



Agenda for 109th PCC Meeting

Date:16.12.2021
Eastern Regional Power Committee
14, Golf Club Road, Tollygunge
Kolkata: 700 033

EASTERN REGIONAL POWER COMMITTEE

AGENDA FOR 109th PROTECTION COORDINATION SUB-COMMITTEE MEETING TO BE HELD ON 16.12.2021 AT 10:30 HOURS

PART – A

ITEM NO. A.1: Confirmation of minutes of 108th Protection Coordination sub-Committee Meeting held on 16th November 2021 through MS Teams online platform.

The minutes of 108th Protection Coordination sub-Committee meeting held on 16.11.2021 was circulated vide letter dated 02.12.2021.

Members may confirm.

PART – B

ITEM NO. B.1: Disturbance at 220 kV Budhipadar S/S on 30.11.2021 at 10:12 Hrs

On day of incident 220 kV Bus-1 at Budhipadar S/S was under shutdown. At 10:12 Hrs, Isolator dropper of 220 kV Budhipadar-Lephripada at Budhipadar snapped and created bus fault due to which 220 kV Bus-2 at Budhipadar tripped at Budhipadar which led to total loss of power in 220 kV side of 220/132 kV Budhipadar S/s.

220 kV IB TPS S/s became dead during the above incident.

Detailed report from ERLDC is attached at **Annexure B.1.**

**Load Loss: 82MW, Gen. Loss: 348 MW
Outage Duration: 00:23 Hrs**

OPTCL may explain.

ITEM NO. B.2: Islanding performance assessment for Budhipadar disturbance on 30.11.2021

A. Vedanta Islanding Event:

Chronology of Event:

- At 10:12:31 hrs, Island was formed with tripping of 220 kV Budhipadar-Vedanta D/C circuits due to 220 kV bus fault at 220/132 kV Budhipadar substation.
- Vedanta was importing 20 MW from grid, so there was excess load of 20 MW after separation from grid. Hence in order to balance load, load shedding scheme tripped 2*40 MW rectifier which led to total 80 MW of load tripping in the Vedanta Island.
- With tripping of 80 MW load, island became generation surplus of 60 MW, hence one unit went to house load (30-35 MW), which was earlier running at 125-130 MW. So, now the total excess load was approx. 40 MW in the islanded system.
- Out of 9*135 MW units in Vedanta captive generation, one unit was under annual overhaul and one went to house load. So, now only 7 captive units were in service to provide governor action within the island. These units were already running near to full load so,

adequate governor action provided by all units and load –generation was balanced in the island subsequent. Due to this, frequency was 50 Hz in the island.

- Frequency was steady at 50 Hz but it started decreasing after sustaining for 20 minutes due to reducing steam pressure, and some quantum of load picking meanwhile with manual action. This resulted in frequency to reach UFLS stg-2 which was set at 47.2 Hz for 1 second delay which caused tripping of load in the island via UFLS which could have been avoided if, some amount of load shedding could have been done in this duration.
- This load shedding led to higher frequency and caused further OFGS (Over frequency generation shedding) operation with frequency reaching 52.3 Hz for more than 500 ms that resulted in repeated phenomenon of UFLS & OFGS operation subsequently leading to collapse of islanded system.

B. BHUSAN Islanding Event:

- Bhusan was importing 60 MW from the grid prior to event at Budhipadar substation.
- 130 MW X 3 Units got islanded, however it did not survive as Unit 1 & 3 tripped within 2 second and Unit 2 tripped after 8 seconds. As per the islanding scheme it should survive with house load at 33 kV.
- 60 MW unit in the Bhushan steel got islanded and went to house load with 15 MW of load.

C. Aditya Aluminium Islanding Event:

Prior to islanding flow was almost floating, after islanding it survived.

Detailed report is attached at **Annexure B.2.**

Concerned CPPs may explain.

ITEM NO. B.3: Multiple tripping at 220/132 kV Jayanagar (OPTCL) Substation on 04.11.2021.

At 10:11 Hrs on 04.11.2021, following elements tripped at 220/132 kV Jaynagar substation

Sl.No.	Name of the feeder	Trip Time/ Date	Restoration time/Date	Local end	Remote end
1	220 KV Jayanagar-Upper Kolab-1	10:19 Hrs, 04-11-2021	12:12/ 04.11.2021	Tripped with Z-2, Dist- 5.87KM, fault current IA- 6.929 KA	Tripped on Z-1, Dist- 3.5KM, IA- 2.89KA
2	220 KV Jayanagar-Jeypore(PGCIL)-3		12:05/ 04.11.2021	Tripped on 86A, 86B	Didn't trip at PGCIL end.
3	220 KV Jayanagar-Jeypore(PGCIL)-4		12:09/ 04.11.2021	Tripped on 86A, 86B.	Didn't trip at PGCIL end
4	132KV Jayanagar-Meenakshi		11:03/ 04.11.2021	Tripped without relay indication.	Tripped on Z-III, Dist-120.6KM, B-Ph O/C

Event Analysis:

- Fault was in 220 kV Jayanagar-Upper Kolab-1 which was detected in Zone-2 from Jaynagar end and Zone-1 from upper kolab end. Since PLCC is unhealthy fault was cleared in Zone-2 time from Jayanagar end.
- 220 kV Jeypore-Jayangar-3 & 4 are newly commissioned lines where due to wrong logic tripping occurred from Jayanagar end which is already rectified. Carrier was unhealthy at tripping instance at OPTCL end.
- 132KV Jayanagar-Meenakshi feeder tripped in zone -3.

Detailed report is attached at **Annexure B.3**.

OPTCL may explain.

ITEM NO. B.4: Bus tripping occurred in Eastern Region during November 2021

During November 2021 following incidents of bus bar tripping have been observed in Eastern Region.

Element Name	Tripping Date	Reason	Utility
400 kV Main Bus-1 at FSTPP	04-11-2021 at 09:40 Hrs	CB of 400 kV FSTPP-Durgapur-2 stuck at FSTPP. LBB operated.	Farakka NTPC
400 kV Main Bus-1 at New Purnea	15-11-2021 at 10:20 Hrs	Due to spurious LBB signal during s/d of 400 kV New Purnea-Binaguri-1 & 2	PG ER-1
400 kV Main Bus-2 at Jeypore	30-11-2021 at 10:41 Hrs	Tripped due to mal-operation	PG Odisha Projects

NTPC, Powergrid ER-1 & Powergrid Odisha may explain.

ITEM NO. B.5: Repeated Spurious Tripping of 400 kV Barh-Patna-1

400 kV Barh-Patna-1 had tripped on three occasions on Direct Trip (DT) receipt at Barh end whose details are as follows-

>	400KV-PATNA-BARH-1	13/11/2021	08:36	DT recieved at Barh.No trip at Patna end	13/11/2021	09:58
>	400KV-PATNA-BARH-1	13/11/2021	04:09	Barh: DT recieved, 86 relay operated Patna: Not Tripped	13/11/2021	04:45
>	400KV-PATNA-BARH-1	08/11/2021	13:57	TRIPPED FROM ONLY BARH END	08/11/2021	14:49

NTPC and Powergrid may explain.

ITEM NO. B.6: Protection Audit in Eastern Region

Protection audit is a primary activity to ensure power system protection implemented at substations and power plants are well coordinated and is as per CEA standards. Due to COVID-19, the activity

could not be started since March 2020. Since then, various events have occurred where issues of protection coordination have been observed and several new substation and grid element has been connected with the grid. Therefore, it is now prime requirement to re-commence protection audit of substations and power plants in the Eastern Region. In view of this, following activities have been decided to streamline the audit process:

PCC activities

- Formation of Three-Four core audit teams-All utilities to nominate their members
- Nodal officer from all utilities to co-ordinate with audit activities
- Identification of S/s to be audited
- Finalization of audit format

Pre-audit activities

- Utilities of S/s thus identified to check and update latest protection settings in PDMS database within next 7 days
- S/s to fill up pre-requisite data as per format attached before visit of audit team

Input to be obtained from protection database

- SLD of the S/s
- List of elements
- Updated settings from PDMS database (PDF/excel)
- Model setting for the elements of substation being audited

On the day of Audit at Substation/Plants

- Verification of protection setting as per details provided.
- All testing reports
- Equipment's healthiness status, DC healthiness, Aux system healthiness etc.

Audit team observation will be shared with utilities and in PCC for action plans and compliance monitoring.

Format for protection audit checklist is attached at **Annexure B.6.**

Members may discuss.

ITEM NO. B.7: Tripping Incidence in month of November 2021

Tripping incidents in the month of November 2021 which needs explanation from constituents of either of the end is attached at **Annexure B.7.**

Concerned utilities may explain.

