	Ohm
Z4 Sensit. Ignd>1	75.0	mA
Mem Volt Dura	16.0	

34.80: TRIP ON CLOSE:

34.81: SOTF Status: En Pdead + Pulse

34.82: SOTF Delay: 110.0 s

34.83: SOTF Tripping: 0000011

34.84: TOR Status: Enabled

34.85: TOR Tripping: 0000011

34.86: TOC Reset Delay: 500.0 ms

34.87: SOTF Pulse: 10.00 s

34.88: TOC Delay: 200.0 ms

34.B0: Z1 EXTENSION:

34.B1: Z1 Ext Scheme: Disabled

34.C0: LOSS OF LOAD:

34.C1: LOL Scheme: Disabled

TRIP ON CLOSE		
SOTF Status	En Pdead + Pulse	
SOTF Delay	110.0	sec
SOTF Tripping	0000011	
TOR Status	Enabled	
TOR Tripping	Z1 only	
TOC Reset Delay	500.00	msec
TOC Delay	200.00	msec
Z1 Extension		
Z1 Ext Scheme	Disabled	
LOSS OF LOAD		
LOL Scheme	Disabled	

GROUP 1 EARTH FAULT

38.01: IN>1 Status: Enabled
 38.25: IN>1 Function: IEC S Inverse
 38.26: IN>1 Directional: Directional Fwd
 38.29: IN>1 Current Set: 250.0 mA
 38.2D: IN>1 TMS: 440.0e-3
 38.33: IN>1 tRESET: 100.0 ms
 38.35: IN>2 Status: Disabled
 38.46: IN>3 Status: Disabled
 38.4D: IN>4 Status: Disabled
 38.54: IN> Blocking: 000001
 38.55: IN> DIRECTIONAL:
 38.56: IN> Char Angle: -45.00 deg
 38.57: IN> Polarisation: Neg Sequence
 38.5A: IN> V2pol Set: 5.000 V
 38.5B: IN> I2pol Set: 50.00 mA

DIRECTIONAL EARTH FAULT PROTECTION: 67N	
Direction of Stage 1	Directional Forward
Pickup current in Amps	IN>1 20% of CTR 0.2*800 160
Equivalent secondary in Amps	160/(800/1) 0.20
Delay Type	IDMT
Downstream operating time (Zone-3 time delay) (As per NERPC philosophy)	0.80
Grading margin	0.2
Time delay in sec	1.00
Maximum fault current in Amps (Assumed)	50,000
Note: The IDMT curves shall saturate if the fault current is more than 20 times of pickup current. As in this case the actual fault current is 50000 A which is more than 20 times of pickup current hence for calculation purpose we shall consider 20*160=3200 A	
Fault current considered for calculations	3,200
Operating time t1 in sec @ TMS = 1	$0.14 \times \text{TMS} / ((\text{IF}/\text{I})^2 - 1)^{0.02-1}$ $0.14 \times 1 / ((3200/160)^2 - 1)^{0.02-1}$ 2.27
TMS	treq/t1 1/2.27 0.44
IN> tRESET	0 sec
IN> Blocking	000001
IN> Char Angle	-45°
IN> Polarisation	Zero Sequence
IN> Vnpol Set	5.000 V

GROUP 1 POWER SWING BLK.

3D.01: PSB Status: Blocking
 3D.02: Power Swing Mode: Advanced
 3D.03: Zone 1 Ph. PSB: Delayed Unblock
 3D.05: Zone 2 Ph. PSB: Delayed Unblock
 3D.07: Zone 3 Ph. PSB: Delayed Unblock
 3D.09: Zone P Ph. PSB: Blocking
 3D.0B: Zone 4 Ph. PSB: Delayed Unblock
 3D.0D: Zone 1 Gnd. PSB: Delayed Unblock
 3D.0F: Zone 2 Gnd. PSB: Delayed Unblock
 3D.11: Zone 3 Gnd. PSB: Delayed Unblock
 3D.13: Zone P Gnd. PSB: Blocking
 3D.15: Zone 4 Gnd. PSB: Delayed Unblock
 3D.16: WI Trip PSB: Inhibit Trip
 3D.19: Zone Q Ph. PSB: Blocking
 3D.1B: Zone Q Gnd. PSB: Blocking

POWER SWING SETTING: 68

PSB Status	Blocking
Zone 1 Ph. PSB	Blocking
Zone 2 Ph. PSB	Blocking
Zone 3 Ph. PSB	Blocking
Zone P Ph. PSB	Blocking
Zone 4 Ph. PSB	Blocking
Zone 1 Gnd. PSB	Blocking
Zone 2 Gnd. PSB	Blocking
Zone 3 Gnd. PSB	Blocking
Zone P Gnd. PSB	Blocking
Zone 4 Gnd. PSB	Blocking
WI Trip PSB	Inhibit Trip
PSB Unblocking	Enabled
PSB Unblock delay	2 sec
PSB Reset delay	200 msec
OST Mode	Disabled
Slow Swing	Enabled
The Power swing detection uses an impedance band which surrounds the entire phase fault trip characteristic. Typically the ΔR and ΔX band settings are both set between 10% to 30% of R3ph	
Considering 20% of the R3ph ΔR and ΔX in Ohms	0.2*43.19 8.64
PSB Z7 in Ohms	Zone 3 Forward reach + ΔR 26.90
PSB Z8 in Ohms (1.1*Z7)	29.59
PSB Z7' in Ohms	-(Zone 4 (Reverse) reach + ΔR) -9.40
PSB Z8' in Ohms (1.1*Z7')	-10.34
PSB R7 in Ohms	R3,PP + ΔR 51.83
PSB R8 in Ohms (1.1*R7)	57.01
PSB R7' in Ohms	-(R3,PP + ΔR) -51.83
PSB R8' in Ohms (1.1*R7')	-57.01

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3D.20: PSB Unblocking: Enabled
 3D.21: PSB Unblock dly: 2.000 s
 3D.22: PSB Reset Delay: 200.0 ms
 3D.23: OST Mode: OST Disabled
 3D.40: Slow Swing: Enabled
 3D.41: PSB Z7: 18.27 Ohm
 3D.42: PSB Z8: 20.44 Ohm
 3D.43: PSB Z7': -400.1 mOhm
 3D.44: PSB Z8': -2.580 Ohm
 3D.45: PSB R7: 24.91 Ohm
 3D.46: PSB R8: 27.09 Ohm
 3D.47: PSB R7': -24.00 Ohm
 3D.48: PSB R8': -26.18 Ohm
 3D.49: Alpha: 84.00 deg
 3D.4A: PSB Timer: 50.00 ms

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 19/1, G.S.T. ROAD, PALLAVARAM,
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Main-2 Protection Mismatches