PART- C::OTHER ITEMS

ITEM NO. C.1: Requirement of additional MiP-PSCT License key with Laptop

44thTCC advised all the utilities of ER including JUSNL to furnish their requirement, if any, for additional MiP-PSCT license to ERPC Secretariat citing proper justification.

Further in 44th ERPC meeting, ERPC advised all the utilities to submit their requirement, if any, by 15th October 2021. ERPC further advised ERPC Secretariat to prepare and submit a DPR for additional MiP-PSCT licenses required for ER utilities for PSDF funding.

In 106th PCC meeting, PCC advised concerned utilities to submit their additional requirement of PSCT license, if any, to ERPC secretariat within fifteen (15) days.

The requirement for additional MiP-PSCT license key had been received from SLDC Odisha, JUSNL & WBSETCL.

In 108th PCC Meeting, ERPC informed that requirement for additional MiP-PSCT license key was received from SLDC Odisha, JUSNL & WBSETCL.

PCC advised remaining utilities to submit their additional requirement of PSCT license, if any, to ERPC secretariat within fifteen (15) days

Members may discuss.

ITEM NO. C.2: List of works carried out by PRDC Pvt. Ltd. during the period of November 2020 to October, 2021.

The Protection Database project has been implemented by PRDC and declared "Go Live" on 31st October, 2017. In continuation to above, PRDC submitted report for verification of works carried out during the period of November, 2020 to October, 2021.

PRDC may present. Members may discuss.

ITEM NO. C.3: Follow-up of Decisions of the Previous Protection Sub-Committee Meeting(s)

The decisions of previous PCC meetings are attached at **Annexure C.3.**

Members may update the latest status.

ITEM NO. C.4: Implementation of Differential protection for shorter lines

As per the CEA standard, transmission line protection can have either distance or differential protection scheme as main protection scheme. It has been observed that for short lines distance protection scheme tends to over reach and pose protection coordination issues with other elements from the substation. Further many a times due to this short line distance protection the longer lines from remote ends have to increase their zone-2-time delays to higher values (500-600 ms).

In view of this inherent issue the REPORT OF THE TASK FORCE ON POWER SYSTEM ANALYSIS UNDER CONTINGENCIES recommends the following:

LINE DIFFERENTIAL PROTECTION- Many transmission lines are now having OPGW or separate optic fiber laid for the communication. Where ever such facilities are available, it is recommended to have the line differential protection as Main-I protection with distance protection as backup (built-in Main relay or standalone). Main-II protection shall continue to be distance protection. For cables and composite lines, line differential protection with built in distance back up shall be applied as Main-I protection and distance relay as Main-II protection. Auto-recloser shall be blocked for faults in the cables.

Based on the above in the 68th PCC ER forum members agreed on:

PCC opined that differential protection should be implemented for all short lines(<20 kM) to overcome relay coordination issues with respect to distance and over current protection.

In view of the above, the status of implementation differential protection for shorter lines in the eastern region may be followed up at ER PCC forum level.

A list of short lines (< 20 Km) at 220 kV and above voltage level is attached at **Annexure C.4**.

Members may discuss.

ITEM NO. C.5: New Element Integration

As per information received at ERLDC, 400 kV Kahalgaon (KhSTPP)-Durgapur-2 is going to be first time charged. This circuit is a reconfiguration of 400 kV Farakka (FSTPP)-Kahalgaon (KhSTPP)-4 and 400 kV Farakka (FSTPP)-Durgapur-2 bypassing Farakka substation.

Its modified line parameter as provided below as received from the PGCIL:

Name	Conductor type	Length
400 kV Kahalgaon (KhSTPP)-Durgapur-2	ACSR Twin Moose	242.941 km

In view of this, Protection coordination may be required as per the following table (Based on information available at ERLDC):

Reason	Settings to be reviewed for	Settings to be reviewed at substation	Utility	Remarks
FTC of 400 kV Kahalgaon (KhSTPP)-Durgapur-2 (Bypass near Farakka)	400 kV Kahalgaon (KhSTPP)-Durgapur-2	KhSTPP, Durgapur	NTPC KhSTPP , PG ER-2	Protection coordination to be done for newly connected element as per ERPC guidelines.
	400 kV Farakka (FSTPP)-Kahalgaon-1,2,3	FSTPP	NTPC FSTPP	Adjacent longest line for these lines will now be 400 kV Kahalgaon-Durgapur-2 (242.941 km). Hence Zone-3 settings at respective S/s may be reviewed keeping in view it should not encroach next voltage level. Kindly check and confirm any setting revision if any change in adjacent short and long line.
	400 kV Maithon A-Kahalgaon (KHSTPP)	Maithon A	PG ER-2	
	400 kV Maithon B-Kahalgaon (KHSTPP)	Maithon B	PG ER-2	
	400 kV Barh-Kahalgaon D/c	Barh	NTPC Barh	
	400 kV Banka-Kahalgaon D/c	Banka	PG ER-1	
	400 kV Lakhisarai-Kahalgaon D/c	Lakhisarai	PG ER-1	
	400 kV Maithon-Durgapur A D/c	Maithon	PG ER-2	

400 kV Sagardighi-Durgapur B D/c*	Sagardighi	WBPDC L
400 kV Bidhannagar-Durgapur B D/c*	Bidhannagar	WBSET CL
400 kV Farakka (FSTPP)-Durgapur B (Ckt-1)*	FSTPP	NTPC FSTPP
400 kV Jamshedpur-Durgapur B*	Jamshedpur	PG ER-1
* Setting for the scenario when bus coupler at 400/220 kV Durgapur S/s is in closed condition. At present, bus coupler is in closed condition however in future it will be opened when desired changes at Durgapur substation are in place as per bus split plan decided in previous ERPCTP MoM.		

In future, when Bus coupler at Durgapur will be kept open, Then Zone-3 setting of following lines may need to be reverted back to present setting in future:

Settings to be reviewed in	S/s to change	Utility
400 kV Sagardighi-Durgapur B D/c	Sagardighi	WBPDC
400 kV Bidhannagar-Durgapur B D/c	Bidhannagar	WBSETCL
400 kV Farakka (FSTPP)-Durgapur B (Ckt-1)	FSTPP	NTPC FSTPP
400 kV Jamshedpur-Durgapur B	Jamshedpur	PG ER-1

Following details to be shared:

- Respective utilities may share whether revision of any existing protection setting at above mentioned S/S is required or not. In case of any revision, the revised setting may be shared with ERPC and ERLDC. All revisions may be carried out as per ERPC protection philosophy.
- Status of carrier protection and PLCC channel in the all above mentioned section to be ensure and same may be shared.
- Utilities should ensure that proper protection coordination are in place after charging of these lines/elements.

Members may update.

पावर सिस्टम ऑपरेशन करपोरेशन लिमिटेड

(भारत सरकार का उद्यम)

POWER SYSTEM OPERATION CORPORATION LIMITED

(A Government of India Enterprise)



Eastern Regional Load Despatch Centre: 14, Golf Club Road, Tollygunge, Kolkata-700 033.

CIN: U40105DL2009GOI188682

फ़ोन: 033- 24235755, 24174049 फ़ैक्स : 033-24235809/5029 Website:www.erldc.org, Email ID- erldc@posoco.in

घटना संख्या: 30-11-2021/1

दिनांक: 03-12-2021

Report on the grid event in Eastern Region (पूर्वी क्षेत्र में ग्रिड घटना पर रिपोर्ट)

Summary of the event (घटना का सारांश):

At 10:12 Hrs, 220 kV Bus-2 at Budhipadar tripped (220 kV Bus-1 was under shutdown), leading to total power failure in 220 kV side of 220/132 kV Budhipadar S/s, 220 kV IB Thermal. There are three captive plants in vicinity-Vedanta, Bhushan Steel and Aditya Aluminium. Vedanta island survived for 22 minutes. Bhushan steel island didn't survive. Aditya Aluminium island survived. Total 348 MW generation loss occurred at IB TPS, and 82 MW load loss occurred (supply to Vedanta, Bhushan and Aditya Aluminium CPP).

Date / Time of disturbance: 30-11-2021 at 10:12 hrs.

- **Event type:** GD - 1
- **Systems/ Subsystems affected:** 220kV Budhipadar, IB thermal, Vedanta
- **Load and Generation loss.**
 - 348 MW generation loss at IBTPS
 - 82 MW load loss (supply to Vedanta, Bhushan and Aditya Aluminium CPP).

Important Transmission Line/element if out (महत्वपूर्ण संचरण लाइने जो बंद हैं):

- 220 kV Bus-1 at Budhipadar

Major elements tripped (प्रमुख ट्रिपिंग):

- 220 kV Budhipadar-Lapanga D/c
- 220 kV Budhipadar-Tarkera-D/c
- 220 kV Budhipadar-Vedanta D/c
- 220 kV Budhipadar-IB Thermal Q/c
- 220 kV Budhipadar-Bhushan Steel D/c
- 220 kV Budhipadar-Aditya Aluminium D/c
- 220 kV Budhipadar-SPS-1

Network across the affected area (प्रभावित क्षेत्र का नक्शा)

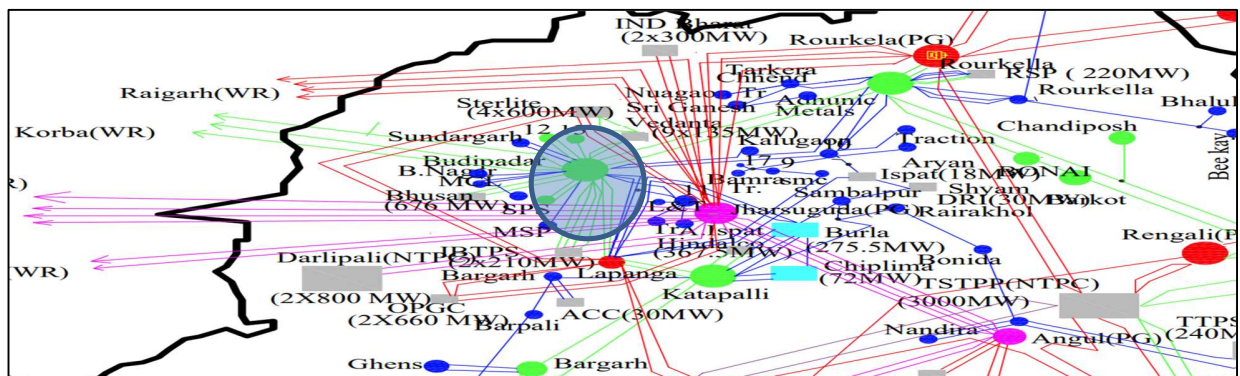


Figure 1: Network across affected area

Relay indication and PMU observation (रिले संकेत और पीएमयू पर्यवेक्षण):

समय	नाम	उप केंद्र 1 रिले संकेत	उप केंद्र 2 रिले संकेत	पीएमयू पर्यवेक्षण
11:57	220 kV Budhipadar-Tarkera-D/c		Ckt 1: R_Y, 108.6 km (98.9%), Ir-1.81 kA, Iy-1.88 kA	16 kV dip in R_ph and Y_ph at Rourkela
	220 kV Budhipadar-Vedanta D/c			
	220 kV Budhipadar-Aluminium D/c	Didn't trip		
	220 kV Budhipadar-Bhushan Steel D/c	Didn't trip		
	220 kV Budhipadar-SPS-1	Didn't trip		
	220 kV Budhipadar-Korba D/c	Didn't trip		
	220 kV Budhipadar-Raigarh			
	220 kV Budhipadar-IBTPS-Q/c	Didn't trip		
	220 kV Budhipadar-Lapanga-D/c	Didn't trip	Ckt 1: R_Y, Z-2, 17.6 km, Ir-4.5 kA, Iy-4.75 kA Ckt 2: R_Y, Z-2, 16.9 km, Ir-4.65 kA, Iy-4.75 kA	
	220/132 kV ATR-1 (160 MVA)-220 kV side	Back UP O/c		
10:30	220 kV Budhipadar-Lephripada	Hand Tripped from both ends		

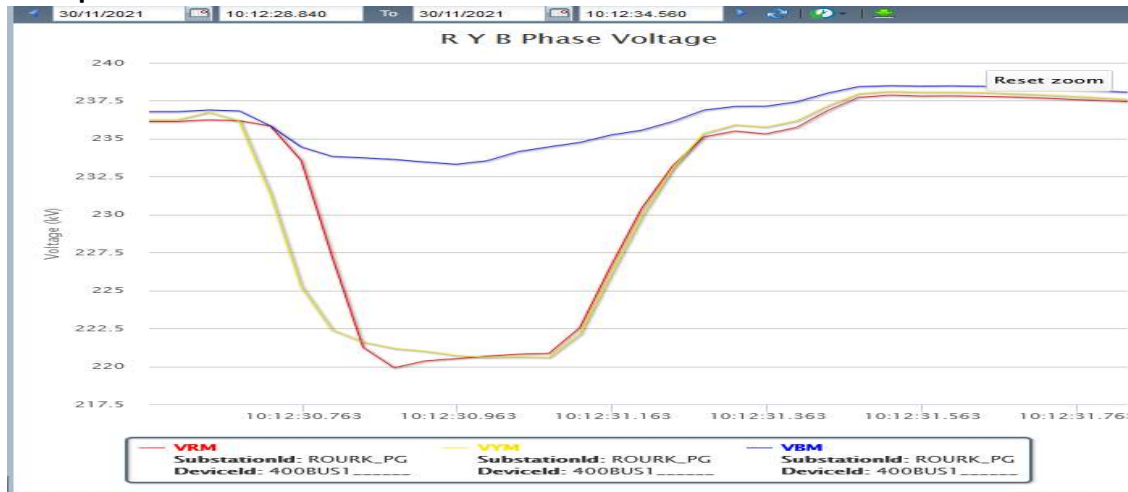
Restoration (पूर्वावस्था की प्रप्ति):

Sl. No.	Name of the Element	Restoration Time
1	220KV Budhipadar-Tarkera-D/c	10:35/10:37 Hrs
2	220KV Budhipadar-Aditya Aluminium D/c	10:43 Hrs
3	220 KV Budhipadar-SPS-1	10:50 Hrs
4	220 KV Budhipadar-Lapanga D/c	10:50/11:05 Hrs
5	220 KV Budhipadar-Vedanta D/c	11:01/11:06 Hrs
6	220 KV Budhipadar-Bhushan Steel D/c	11:06/12:07 Hrs
7	220 KV Budhipadar-Raigarh	11:58 Hrs
8	220 KV Budhipadar-Korba-I	12:02 Hrs
9	220 KV Budhipadar-Korba-II	12:03 Hrs
10	220 KV Budhipadar-Lephripada	11:31
11	220 KV Budhipadar-IBTPS-Q/c	-
12	220 KV side of 160MVA ATR-1	11:03 Hrs

Analysis of the event (घटना का विश्लेषण) & Protection issue (सुरक्षा समस्या):

- **Antecedent condition:** 220 kV Bus-1 at Budhipadar was under shutdown. 220 kV Lephripada feeder was charged through TBC.
- During normalization of 220 kV Budhipadar-Lephripada from TBC to main bus, R_ph isolator dropper snapped and bus fault occurred in 220 kV Bus-2.
- Bay units of 220 kV Vedanta-1, Aditya Aluminium-1, ATR-1 bays were defective. Bus bar protection was kept out of service. **OPTCL to explain.**
- Bus fault was cleared by remote end of all the lines in Zone-2 time (350 msec).
- If Bus Bar Protection was out of service, Zone-4 time of all feeders should have been reduced to avoid delayed fault clearance. **OPTCL to explain.**
- Multiple shutdown activities at a Sub-station maybe avoided.
- Vedanta island survived for 22 minutes. Bhushan Steel Island didn't survive. Aditya Aluminium island survived. Detailed report of the islanding event still awaited. **Vedanta, Bhushan Steel, Aditya Aluminium to submit islanding report.**