GROUP 1 DIST. ELEMENTS	
32.01: PHASE DISTANCE:	
32.02: Z1 Ph. Reach:	6.090 Ohm
32.03: Z1 Ph. Angle:	84.00 deg
32.07: R1 Ph. Resistive:	43.19 Ohm
32.08: Z1 Tilt Top Line:	-3.000 deg
32.09: Z1 Sensit. Iph>1:	75.00 mA
32.10: Z2 Ph. Reach:	11.41 Ohm
32.11: Z2 Ph. Angle:	84.00 deg
32.15: R2 Ph. Resistive:	43.19 Ohm
32.16: Z2 Tilt Top Line:	-3.000 deg
32.17: Z2 Sensit. Iph>2:	75.00 mA
32.20: Z3 Ph. Reach:	16.75 Ohm
32.21: Z3 Ph. Angle:	84.00 deg
32.25: R3 Ph. Resistive:	43.19 Ohm
32.27: Z3 Tilt Top Line:	-3.000 deg
32.28: Z3 Sensit. Iph>3:	75.00 mA
32.40: Z4 Ph. Reach:	1.520 Ohm
32.41: Z4 Ph. Angle:	84.00 deg
32.42: R4 Ph. Resistive:	43.19 Ohm
32.45: Z4 Tilt Top Line:	-3.000 deg
32.46: Z4 Sensit. Iph>4:	75.00 mA



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Recommended settings for Phase Distance		Grouped Elements \ Group1 \ Phase Distance				
Function	Application	Zone1	Zone 2	Zone 3	Zone 4	Zone 5
Set: Enabled for Operation and Disabled for NO-Operation		Enabled	Enabled	Enabled	Enabled	Disabled
Direction	Set: Forward for Forward reaches length ahead of CT and Reverse for reverse reaches length before CT	Forward	Forward	Forward	Reverse	Reverse
Shape	Set: Quad for Quadrilateral/polygonal characteristics impedance and MHO for Circle characteristics	Quad	Quad	Quad	Quad	Quad
Xfmr Vol connection	Set transformer winding vector group for the Voltage phase shift.	None	None	None	None	None
Xfmr Curr connection	Set transformer winding vector group for the Current phase shift.	None	None	None	None	None
Reach Criteria 1 (Highlighted criteria parameter shall get fed in the relay) (As per NERPC philosophy)	Impedance zone reaches calculated based on Conductor primary data provided, Applicable only if direction selected as forward	6.09	11.42	18.27	0.76	0.76
RCA	Relay characteristic angle should be set to the Impedance angle of the line. Applicable only if direction selected as forward	84.03	84.65	84.03	84.03	84.03
Rev Reach Criteria 1 (Highlighted criteria parameter shall get fed in the relay) (As per NERPC philosophy)	Impedance zone reaches calculated based on Conductor primary data provided. Applicable only if direction selected as reverse	6.09	11.42	18.27	0.76	0.76
Rev Reach RCA	Relay characteristic angle should be set to the Impedance angle of the line. Applicable only if direction selected as reverse	84.03	84.65	84.03	84.03	84.03
Comp Limit	Compensation limit is to limit the borders for impedance characteristics on QUAD shape shall be set less than or equal to 90 deg typically	90.00	90.00	90.00	90.00	90.00

32.50: GROUND DISTANCE:	
32.51: Z1 Gnd. Reach:	6.090 Ohm
32.52: Z1 Gnd. Angle:	84.00 deg
32.53: Z1 Dynamic Tilt:	Enabled
32.54: Z1 Tilt Top Line:	-3.000 deg
32.55: kZn1 Res. Comp.:	1.070
32.56: kZn1 Res. Angle:	-6.000 deg
32.59: R1 Gnd Resistive:	28.79 Ohm
32.58: Z1 Sensit Ignd>1:	75.00 mA
32.60: Z2 Gnd. Reach:	7.650 Ohm
32.61: Z2 Gnd. Angle:	84.00 deg
32.63: Z2 Dynamic Tilt:	Enabled
32.64: Z2 Tilt Top Line:	-3.000 deg
32.65: kZn2 Res. Comp.:	1.070
32.66: kZn2 Res. Angle:	-6.000 deg
32.69: R2 Gnd Resistive:	28.79 Ohm
32.68: Z2 Sensit Ignd>2:	75.00 mA
32.70: Z3 Gnd. Reach:	9.220 Ohm
32.71: Z3 Gnd. Angle:	84.00 deg
32.73: Z3 Dynamic Tilt:	Enabled
32.74: Z3 Tilt Top Line:	-3.000 deg
32.75: kZn3 Res. Comp.:	1.070
32.76: kZn3 Res. Angle:	-6.000 deg
32.79: R3 Gnd Resistive:	28.79 Ohm
32.7C: Z3 Sensit Ignd>3:	75.00 mA
32.90: Z4 Gnd. Reach:	1.520 Ohm
32.91: Z4 Gnd. Angle:	84.00 deg
32.93: Z4 Dynamic Tilt:	Enabled
32.94: Z4 Tilt Top Line:	-3.000 deg
32.95: kZn4 Res. Comp.:	1.070
32.96: kZn4 Res. Angle:	-6.000 deg
32.99: R4 Gnd Resistive:	28.79 Ohm
32.9B: Z4 Sensit Ignd>4:	75.00 mA
32.80: Mem Volt Dura:	16

Recommended settings for Ground Distance		Grouped Elements \ Group1 \ Ground Distance				
Function	Application	Zone1	Zone 2	Zone 3	Zone 4	Zone 5
Set: Enabled for Operation and Disabled for NO-Operation		Enabled	Enabled	Enabled	Enabled	Disabled
Direction	Set: Forward for Forward reaches ahead of CT and Reverse for reverse reaches before CT	Forward	Forward	Forward	Reverse	Reverse
Shape	Set: Quad for Quadrilateral/polygonal characteristics impedance and MHO for Circle characteristics	Quad	Quad	Quad	Quad	Quad
Z0/Z1 Mag	Earth fault compensation magnitude, line Zero sequence impedance upon Positive sequence impedance	4.204	4.204	4.204	4.204	4.204

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19/1, G.S.T. ROAD PALLAVAR
CHENNAI



Z0/Z1 Ang	Earth fault compensation angle, line Zero sequence impedance upon Positive sequence impedance	-4.65	-4.65	-4.65	-4.65	-4.65
Z0M/Z1 Mag	Mutual impedance compensation magnitude, line Zero sequence mutual impedance upon Positive sequence mutual impedance	0.00	0.00	0.00	0.00	0.00
Z0M/Z1 Ang	Mutual impedance compensation angle, line Zero sequence mutual impedance upon Positive sequence mutual impedance	0.00	0.00	0.00	0.00	0.00
Reach Criteria 1 (Highlighted criteria parameter shall get fed in the relay) (As per NERPC philosophy)	Impedance zone reaches calculated based on Conductor primary data provided, Applicable only if direction selected as forward	6.09	11.42	18.27	0.76	0.76
RCA	Relay characteristic angle should be set to the Impedance angle of the line. Applicable only if direction selected as forward	84.03	84.03	84.03	84.03	84.03