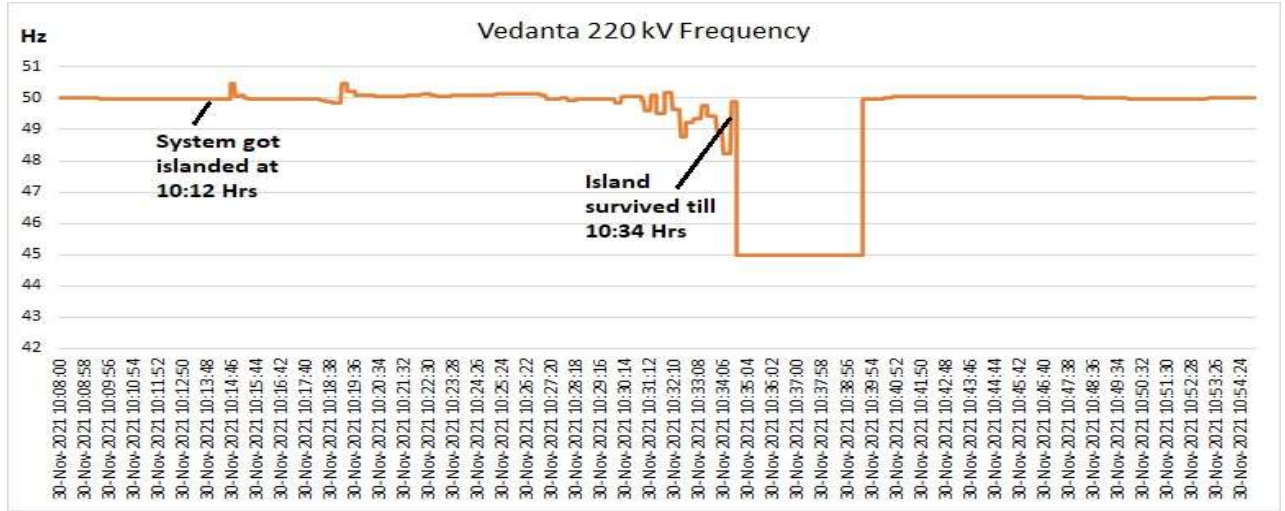
PMU plots



400/220 kV Rourkela Bus-1 voltage

Vedanta Island:

- Vedanta generation was around 950 MW with smelter load around 970 MW
- After tripping of 220 kV Budhipadar-Vedanta D/c, Vedanta island survived for 22 minutes (As per ERLDC SCADA).
- Detailed report from Vedanta awaited.



Frequency of Vedanta (As per ERLDC SCADA)

Bhushan Steel Islanding:

Bhushan Steel island didn't survive.

Aditya Aluminium Islanding:

220 kV Budhipadar-Aditya Aluminium D/c tripped from Aditya Aluminium side on Directional O/c. Exchange with grid was nominal. Both lines were floating. Aditya island survived with 650 MW generation and load.

Vedanta, Bhushan Steel and Aditya Aluminium CPP to share the present event analysis and islanding operation, load generation balance, frequency variation plots.

Non-compliance observed (विनियमन का गैर-अनुपालन):

Issues	Regulation Non-Compliance	Utility
Incorrect/ mis-operation / unwanted operation of Protection system	1. CEA Technical Standard for Construction of Electrical Plants and Electric Lines: 43.4 .A. 2. CEA (Technical standards for connectivity to the Grid) Regulation, 2007: Schedule Part 1. (6.1, 6.2, 6.3)	OPTCL
DR/EL not provided within 24 Hours	1. IEGC 5.2 (r) 2. CEA grid Standard 15.3	OPTCL

Status of Reporting (रिपोर्टिंग की स्थिति):

- DR/EL for all elements awaited from OPTCL.

Annexure 1: Sequence of events recorded at ERLDC SCADA data at the time of the event.

Sequence of event not recorded at time of event.

Annexure 2: DR Recorded

DR/EL not received yet.

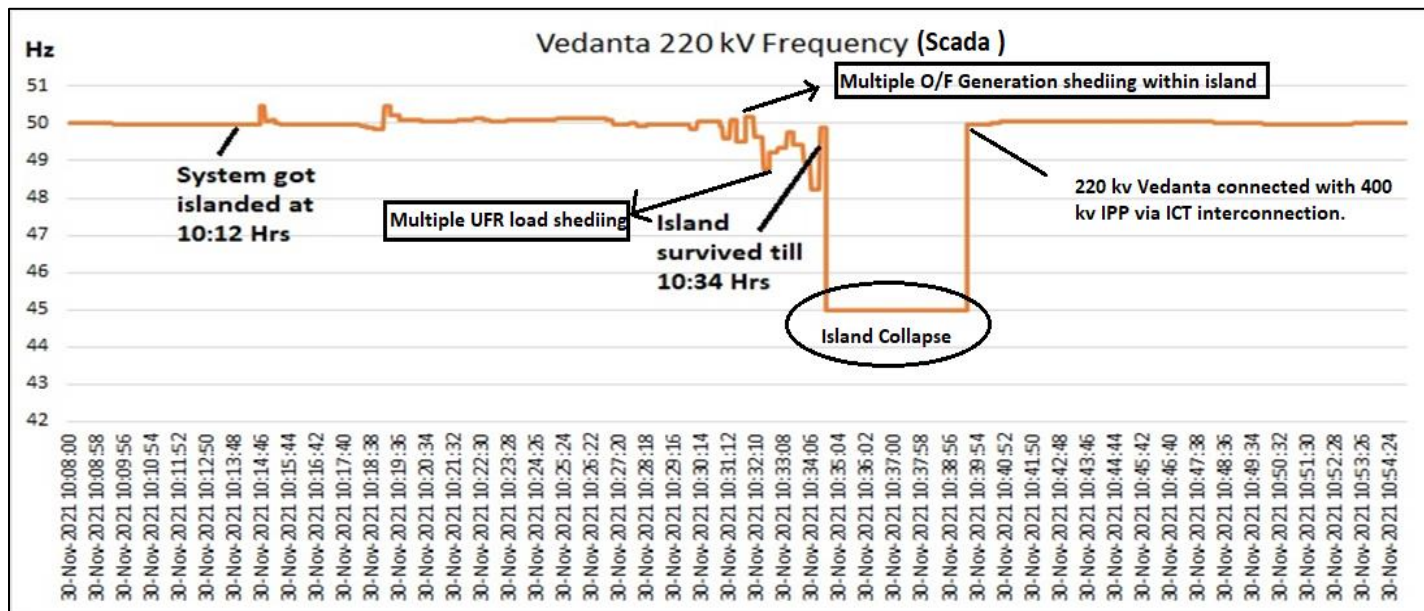
ISLANDING PERFORMANCE ASSESSMENT FOR BUDHIPADAR DISTURBANCE

Summary of the event:

At 10:12 Hrs, 220 kV Bus-2 at Budhipadar tripped (220 kV Bus-1 was under shutdown), leading to total power failure in 220 kV side of 220/132 kV Budhipadar S/s, 220 kV IB Thermal. There are three captive plants in vicinity-Vedanta, Bhushan Steel and Aditya Aluminium. Vedanta island survived for 22 minutes. Bhushan Steel Island didn't survive. Aditya Aluminium island survived. Total 348 MW generation loss occurred at IB TPS, and 82 MW load loss occurred (supply to Vedanta, Bhushan and Aditya Aluminium CPP).

Vedanta Islanding Event:

Frequency plot from Scada data for the event shown below. (See the plot from left to right)



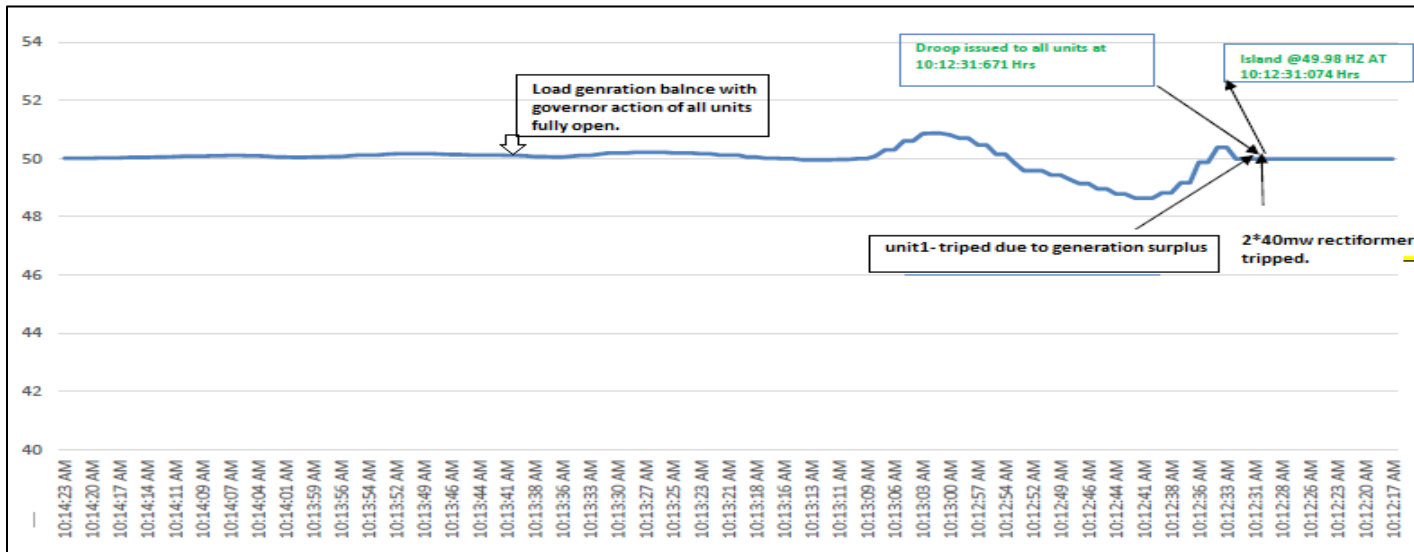
Chronology of Event:

- At 10:12:31 Island formed with tripping of Budhipadar circuits.
- 20 Mw was import from grid, so excess load was of 20 Mw, hence to balance that ,load shedding scheme tripped 2*40 Mw rectifier so total 80 Mw of load tripped . (See the plots attached below).
- With tripping of 80 Mw load, island became generation surplus of 60 Mw , hence one unit went to house load(30-35 Mw) , which was running at 125-130 Mw .So total excess load was approx 40Mw.
- Out of 9*135 Mw units one was under annual overhaul, one went to house load so only 7 units were in service to provide governor action.
- Units were already running near to full so, full governor action came by all units and load – generation was balanced and frequency was 50 Hz as shown below.
- Frequency was steady at 50 hz but it started decreasing after sustaining 20 minutes due to reducing steam pressure , and due to some quantum of load picking meanwhile with manual action .This caused frequency to reach UFLS stg-2 ,47.2 Hz@1sec.(If during this duration some

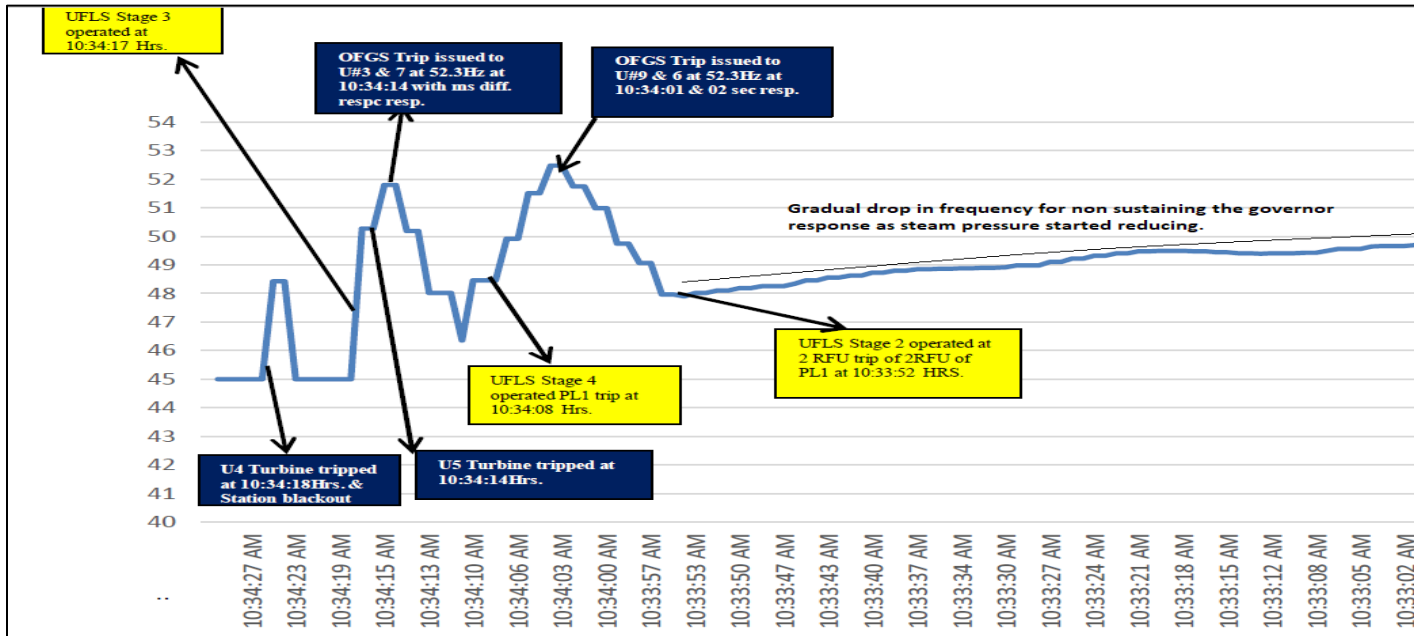
amount of load shedding could be done this may have avoided the slow drop in frequency, some mechanism can be put to ensure the same).

- This caused further OFGS (Over frequency generation shedding) ,52.3Hz@500ms,and same repeated phenomenon of UFLS & OFGS ultimately caused island collapse.(**This sudden UFLS AND OFGS Suspected cause for this is the sluggish response of governor which was unable to cope-up with with load –generation imbalance instantaneously**).
- Steam valve opening is sluggish which needs to be attended and rectified for successful islanding in future events. A co-ordinated governor tuning of all units in islanded mode may be done by Vedanta in this regard to take prompt action for ensuring the successful islanding.

Plot of Frequency Data received from Vedanta: Starting of ISLAND & associated dynamics: (See the plot from right to left)



Before ISLAND collapse & associated dynamics: : (See the plot from right to left)



BHUSAN Islanding Event:

- Bhusan was importing 60 Mw from Grid prior to Event.
- 130 Mw*3 UNIT islanded and did not survive, Unit 1&3 tripped within 2 second and Unit 2 tripped after 8 Seconds. As per the islanding scheme it should survive with house load at 33kv.
- 60Mw unit islanded and went to house load with 15 Mw of load.
- 2*40 Mw unit were under Shutdown.
- **Detailed analysis for root cause of Non-survival is pending and remedial measures to be taken to ensure successful islanding.**

Aditya Aluminium Islanding Event:

- Prior to islanding flow was almost floating, after islanding it survived.

Root Cause Analysis for multiple tripping at Jeynagar

Following tripping's occurred o 04 th November .

Sl. No.	Name of Grid S/S	Name of the feeder	Trip Time/Date	Close time/Date	Duration	Relay Indication	
						Local end	Remote end
1	220/132/33KV GSS ,Jayanagar	220 KV Jayanagar-Upper Kolab ckt-I	10:19/04.11.2021	12:12/ 04.11.2021	01:53 min.	Tripped with Z-2, Dist- 5.87KM, fault current IA- 6.929 KA	Tripped on Z-1, Dist- 3.5KM, IA- 2.89KA
2		220 KV Jayanagar-Jeypore(PGCIL)ckt-III	10:19/04.11.2021	12:05/ 04.11.2021	01:46 min.	Tripped on 86A, 86B	Didn't tripped at PGCIL end.
3		220 KV Jayanagar-Jeypore(PGCIL)ckt-IV	10:19/04.11.2021	12:09/ 04.11.2021	01:50 min.	Tripped on 86A, 86B.	Didn't tripped at PGCIL end
4		132KV Jayanagar-Meenakshi feeder	10:19/04.11.2021	11:03/ 04.11.2021	00:44 min.	Tripped without relay indication.	Tripped on Z-III, Dist- 120.6KM, B-Ph O/C

Antecedent Condition:

- 220 kv Jeypore – Jeynagar III& IV newly commissioned line.
- At the time of disturbance Carrier was unhealthy for Jeypore – Jeynagar ckt 3&4.
- 220 kv Jaynagar-Upper kolab Carrier was unhealthy.

Event Analysis:

- Fault was in 220 kv Jaynagar-Upper kolab –I , in Zone-2 from jaynagar and z-1 from upper kolab but as the PLCC is unhealthy it tripped after zone 2 time from jeynagar.
- 220 KV Jayanagar-Jeypore(PGCIL) III &iv are newly commissioned where wrong logic was set for tripping which caused tripping of these two circuits . **Carrier was unhealthy for both the lines at the tripping instance.**
- **(Logic implemented should be operation of MASTER TRIP 86 A &B when zone-1 trip with A/R block and carrier unhealthy)** but instead of zone-1 trip ,**any trip was enabled in logic** , due to which for the fault of Jeyanagr –upper kolab ,zone-4 at Jeynagar end of Jeynagar –jeypore 3&4 was picked up and as per the wrong logic, any start high along with carrier unhealthy caused tripping of both circuit from Jeynagar.
- 132KV Jayanagar-Meenakshi feeder tripped on zone -3 which should not occur as fault was cleared within zone-2 time , zone-3 timing to be checked and revised at meenakshi end which has been communicated to OPTCL.

Remedial Measure:

- Same has been rectified and logic changed to zone-1 instead of any trip.
- Carrier healthiness to be ensured for all lines.
- OPTCL communicated to change zone-3 settings at Meenakshi end.