GROUP 1 BROKEN CONDUCTOR

37.01: Broken Conductor: Enabled
37.02: I2/I1 Setting: 200.0e-3
37.03: I2/I1 Time Delay: 60.00 s

Recommended settings for Broken Conductor		Monitoring Elen
Elements		BRC
Function	Set: Enabled for Operation and Disabled for NO-Operation	Enabled
Signal Source	Source allocation for the broken conductor, as per drawing	SRC1
I2/I1 ratio	I2/I1 Current ratio threshold for function to operate in percentage	20.00
Broken Conductor I1 min	Maximum I1 current required for BRC operation	0.1
Broken Conductor I1 max	Maximum I1 current required for BRC operation if increases beyond then it is considered as fault	1.5
Broken Conductor Pkp delay 1 (As per NERPC philosophy)	time delay for the operation	5.00
Broken Conductor 1 Blk	Logic elements can be assigned to block	Logic
Broken Conductor 1 target	To make the protection operation signal latched in the HMI, when protection operates, will be reset if acknowledged by user	Latched
Events	To trigger events on the protection operation	Enabled

Proper Functioning of Fault Locators at both ends of the Line needs to be ensured and any mismatch in readings with actual location of fault may be taken up with the Manufacturer of the Protection Relays for necessary modification of the Scheme and setting adopted as there was mismatch between fault locator for tripping of these lines on 10.05.2025. Accurate identification of fault location will minimize Outage duration as well.

The DR channel configuration of Main-1 and Main-2 protections for both circuits were found to be in compliance with the standard guidelines.

Power Swing function

Upon analysing the protection philosophy of Bongaigaon substation, it was found that in 220 kV lines, Power Swing protection blocks all zones and Out of Step function is disabled.

As regard Power Swing blocking function, Rama Krishna Committee had recommended two options, in brief, as under:

There are a number of options one can select in implementing power-swing protection in their system. Designing the power system protection to avoid or preclude cascade tripping is a requirement of modern day power system. Below we list two possible options:

- Block all Zones except Zone-1
- Block all Zones and Trip with Out of Step (OOS) Function

12.3. Placement of OOS trip Systems

Out of step tripping protection (Standalone relay or built-in function of Main relay) shall be provided on all the selected lines. The locations where it is desired to split the system on out of step condition shall be decided based on system studies. The selection of network locations for placement of OOS systems can best be obtained through transient stability studies covering many possible operating conditions.

Till such studies are carried out and Out-of-Step protection is enabled on all identified Lines, it is recommended to continue with the existing practice of Non- Blocking of Zone-I on Power Swing. However, it should be remembered that with this practice the line might trip for a recoverable swing and it is not good to breakers.

Committee strongly recommends that required studies must be carried out at the earliest possible time (within a timeframe of one year) to exercise the options above.

In view of recommendation as above, NBTL may expedite Transient Stability study so that appropriate feature can be enabled in the Line Protection Relay.

Observations on available trip data are as under:

1. Tripping of 220 kV Nangalbibra Line-1 on 10.05.2025
 - Fault locator reading is not matching with the actual fault location distance. Hence, relay setting data and configuration is to be reviewed for their accuracy.
 - For R phase fault, both Main-1 and Main-2 protection operated correctly and extended trip command to R phase Main CB and also extended permissive trip to remote end
 - Subsequently, fault appeared in Y phase within the dead time of 1 second, both Main-1 and Main-2 operated correctly again and all the three poles of Main CB tripped.
 - In the DR, channel no. 29, 30 and 31 got high for Auto Reclosure start initiation for R ph, Y ph and B ph which is not explainable as CB has to go for lockout condition for a fault appearing in dead time. However, it seems that these channels should be labelled as A/R lockout for R ph, Y ph and B ph. The same may be reviewed and verified with respect to DR configuration for corrective action.
 - DR PDF output report header shows Line-7 for Ckt-1. It is suggested to incorporate Circuit name in the output file to bring about more clarity and should be programmed accordingly for retrieval of DR data
2. Tripping of 220 kV Nangalbibra Line-2 on 10.05.2025
 - Fault locator reading is not matching with the actual fault location distance. Hence, relay setting data and configuration is to be reviewed for their accuracy.
 - For B phase fault, both Main-1 and Main-2 protection operated correctly and extended trip command to B phase Main CB and also extended permissive trip to remote end
 - Subsequently, on completion of dead time of 1 second, closing of faulty phase attempted but on persisting fault both Main-1 and Main-2 again operated correctly again and all the three poles of Main CB tripped.
 - In the DR, channel no. 29, 30 and 31 got high for Auto Reclosure start initiation for R ph, Y ph and B ph which is not explainable as CB has to go for lockout condition for persisting fault in dead time. However, it seems that these channels should be labelled as A/R lockout for R ph, Y ph and B ph. The same

may be reviewed and verified with respect to DR configuration for corrective action.

- DR PDF output report header shows Line-7 for Ckt-2. It is suggested to incorporate Circuit name in the output file to bring about more clarity and should be programmed accordingly for retrieval of DR data

Fault Location data as provided by Main- 1 & 2 Distance Protection Relays at both ends of Lines vis- a- vis actual locations of Fault reported by Transmission Line Maintenance gang are as tabulated below:

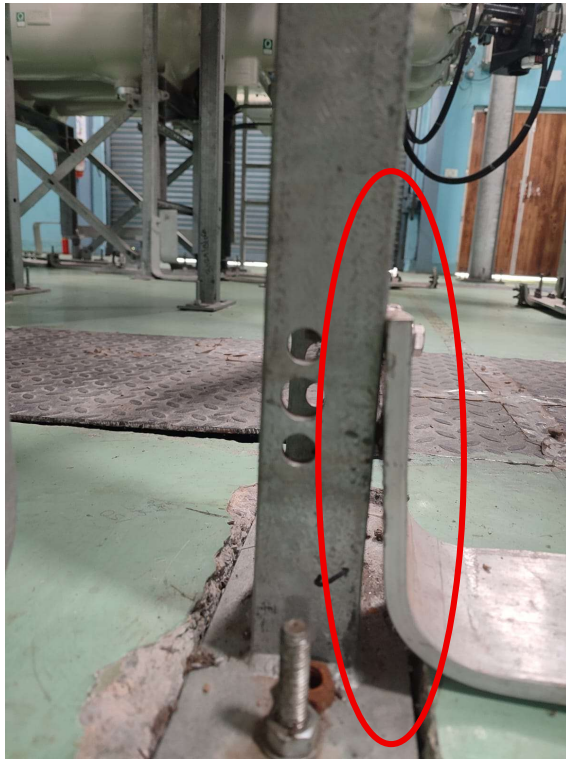
Name of Line	Date	Time	Line Length (KM)	Fault Current fed from Bongaigaon (kA)	Fault Distance from Bongaigaon end (KM)		Actual Fault Distance from Bongaigaon end (KM)
					Main-1	Main-2	
Nangalbibra Line-1	10.05.2025	17:49:57	122.9	4.368	73.61 KM	77.86 KM	39.95 KM
Nangalbibra Line-2	10.05.2025	17:49:57	122.9	4.156	73.29 KM	72.56 KM	39.95 KM