PROTECTION AUDIT REPORT

General information

Substation name:

SS voltage level:

Fault level of all equipment
(for that voltage level)

Date of commissioning
of the substation:

Region:

Audit date:

Name of utility which owns the
substation (e.g POWERGRID,
MSETCL, ADANI POWER, etc.)

Audit Team

Name	Company name
.....
.....

Regional representatives:

Name	Company name
.....
.....
.....
.....
.....
.....

Attached documents:

- 1 List of the faults that was/were not eliminated by the protection;
- 2 Record of previous trippings for last six months and associated fault analysis.
- 3 Single/three pole auto-recloser events, if any in last six months;
- 4 Details on periodicity of relay testing and latest relay test report
- 5 Communication from concerned department for the revised settings and record for implementation of the revised settings.
- 6 CT characteristics at all taps in case of multi-ratio CTs
- 7 df/dt, UFR relay details and settings if its available
- 8 Special Protection Schemes details if applicable. (Including test results & last operation records),
implemented schematic diagram for SPS
- 9 Single Line Diagram

CONCLUSIONS OF PROTECTION AUDIT REPORT

Item no.	Issues	Remarks
1	Recommendations of last Protection Audit	Status of works&reason for pending/suggestions
2	Review of Existing Settings at Substations	
	Any inadvertently enabled settings/functions observed. (Yes/No)	
3	Disturbance recorder - list of 3 trippings in last 6 months	Recommended action
3.a	DR as well as EL records for the trippings available (Yes/No)	
3.b	Records available for Tripping analysis and corrective actions taken (Yes/no)	
3.c	Time Synch Matched Between EL signals and DR signals (Yes/No)	
3.d	Digital Signals of DR named properly (main CB Trip, Z1 Trip etc.) (Yes/No)	
4	Chronic reason of tripping, if any	Recommended action

Item no.	Issues	Remarks
5	Existing process for record of changes incorporated in the relay settings	See attached corespondence
6	Overvoltage grading for parallel line (time&pick up grading, provided or not)	Recommended action
7	Other deficiencies/Nonconformity observed (including the major non-conformaties mentioned in the audit format. ex: Single AC source etc.)	Recommended action

Appendix-9.4

CHECK LIST TO ENABLE AUDIT OF PRACTICES FOLLOWED IN PROTECTION APPLICATION & CRITERIA USED FOR SETTING CALCULATIONS IN 220KV, 400KV & 765KV SUBSTATIONS

CHECK-LIST: Check list for different protected objects & elements in fault clearance system are as under:

(put \checkmark mark in the appropriate box)

A. Transmission Lines (OHL and Cables)

1.	Independent Main-I and Main-II protection (of different make OR different type) is provided with carrier aided scheme	<input type="checkbox"/> YES	<input type="checkbox"/> NO
2.	Are the Main-I & Main-II relays connected to two separate DC sources (Group-A and Group-B)	<input type="checkbox"/> YES	<input type="checkbox"/> NO
3.	Is the Distance protection (Non-switched type, suitable for 1-ph & 3-ph tripping) as Main1 and Main2 provided to ensure selectivity & reliability for all faults in the shortest possible time	<input type="checkbox"/> YES	<input type="checkbox"/> NO
4.	Is both main-I & Main-II distance relay are numerical design having Quadrilateral or Polygon operating characteristic	<input type="checkbox"/> YES	<input type="checkbox"/> NO
5.	In the Main-I / Main-II Distance protection, Zone-I is set cover 80% of the protected line section	<input type="checkbox"/> YES	<input type="checkbox"/> NO
6.	In the Main-I / Main-II distance protection, Zone-2 is set cover 120% of the protected line section in case of Single circuit line and 150% in case of Double circuit line	<input type="checkbox"/> YES	<input type="checkbox"/> NO
7.	In the Main-I / Main-II distance protection, Zone-3 is set cover 120% of the total of protected line section plus longest line at remote end as a minimum.	<input type="checkbox"/> YES	<input type="checkbox"/> NO
8.	Resistive reach for Ground fault element set to give maximum coverage considering fault resistance, arc resistance & tower footing resistance. (In case, It is not possible to set the ground fault and phase fault reaches separately, load point encroachment condition imposed on Phase fault resistive reach shall be applied)	<input type="checkbox"/> YES	<input type="checkbox"/> NO
9.	Resistive reach for Phase fault element set to give maximum coverage subject to check of possibility against load point encroachment considering minimum expected voltage and maximum load.	<input type="checkbox"/> YES	<input type="checkbox"/> NO
10.	In case of short lines, is manufacturers recommendation considered in respect of resistive setting vis a vis reactance setting to avoid overreach.	<input type="checkbox"/> YES	<input type="checkbox"/> NO
11.	Is Zone-2 time delay of Main-I / Main-II distance relay set to 0.350 seconds ? In case any other value has been set for Zone-II timer, kindly specify the value and justification thereof.	<input type="checkbox"/> YES	<input type="checkbox"/> NO
12.	Is Zone-3 timer is set to provide discrimination with the operating time of relays at adjacent sections with which Zone-3 reach of relay is set to overlap. Please specify the Zone-3 time set.	<input type="checkbox"/> YES	<input type="checkbox"/> NO
13.	Is Zone-4 reach set in reverse direction to cover expected levels of apparent bus bar fault resistance, when allowing for multiple in feeds from other circuits?	<input type="checkbox"/> YES	<input type="checkbox"/> NO
14.	Is reverse looking Zone-4 time delay set as Zone-2 time delay?	<input type="checkbox"/> YES	<input type="checkbox"/> NO

Report of the Task Force on Power System Analysis Under Contingencies

15.	<p>Is Switch on to fault (SOTF) function provided in distance relay to take care of line energisation on fault?</p> <p>Whether SOTF initiation has been implemented using hardwire logic</p> <p>In case of Breaker and half switching scheme, whether initiation of line SOTF from CB closing has been interlocked with the other CB</p>	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES <input type="checkbox"/> NO
16.	Whether VT fuse fail detection function has been correctly set to block the distance function operation on VT fuse failure	<input type="checkbox"/> YES <input type="checkbox"/> NO
17.	Is the sensitive IDMT directional E/F relay (either separate relay or built-in function of Main relay) for protection against high resistive earth faults?	<input type="checkbox"/> YES <input type="checkbox"/> NO
18.	Is additional element (Back-up distance) for remote back-up protection function provided in case of unit protection is used as Main relay for lines?	<input type="checkbox"/> YES <input type="checkbox"/> NO
19.	In case of Cables, is unit protection provided as Main-I & Main-II protection with distance as back-up.	<input type="checkbox"/> YES <input type="checkbox"/> NO
20.	Are the line parameters used for setting the relay verified by field testing	<input type="checkbox"/> YES <input type="checkbox"/> NO
21.	<p>Is Two stages Over-Voltage protection provided for 765 & 400kV Lines?</p> <p>Do you apply grading in over-voltage setting for lines at one station.</p> <p>Please specify the setting values adopted for: Stage-I : (typical value - 106 to 112 % , delay : 4-7 Sec) Stage-II: (typical value - 140 to 150%, delay: 0 to 100msec.)</p>	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> YES <input type="checkbox"/> NO
22.	<p>Is 1-ph Auto –reclosing provided on 765, 400 & 220kV lines?</p> <p>Please specify the set value: Dead time: (typical 1 Sec) Reclaim time: (typical 25 Sec)</p>	<input type="checkbox"/> YES <input type="checkbox"/> NO
23.	<p>Is the Distance communication. Scheme Permissive Over Reach (POR) applied for short lines and Permissive Under Reach (PUR) applied for long lines?</p> <p>If any other communication scheme has been applied, please provide the detail with justification thereof.</p>	<input type="checkbox"/> YES <input type="checkbox"/> NO
24.	Is the Current reversal guard logic for POR scheme provided on Double circuit lines?	<input type="checkbox"/> YES <input type="checkbox"/> NO
25.	In case the protected line is getting terminated at a station having very low fault level i.e. HVDC terminal, whether weak end-infeed feature has been enabled in respective distance relay or not	<input type="checkbox"/> YES <input type="checkbox"/> NO
26.	In case of protected line is originating from nuclear power station, are the special requirement (stability of nuclear plant auxiliaries) as required by them has been met	<input type="checkbox"/> YES <input type="checkbox"/> NO
27.	<p>What line current , Voltage and Load angle have been considered for Load encroachment blinder setting and what is the resultant MVA that the line can carry without load encroachment.</p> <p>(In the absence of Load encroachment blinder function, this limit shall be applied to Zone-3 phase fault resistive reach.)</p>	I= V= Angle: S=
28.	<p>a) What are the Zones blocked on Power swing block function:</p> <p>b) Setting for Unblock timer: (typical 02 second)</p> <p>c) Out of Step trip enabled</p>	Z1 / Z2 / Z3 / Z4 Time: <input type="checkbox"/> YES <input type="checkbox"/> NO
29.	Whether the location of Out of step relay has been identified on the basis of power system simulation studies	<input type="checkbox"/> YES <input type="checkbox"/> NO

30.	<p>a) Is Disturbance recorder and Fault locator provided on all line feeder ?</p> <p>b) Whether standalone or built in Main relay</p> <p>c) Whether DR is having automatic fault record download facility to a central PC</p> <p>d) Whether DR is time synchronised with the GPS based time synchronising equipment</p> <p>e) Whether DR analog channels contain line phase & neutral current and line phase & neutral voltage.</p> <p>f) Whether DR digital channel as a minimum contain the CB status, Main-I & II trip status, LBB trip status, Over-voltage trip status, Stub protn trip status, Permissive and direct carrier receive status, Line reactor trip status.</p>	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Standalone / built-in</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>
31.	Does the Setting document for the numerical relays (IED) contain all the settings for all functions that are used and indicates clearly the functions not used (to be Blocked / Disabled). Are all default settings validated or revised settings given in the setting document?	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>

B. Power Transformers

1.	Do you use Group A and Group B protections connected to separate DC sources for power transformers	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
2.	Do you follow CBIP guideline (274 & 296) for protection setting of transformer	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
3.	Do you use duplicated PRD and Bucholtz initiating contact for power transformers at 765kV and 400kV levels	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
4.	<p>Do you classify transformer protections as below in groups:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Group A</td> <td style="width: 50%;">Group B</td> </tr> <tr> <td>• Biased differential relay</td> <td>Restricted earth fault (REF) relay</td> </tr> <tr> <td>• PRD , WTI</td> <td>Buchholz Protection, OTI</td> </tr> <tr> <td>• Back up Protection(HV)</td> <td>Back up Protection(MV)</td> </tr> <tr> <td>• Over fluxing protection(HV)</td> <td>Over fluxing protection(MV)</td> </tr> </table>	Group A	Group B	• Biased differential relay	Restricted earth fault (REF) relay	• PRD , WTI	Buchholz Protection, OTI	• Back up Protection(HV)	Back up Protection(MV)	• Over fluxing protection(HV)	Over fluxing protection(MV)	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Group A or B</p>
Group A	Group B											
• Biased differential relay	Restricted earth fault (REF) relay											
• PRD , WTI	Buchholz Protection, OTI											
• Back up Protection(HV)	Back up Protection(MV)											
• Over fluxing protection(HV)	Over fluxing protection(MV)											
5.	In case of Breaker & half switching scheme, whether CT associated with Main & Tie Breakers are connected to separate bias winding of the low impedance Biased differential protection in order to avoid false operation due to dissimilar CT response.	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
6.	Is Restricted earth fault (REF) protection used a high impedance type	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
7.	Are Main protection relays provided for transformers are of numerical design.	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
8.	<p>a) Are directional over current & earth fault relays provided as back-up protection of Transformer are of numerical design.</p> <p>b) Do the back-up earth fault relays have harmonic restrain feature</p>	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
9.	Is Fire protection system (HVW type) provided for power transformer and functioning	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										
10.	<p>a) Is the Disturbance recorder provided for Transformer feeder</p> <p>b) Whether standalone or built in Main relay</p> <p>c) Whether DR is having automatic fault record download facility to a central PC</p> <p>d) Whether DR is time synchronised with the GPS time synchronising equipment</p>	<p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>Standalone/built-in</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p>										

11.	Does the Setting document for the numerical relays (IED) contain all the settings for all functions that are used and indicates clearly the functions not used (to be Blocked / Disabled). Are all default settings validated or revised settings given in the setting document?	<input type="checkbox"/> YES <input type="checkbox"/> NO
------------	--	--

C. Shunt Reactors

1.	Do you use Group A and Group B protections connected to separate DC sources for reactors	<input type="checkbox"/> YES <input type="checkbox"/> NO
2.	Do you follow CBIP guideline (274 and 296) for protection setting of reactors	<input type="checkbox"/> YES <input type="checkbox"/> NO
3.	Do you use duplicated PRD and Bucholtz initiating contact for Reactors at 765kV and 400kV levels	<input type="checkbox"/> YES <input type="checkbox"/> NO
4.	Do you classify Reactor protections as below in groups: <div style="display: flex; justify-content: space-around;"> <div style="text-align: left;"> <p>Group A</p> <ul style="list-style-type: none"> • Biased differential relay • PRD , WTI • Back up impedance protection </div> <div style="text-align: left;"> <p>Group B</p> <ul style="list-style-type: none"> R.E.F Protection Buchholz Protection, OTI Direction O/C & E/F relay </div> </div>	<input type="checkbox"/> YES <input type="checkbox"/> NO Group A or B
5	In case of Breaker & half switching scheme, whether CT associated with Main & Tie Breakers are connected to separate bias winding of the low impedance Biased differential protection in order to avoid false operation due to dissimilar CT response.	<input type="checkbox"/> YES <input type="checkbox"/> NO
6	Is Restricted earth fault (REF) protection used a high impedance type	<input type="checkbox"/> YES <input type="checkbox"/> NO
7	Are Main & back-up protection relays provided for Reactor are of numerical design.	<input type="checkbox"/> YES <input type="checkbox"/> NO
8	Is Fire protection system (HVW type) provided for Reactor and functioning	<input type="checkbox"/> YES <input type="checkbox"/> NO
9	a) Is the Disturbance recorder and Fault locator provided on all the Shunt Reactors used in 765 kV, 400 kV substations? b) Whether standalone or built in Main relay c) Whether DR is having automatic fault record download facility to a central PC	<input type="checkbox"/> YES <input type="checkbox"/> NO Standalone/built-in <input type="checkbox"/> YES <input type="checkbox"/> NO
10.	Does the Setting document for the numerical relays (IED) contain all the settings for all functions that are used and indicates clearly the functions not used (to be Blocked / Disabled). Are all default settings validated or revised settings given in the setting document?	<input type="checkbox"/> YES <input type="checkbox"/> NO

D. Bus bars

1.	Bus Bar protection for 765, 400 & 220kV buses is provided	<input type="checkbox"/> YES <input type="checkbox"/> NO
2.	Duplicated Bus bar protection is provided for 765kV and 400kV buses	<input type="checkbox"/> YES <input type="checkbox"/> NO
3.	CBIP guideline for Protection (274 and 296) settings is followed	<input type="checkbox"/> YES <input type="checkbox"/> NO
4	In an existing substation if CTs are of different ratios, is biased type bus protection provided.	<input type="checkbox"/> YES <input type="checkbox"/> NO
5	In stations where single bus bar protection is provided, is backup provided by reverse looking elements of distance relays or by second zone elements of remote end distance relays?	<input type="checkbox"/> YES <input type="checkbox"/> NO

6	In case of GIS where burn through time of SF6 is shorter than remote back up protection is the bus bar protection duplicated irrespective of voltage level?	<input type="checkbox"/> YES	<input type="checkbox"/> NO
7	Since it is difficult to get shutdowns to allow periodic testing of bus protection, numerical bus protections with self-supervision feature is an answer. Is this followed?	<input type="checkbox"/> YES	<input type="checkbox"/> NO
8	Does the Setting document for the numerical relays (IED) contain all the settings for all functions that are used and indicates clearly the functions not used (to be Blocked / Disabled). Are all default settings validated or revised settings given in the setting document?	<input type="checkbox"/> YES	<input type="checkbox"/> NO