From the above, it can be observed that there is wide difference in Fault Distances provided by Main-1 & 2 Distance Protection Relays in both 220 kV Lines. It is suggested that Protection Relay settings be reviewed once again to fine tune the distance measurement by Line Protection Relays. This will provide very valuable information to the Line Maintenance Crews to pin point the location of fault and rectification of defect in shortest possible time.

3.0 Earthing

Measurement record of Earth grid resistance last undertaken on 16.08.2024 was reviewed and it was observed that Earth grid resistance is in the range of 0.3- 0.4 Ω .

Earthing of GIS structure of NBTL bays was inspected, it was observed that earth strip was not making proper contact with the support structure near Nangalbibra Ckt-1 bay. Since, earthing of equipment is of paramount importance for safety, it is recommended to get it rectified at the earliest opportunity.



Earthing of ladders in the GIS hall needs to be ensured. All metallic structure/ enclosure/ non-current carrying parts including Rail, Signage Boards, Ladder, Metal Box/ cubicle etc. need to be earthed.



4.0 General

During GIS hall inspection, it was observed that oil is spilled on the floor near 220 kV Nangalbibra Line Bays. It needs to be avoided to prevent any injury to operating personnel.



It was also observed that SF₆ gas cylinders are present in the GIS hall but proper demarcation is absent to distinguish the filled and empty cylinders as empty cylinders should be removed from the GIS room.



5.0 Statutory Warnings

Danger Notice Boards need to be displayed in Switchyard/ Bay area as a statutory requirement. In this regard Indian Electricity Rules (1956) stipulates as under:

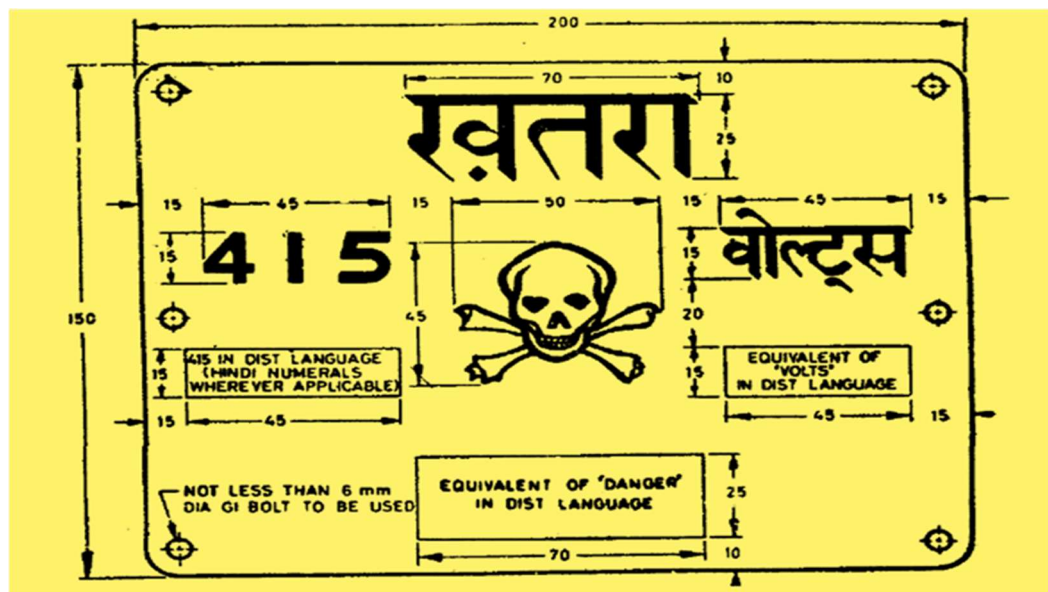
35.Danger Notices:- The owner of every medium, high and extra-high voltage installation shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the district, with a sign of skull and bones 1[of a design as per the relevant IS No.2551]....

Relevant provision in IS2551 is as under



3. MATERIAL AND FINISH

The plate shall be made from mild steel, at least 1.6 mm thick and vitreous enamelled white, with letters, figures and the conventional skull and cross-bones in signal red colour [see IS:5-1978t] on the front side. The rear side of the plate shall also be enamelled.



- NOTE 1 — All letterings should be centrally spaced.
NOTE 2 — The dimensions for the words in district language are mainly for guidance, however, care should be taken to space them centrally between the edges and the area of the skull and bones.
NOTE 3 — The location of the fixing holes shall be left to the choice of the user.
NOTE 4 — The corners of the plates should be rounded off.

All dimensions in millimetres.

NBTL to ensure compliance in the above stipulation in the statute.

OBSERVATIONS DURING VISIT OF 132 kV LINE OF 132/33 kV HATSINGIMARI

AT 132/33 kV HATSINGIMARI SUBSTATION

As per of No. 132/33 kV

132 kV Ampati Line Bays at

132/33 kV Hatsingimari

Substation

132 kV Ampati Line Bays at

132/33 kV Hatsingimari

132 kV Ampati Line Bays at 132/ 33 kV Hatsingimari Substation

OBSERVATIONS DURING AUDIT OF 2 NO. 132 kV BAYS OF RESONIA GROUP

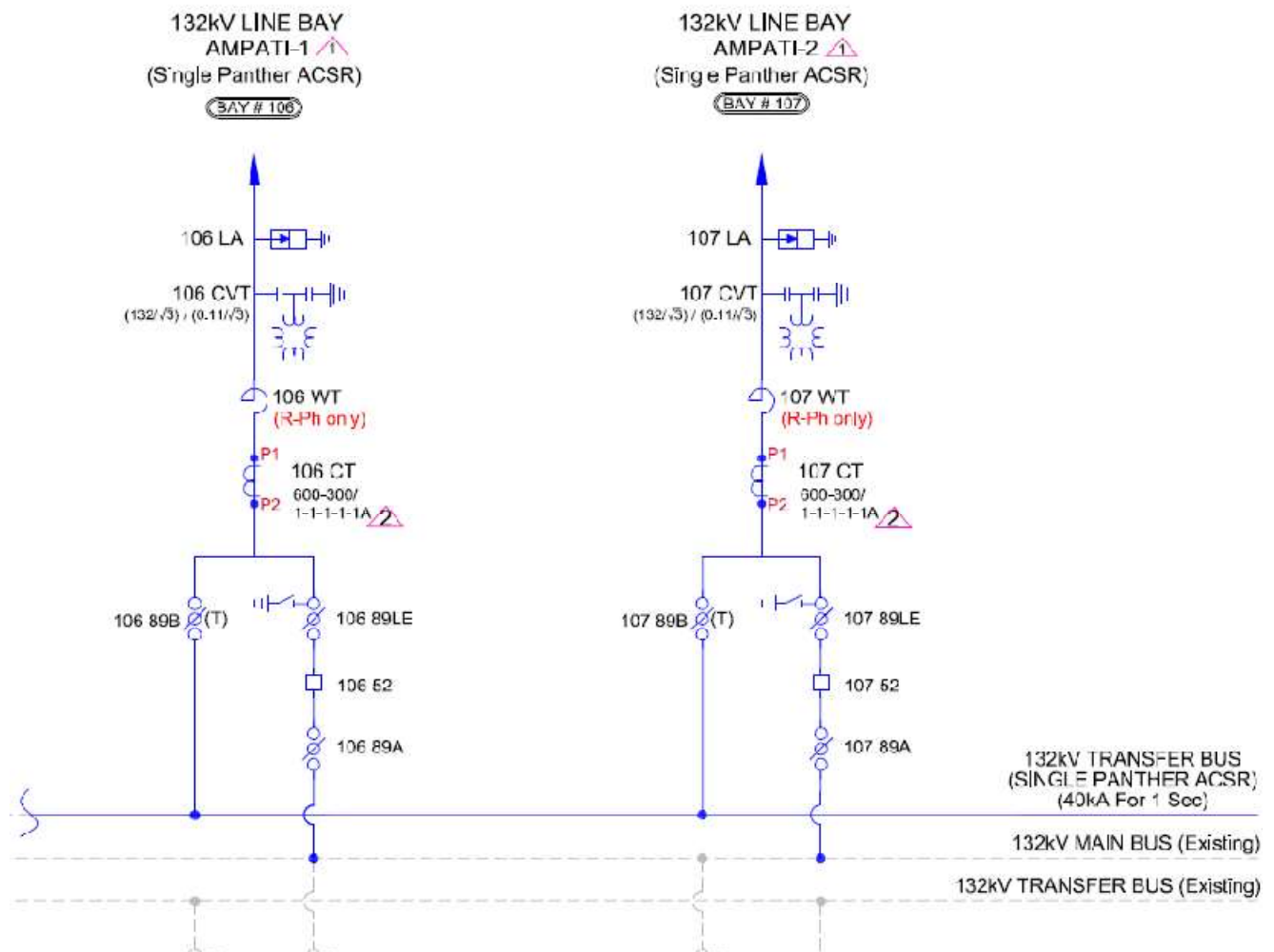
AT 132/ 33 kV AEGCL HATSINGIMARI SUBSTATION

As part of Nangalbibra Bongaigaon Transmission Limited (NBTL) project, 2 no. 132 kV line bays pertaining to 132 kV Hatsingimari- Ampati Double circuit lines were commissioned on 07.09.2024 by Resonia Group at 132/ 33 kV Hatsingimari substation of Assam Electricity Grid Corporation Limited (AEGCL).

Dates of commissioning of various elements are as under:

S.N.	132 kV Lines	Line Length (KM)	Date of Commissioning
1	Ampati Ckt-1	18.58	07/09/2024
2	Ampati Ckt-2	18.58	07/09/2024

The 132 kV system of Resonia Group at Hatsingimari substation of AEGCL has been shown in the Single Line Diagram as attached below:



Observations and Suggestions by team of Auditors during visit to the Substation premises and during perusal of records placed before the team of Auditors are as under:

1.0 Operation and Maintenance

The line bays are installed in AEGCL Hatsingimari substation and the O&M of NBTL equipments is being done by AEGCL on chargeable basis.

Third Harmonic Resistive Current (THRC) of LAs was measured after charging of the system on 07.09.2024. The leakage current values reviewed were found to be within prescribed limit. It is suggested that the measurement of THRC be undertaken pre-monsoon and post-monsoon basis to ensure healthiness of the LAs.

Thermo-vision scanning of substation equipments has not been undertaken by NBTL personnel since charging of the substation. It is suggested that thermo-vision scanning be undertaken at the time of peak load to check for any loose connection/ hot-spots on any equipment in the substation.

2.0 Control and Protection

The approved relay settings for all the protection relays of Main-1 and Main-2 protection were verified through relay HMI and were found to be in order.

No line fault has occurred on the Transmission Lines since commissioning; hence, no DR record was generated in the Relays. No trip analysis was carried out by the audit team as it is not applicable in absence of any line fault occurring in the system since commissioning. The real time line parameters were verified and were found to be OK. No alarm was appearing on both Main-1 and Main-2 protection of both Hatsingimari transmission lines at the substation.

Analog and Digital Channels of Disturbance Recorder needs be configured as per standard guidelines and events which are not relevant for analysis of Disturbances may not be mapped in Disturbance Recorder.

Power Swing function

Upon analysing the protection philosophy of Hatsingimari substation, it was found that in 132 kV lines, Power Swing protection blocks all zones except Zone-1 is enabled.

As regard Power Swing blocking function, Rama Krishna Committee had recommended two options, in brief, as under:

There are a number of options one can select in implementing power-swing protection in their system. Designing the power system protection to avoid or preclude cascade tripping is a requirement of modern day power system. Below we list two possible options:

- Block all Zones except Zone-1
- Block all Zones and Trip with Out of Step (OOS) Function

12.3. Placement of OOS trip Systems

Out of step tripping protection (Standalone relay or built-in function of Main relay) shall be provided on all the selected lines. The locations where it is desired to split the system on out of step condition shall be decided based on system studies. The selection of network locations for placement of OOS systems can best be obtained through transient stability studies covering many possible operating conditions.

Till such studies are carried out and Out-of-Step protection is enabled on all identified Lines, it is recommended to continue with the existing practice of Non- Blocking of Zone-I on Power Swing. However, it should be remembered that with this practice the line might trip for a recoverable swing and it is not good to breakers.

Committee strongly recommends that required studies must be carried out at the earliest possible time (within a timeframe of one year) to exercise the options above.

In view of recommendation as above, NBTL may expedite Transient Stability study so that appropriate feature can be enabled in the Line Protection Relay.

3.0 Earthing

Measurement record of Earth grid resistance last undertaken on 27.09.2023 was reviewed and it is observed that Earth grid resistance is 0.3 Ω . Since, the earth resistance is to be measured yearly, therefore, it is advised to get the earth resistance measured at the earliest.

Drive mechanism box of Isolators and Earth Switches may not be earthed by rigid connection with earth strip, instead flexible braided link may be used between the earthing terminal of mechanism box and GI earth strip.



Practice of grounding Isolator operating shafts as recommended in IEEE80-2013 is reproduced below as reference:

IEEE Std 80-2013
IEEE Guide for Safety in AC Substation Grounding



Figure 34—Typical braided ground



IEEE Std 80-2013
IEEE Guide for Safety in AC Substation Grounding

17.2 Switch shaft and operating handle grounding

The practices for grounding switch operating shafts are varied. The results of a worldwide survey conducted in 2009 indicated that 82% of the utilities that responded required grounding of substation air switch operating shafts to the grounding grid. The survey also showed 100% of the respondents took extra precautions to reduce surface gradients where the switch operator stands. The methodology to ground the operating shaft was almost equally divided among those responding to the questionnaire. Approximately half of the utilities provided a direct jumper between the switch shaft and the ground mat, while the other half provided a jumper from the switch shaft to the adjacent grounded structural steel. The steel is used as part of the conducting path. Approximately 90% of the utilities utilized a braid for grounding the switch shaft. The remaining 10% utilized a braidless grounding device. A typical braided ground is shown in Figure 34 and a braidless grounding device is shown in Figure 35. The methodology for reducing the surface gradients where the switch operator would be standing was divided between utilizing: a grounded platform, a closely spaced wire mesh under the surface material, or closer spacing of the primary grid.

4.0 Auxiliary DC System

Measurement of DC Auxiliary Voltage was undertaken; Source-I & II was found to be as under:

Description	Source- I	Source- II
Positive to Negative	116.3 V	118.8 V
Positive to Earth	58.7 V	63.4 V
Negative to Earth	-56.5 V	-57.3 V

Description	Voltage
Positive of Source-I to Negative of Source-II	116.1 V
Negative of Source-I to Positive of Source-II	111.6 V

Measurement of DC Auxiliary Voltage for communication equipment was undertaken and was found to be as under:

Description	Source- I
Positive to Negative	52.8 V
Positive to Earth	0.01 V
Negative to Earth	-52.7 V

The 110V DC Source-II has DC earth fault leading to unbalance DC voltage. This has to be rectified by locating and removing the earthing and thereby arresting the DC leakage.

5.0 General

The alignment of tandem isolators (Transfer bus isolator of Ckt-1) at Hatsingimari substation seem to be improper/ off-centre and needs proper alignment for operation of isolator and good contact penetration. Since, they were in open position, hence whether they make proper contact when closed couldn't be verified. It is suggested to get them re-aligned and ensure that proper contact is being formed. Thermo-vision scanning may also be done to ensure proper male-female contact.



During the site visit, it was observed that switchyard equipment identification is existing but the operating box of CB may also be suitably marked for easy identification of the particular bay CB.



Battery room at Hatsingimari substation doesn't have AC system installed. The ventilation of battery room is dependent upon the running of exhaust fan. Since, the batteries installed are VRLA type, it is suggested to get AC installed in the Battery room as per manufacturer recommendations of having controlled temperature for prolonging the life of VRLA battery.



6.0 Statutory Warnings

Danger Notice Boards need to be displayed in Switchyard/ Bay area as a statutory requirement. In this regard Indian Electricity Rules (1956) stipulates as under:

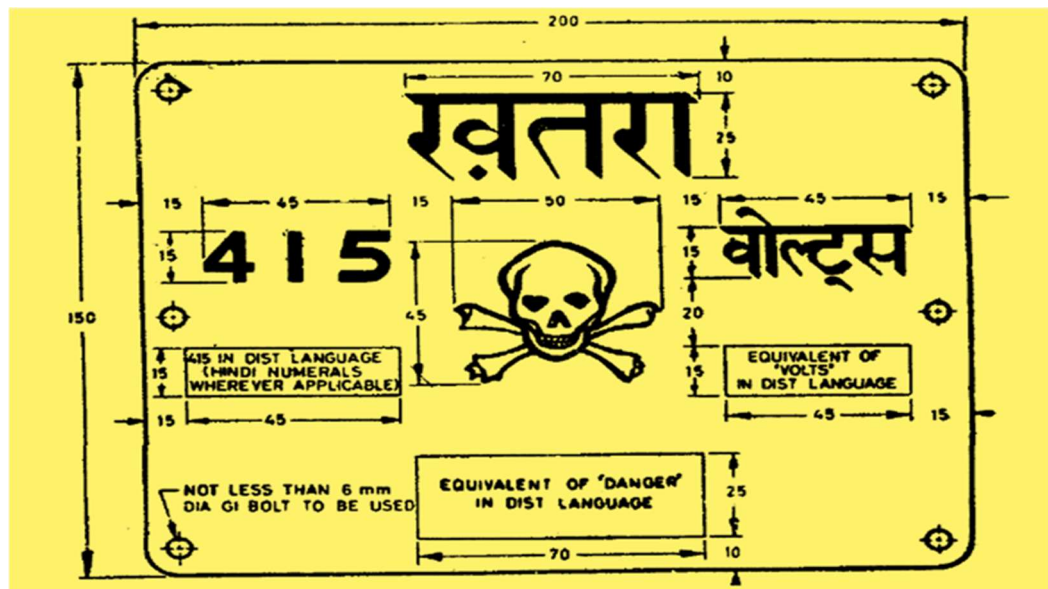
35.Danger Notices:- The owner of every medium, high and extra-high voltage installation shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the district, with a sign of skull and bones 1[of a design as per the relevant IS No.2551].....

Relevant provision in IS2551 is as under



3. MATERIAL AND FINISH

The plate shall be made from mild steel, atleast 1.6 mm thick and vitreous enamelled white, with letters, figures and the conventional skull and cross-bones in signal red colour [see IS:5-1978t] on the front side. The rear side of the plate shall also be enamelled.



- NOTE 1 — All letterings should be centrally spaced.
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NOTE 3 — The location of the fixing holes shall be left to the choice of the user.
NOTE 4 — The corners of the plates should be rounded off.

All dimensions in millimetres.

NBTL to ensure compliance in the above stipulation in the statute.

**132 kV Hatsingimari Line
Bays at 132/ 33 kV Ampati
Substation**

OBSERVATIONS DURING AUDIT OF 2 NO. 132 kV BAYS OF RESONIA GROUP

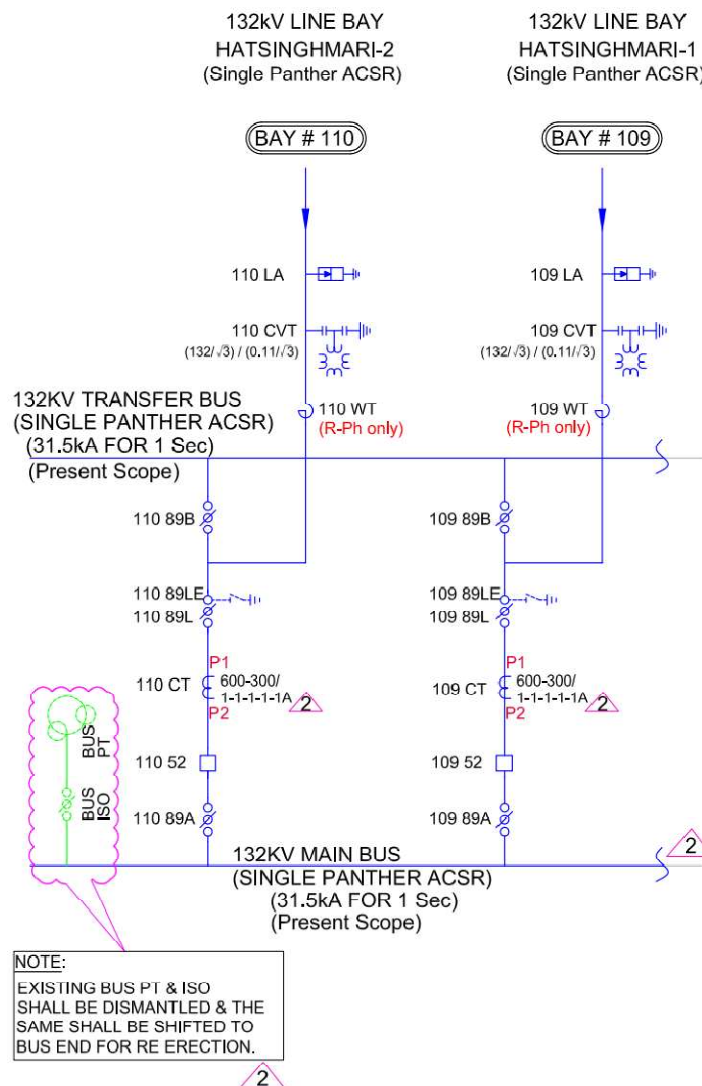
AT 132/ 33 kV MePTCL AMPATI SUBSTATION

As part of Nangalbibra Bongaigaon Transmission Limited (NBTL) project, 2 no. 132 kV line bays pertaining to 132 kV Ampati- Hatsingimari Double circuit lines were commissioned on 07.09.2024 by Resonia Group at 132/ 33 kV Ampati substation of Meghalaya Power Transmission Corporation Limited (MePTCL).

Dates of commissioning of various elements are as under:

S.N.	132 kV Lines	Line Length (KM)	Date of Commissioning
1	Hatsingimari Ckt-1	18.58	07/09/2024
2	Hatsingimari Ckt-2	18.58	07/09/2024

The 132 kV system of Resonia Group at Ampati substation of MePTCL has been shown in the Single Line Diagram as attached below:



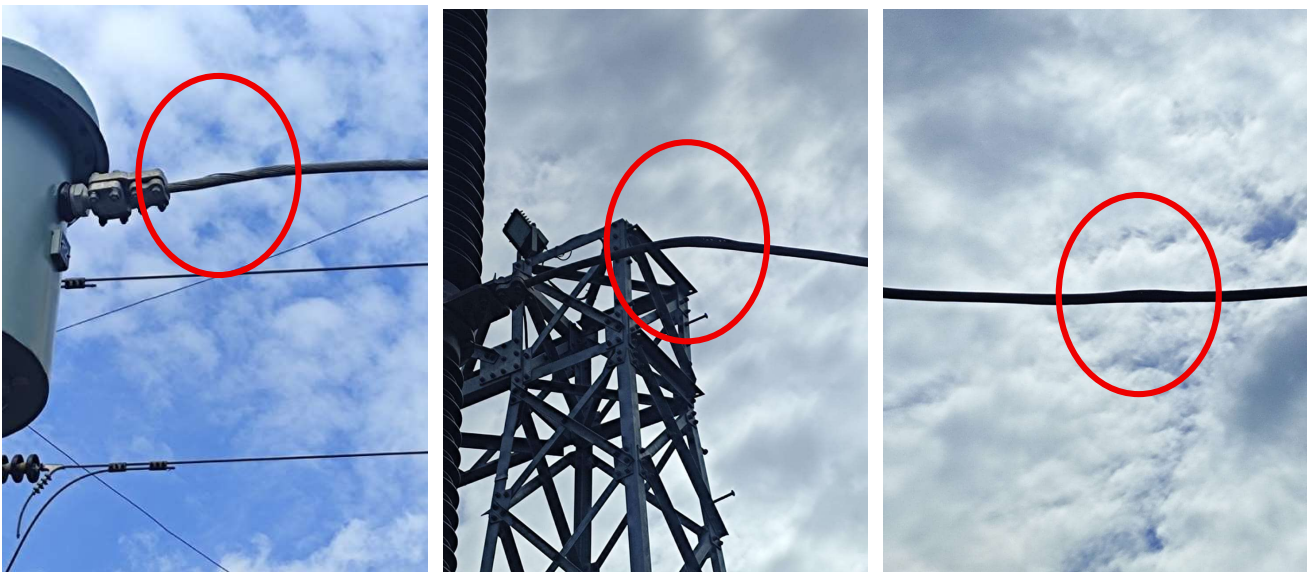
Observations and Suggestions by team of Auditors during visit to the Substation premises and during perusal of records placed before the team of Auditors are as under:

1.0 Operation and Maintenance

The line bays are installed in MePTCL Ampati substation and the O&M of NBTL equipments is being done by MePTCL on chargeable basis.

Third Harmonic Resistive Current (THRC) of LAs was measured after charging of the system on 07.09.2024. The leakage current values reviewed were found to be within prescribed limit. It is suggested that the measurement of THRC be undertaken pre-monsoon and post-monsoon basis to ensure healthiness of the LAs.

Thermo-vision scanning of substation equipments has not been undertaken by NBTL personnel since charging of the substation. During switchyard visit, it was observed that few strands of conductor have got loose near terminal connector of some equipments. Thus, it is inferred that due to hot-spots, the conductor strands have gotten loose. Hence, it is recommended to get the Thermo-vision scanning of the bay equipments be done at the earliest opportunity to identify and rectify the loose connection/ hot-spots on every equipment of the substation.



2.0 Control and Protection

The approved relay settings for all the protection relays of Main-1 and Main-2 protection were verified through relay HMI and were found to be in order.

No line fault has occurred on the Transmission Lines since commissioning; hence, no DR record was generated in the Relays. No trip analysis was carried out by the audit team as it is not applicable in absence of any line fault occurring in the system since commissioning. The real time line parameters were verified and were found to be OK. No alarm was appearing on both Main-1 and Main-2 protection of both Hatsingimari transmission lines at the substation.

Power Swing function

Upon analysing the protection philosophy of Ampati substation, it was found that in 132 kV lines, Power Swing protection blocks all zones except Zone-1 is enabled.

As regard Power Swing blocking function, Rama Krishna Committee had recommended two options, in brief, as under:

There are a number of options one can select in implementing power-swing protection in their system. Designing the power system protection to avoid or preclude cascade tripping is a requirement of modern day power system. Below we list two possible options:

- Block all Zones except Zone-1
- Block all Zones and Trip with Out of Step (OOS) Function

12.3. Placement of OOS trip Systems

Out of step tripping protection (Standalone relay or built-in function of Main relay) shall be provided on all the selected lines. The locations where it is desired to split the system on out of step condition shall be decided based on system studies. The selection of network locations for placement of OOS systems can best be obtained through transient stability studies covering many possible operating conditions.

Till such studies are carried out and Out-of-Step protection is enabled on all identified Lines, it is recommended to continue with the existing practice of Non- Blocking of Zone-I on Power Swing. However, it should be remembered that with this practice the line might trip for a recoverable swing and it is not good to breakers.

Committee strongly recommends that required studies must be carried out at the earliest possible time (within a timeframe of one year) to exercise the options above.

In view of recommendation as above, NBTL may expedite Transient Stability study so that appropriate feature can be enabled in the Line Protection Relay.

Analog and Digital Channels of Disturbance Recorder be configured as per standard guidelines and events which are not relevant for analysis of Disturbances may not be mapped in Disturbance Recorder.

3.0 Earthing

Measurement of Earth grid resistance last undertaken on 29.11.2023 was reviewed and it is observed that Earth grid resistance is in the range of 0.3 ohms to 0.4 ohms. Since, the earth resistance is to be measured yearly, therefore, it is advised to get the earth resistance measured at the earliest.

Drive mechanism box of Isolators and Earth Switches may not be earthed by rigid connection with earth strip, instead flexible braided link may be used between the earthing terminal of mechanism box and GI earth strip.



Practice of grounding Isolator operating shafts as recommended in IEEE80-2013 is reproduced below as reference:

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Figure 34—Typical braided ground

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The practices for grounding switch operating shafts are varied. The results of a worldwide survey conducted in 2009 indicated that 82% of the utilities that responded required grounding of substation air switch operating shafts to the grounding grid. The survey also showed 100% of the respondents took extra precautions to reduce surface gradients where the switch operator stands. The methodology to ground the operating shaft was almost equally divided among those responding to the questionnaire. Approximately half of the utilities provided a direct jumper between the switch shaft and the ground mat, while the other half provided a jumper from the switch shaft to the adjacent grounded structural steel. The steel is used as part of the conducting path. Approximately 90% of the utilities utilized a braid for grounding the switch shaft. The remaining 10% utilized a braidless grounding device. A typical braided ground is shown in Figure 34 and a braidless grounding device is shown in Figure 35. The methodology for reducing the surface gradients where the switch operator would be standing was divided between utilizing: a grounded platform, a closely spaced wire mesh under the surface material, or closer spacing of the primary grid.

4.0 Auxiliary DC System

Measurement of DC Auxiliary Voltage was undertaken; Source-I & II was found to be as under:

Description	Source- I	Source- II
Positive to Negative	241.4 V	240.3 V
Positive to Earth	121.4 V	120.7 V
Negative to Earth	-119.7 V	-119.3 V

Description	Voltage
Positive of Source-I to Negative of Source-II	241.7 V
Negative of Source-I to Positive of Source-II	241.5 V

Measurement of DC Auxiliary Voltage for communication equipment was undertaken and was found to be as under:

Description	Source- I
Positive to Negative	52.13 V
Positive to Earth	0.09 V
Negative to Earth	-52.31 V

The measured values for both 220 V and 48 V sources indicate that the DC system is balanced.

5.0 General

Soil erosion was found near the LAs of the 132 kV bays. It is suggested that some sort of retaining wall be provided in the concerned area to avoid further soil erosion and to safeguard the bay equipments.



During the site visit, it was observed that switchyard equipment identification is existing but the operating box of CB may also be suitably marked for easy identification of the particular bay CB.



Battery room at Ampati substation doesn't have AC system installed. The ventilation of battery room is dependent upon the running of exhaust fan. Since, the batteries installed are VRLA type, it is suggested to get AC installed in the Battery room as per manufacturer recommendations of having controlled temperature for prolonging the life of VRLA battery.

6.0 Statutory Warnings

Danger Notice Boards need to be displayed in Switchyard/ Bay area as a statutory requirement. In this regard Indian Electricity Rules (1956) stipulates as under:

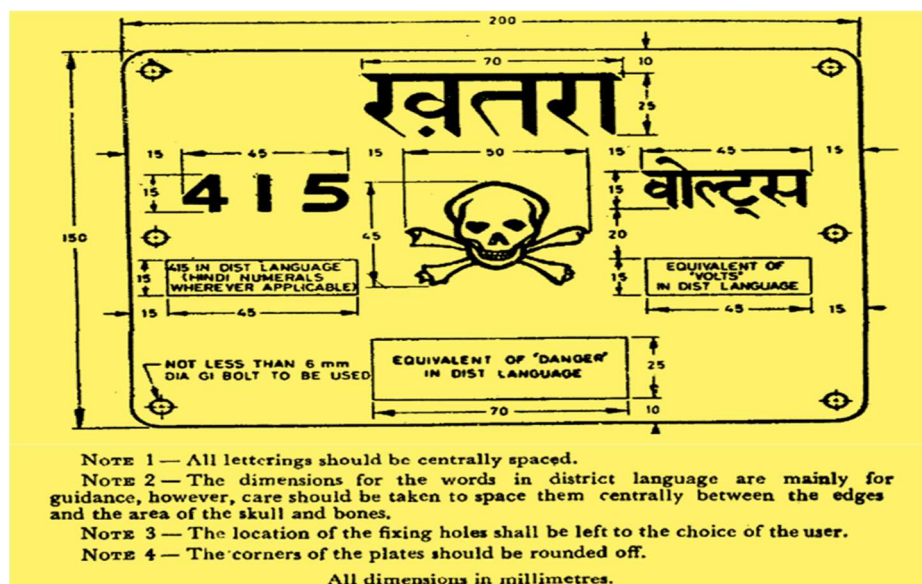
35.Danger Notices:- The owner of every medium, high and extra-high voltage installation shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the district, with a sign of skull and bones 1[of a design as per the relevant IS No.2551]....

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