E. Disturbance Recorder (DR) and Event Logger (EL)

1	<p>a) Is the Disturbance recorder and Fault locator provided on all line feeders of 765, 400 & 220kV substations?</p> <p>b) Whether standalone or built in Main relay</p> <p>c) Whether DR is having automatic fault record download facility to a central PC</p> <p>d) Whether Central PC for DR , EL are powered by Inverter (fed from station DC)</p>	<input type="checkbox"/> YES	<input type="checkbox"/> NO
		Standalone / built-in	
		<input type="checkbox"/> YES	<input type="checkbox"/> NO
		<input type="checkbox"/> YES	<input type="checkbox"/> NO
2.	<p>Whether DR is having the following main signals for lines:</p> <p><u>Analogue signals:</u></p> <ul style="list-style-type: none"> • From CT: IA, IB, IC, IN • From VT: VAN, VBN, VCN • From Aux. VT: V0 <p><u>Digital Signals</u></p> <ul style="list-style-type: none"> • Main 1 Carrier receive • Main 1 Trip • Line O/V Stage I / Stage II • Reactor Fault Trip • Stub Protection Operated. • Main II Trip • Main II Carrier Receive • Direct Trip CH I / II • CB I Status (PH-R, Y & B) • CB II Status (PH R, Y & B) • Bus bar trip • Main / Tie CB LBB Operated • Main / Tie Auto-reclose operated. <p>DR for Transformer / Reactor feeder should contain analog channel like input currents & voltage. Binary signal include all protection trip input, Main & Tie CB status, LBB trip</p>	<input type="checkbox"/> YES	<input type="checkbox"/> NO
3.	Whether substation (765, 400 , 220kV) is having Event logger facility (standalone or built-in-SAS)	<input type="checkbox"/> YES	<input type="checkbox"/> NO
4.	Whether GPS based time synchronizing equipment is provided at the substation for time synchronizing of Main relays / DR/ Event logger / SAS/ PMU / Line Current Differential Relays	<input type="checkbox"/> YES	<input type="checkbox"/> NO

F. Circuit Breakers

1.	Is breaker fail protection (LBB / BFR) provided for all the Circuit Breakers at 220kV , 400kV & 765kV rating	<input type="checkbox"/> YES	<input type="checkbox"/> NO
3.	For Circuit Breaker connected to line feeder / transformer feeder, whether operation of LBB / BFR sends direct trip signal to trip remote end breaker ?	<input type="checkbox"/> YES	<input type="checkbox"/> NO

4.	For lines employing single phase auto reclosing, Is start signal from protection trip to LBB / BFR relay is given on single phase basis?	<input type="checkbox"/> YES <input type="checkbox"/> NO
5.	Is separate relay provided for each breaker and the relay has to be connected from the secondary circuit of the CTs associated with that particular breaker?	<input type="checkbox"/> YES <input type="checkbox"/> NO
6.	Is LBB relay provided with separate DC circuit independent from Group-A and Group-B Protections?	<input type="checkbox"/> YES <input type="checkbox"/> NO
7.	Is the LBB initiation provided with initiating contact independent of CB trip relay contact?	<input type="checkbox"/> YES <input type="checkbox"/> NO
8.	Is Separation maintained between protective relay and CB trip coil DC circuit so that short circuit or blown fuse in the CB circuit will not prevent the protective relay from energizing the LBB scheme?	<input type="checkbox"/> YES <input type="checkbox"/> NO
9.	Is LBB relay initiated by Bus bar protection in addition to other fault sensing relays, since failure of CB to clear a bus fault would result in the loss of entire station if BFP relay is not initiated?	<input type="checkbox"/> YES <input type="checkbox"/> NO
10.	Is tripping logic of the bus bar protection scheme used for LBB protection also?	<input type="checkbox"/> YES <input type="checkbox"/> NO
11.	Are the special considerations provided to ensure proper scheme operation by using Circuit Breaker contact logic in addition to current detectors in cases breaker-fail relaying for low energy faults like buckholz operation?	<input type="checkbox"/> YES <input type="checkbox"/> NO
12.	Are the Current level detectors set as sensitive as the main protection? (Generally setting of 0.2 A is commonly practiced for lines and transformers)	<input type="checkbox"/> YES <input type="checkbox"/> NO
13.	Is timer set considering breaker interrupting time, current detector reset time and a margin? (Generally a timer setting of 200ms has been found to be adequate)	<input type="checkbox"/> YES <input type="checkbox"/> NO
14.	Is the back-up fault clearance time is shorter than the operating time of the remote protections (distance relay Zone-2) ?	<input type="checkbox"/> YES <input type="checkbox"/> NO
15.	Is the breaker failure protection provided with two steps (First stage – retrip own CB, Second stage- Trip all associated CBs) . This mitigates unwanted operation of breaker failure protection during maintenance and fault tracing.	<input type="checkbox"/> YES <input type="checkbox"/> NO
16.	Is the breaker failure protection hardware provided is separate from line /transformer feeder protection?	<input type="checkbox"/> YES <input type="checkbox"/> NO

G. Communication systems

1.	<p>a) Do you use PLCC for tele-protection of distance relays at 765, 400 & 220kV feeders</p> <p>b) Specify type of coupling</p> <p>c) Whether redundant PLCC channels provided for 400 & 765kV lines</p> <p>d) Specify number of PLCC channels per circuit :</p> <p>e) Whether dependability & security of each tele-protection channel measured & record kept ?</p>	<p style="text-align: center;"><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p style="text-align: center;">(Ph-Ph / Ph-G/ Inter-ckt)</p> <p style="text-align: center;"><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p style="text-align: center;">(One / two)</p> <p style="text-align: center;"><input type="checkbox"/> YES <input type="checkbox"/> NO</p>
-----------	--	---

2.	a) In case you use OPGW for tele-protection, are they on geographically diversified route for Main-I and Main-II relay? b) Whether dedicated fibre is being used for Main-I / Main-II relay or multiplexed channel are being used.	<input type="checkbox"/> YES <input type="checkbox"/> NO Dedicated / multiplexed
-----------	---	---

H. Station DC supply systems

1.	Do you have two separate independent DC system (220V or 110V) (Source-A and Source-B)	<input type="checkbox"/> YES <input type="checkbox"/> NO
2.	Do you have two independent DC system (48V) for PLCC (source-A and source-B)	<input type="checkbox"/> YES <input type="checkbox"/> NO
3.	There is no mixing of supplies from DC source-A and DC source-B	<input type="checkbox"/> YES <input type="checkbox"/> NO
4.	Whether the protection relays and trip circuits are segregated into two independent system fed through fuses from two different DC source	<input type="checkbox"/> YES <input type="checkbox"/> NO
5.	Whether Bay wise distribution of DC supply done in the following way: a) Protection b) CB functions c) Isolator / earth switch functions d) Annunciation / Indications e) Monitoring functions	<input type="checkbox"/> YES <input type="checkbox"/> NO
6	Whether following has been ensured in the cabling: a) Separate cables are used for AC & DC circuits b) Separate cables are used for DC-I & DC-II circuits c) Separate cables are used for different cores of CT and CVT outputs to enhance reliability & security	<input type="checkbox"/> YES <input type="checkbox"/> NO
7	Is guidelines prescribed in CBIP manual 274 & 296 followed in general	<input type="checkbox"/> YES <input type="checkbox"/> NO

I. PERFORMANCE INDICES

1.	Is there a system of periodically measuring Dependability & Security of Protection system (as given in CBIP manual 296) and recorded	<input type="checkbox"/> YES <input type="checkbox"/> NO
2.	Is there a system of periodically measuring Dependability of switchgear associated with Protection system and recorded	<input type="checkbox"/> YES <input type="checkbox"/> NO
3.	Is there a process of Root cause analysis of unwanted tripping events	<input type="checkbox"/> YES <input type="checkbox"/> NO
4.	Are improvement action like revision of relay setting, better maintenance practices, modernising & retrofitting of switching & protection system taken based on above data.	<input type="checkbox"/> YES <input type="checkbox"/> NO
5.	Is attention also given to DC supply system, tele-protection signalling, healthiness of tripping cables, terminations etc. in order to improve the performance of fault clearance system	<input type="checkbox"/> YES <input type="checkbox"/> NO

J. ADDITIONAL CHECKS FOR SERIES COMPENSATED LINES

1.	What is the operating principle of Main protection employed	<input type="checkbox"/> Distance <input type="checkbox"/> Line Current diff.
-----------	---	--

Report of the Task Force on Power System Analysis Under Contingencies

2.	Are both main-I & Main-II distance relay are numerical design	<input type="checkbox"/> YES <input type="checkbox"/> NO
3.	Are both main-I & Main-II distance relay suitable for Series compensated lines	<input type="checkbox"/> YES <input type="checkbox"/> NO
4.	Are POR tele-protection scheme employed for distance relays	<input type="checkbox"/> YES <input type="checkbox"/> NO
5.	Position of Line VT provided on series compensated line	<input type="checkbox"/> Between Capacitor and line <input type="checkbox"/> Between Capacitor and Bus
6.	What is the under reaching (Zone 1) setting used in teleprotection schemes (Local & Remote end)	% of line length Rationale:
7.	What is the overreaching (Zone 2) setting in used teleprotection schemes	% of line length Rationale:
8.	What kinds of measurement techniques are used to cope with voltage inversion?	<input type="checkbox"/> Phase locked voltage memory <input type="checkbox"/> Intentional time delay Other, specify:
9.	Whether system studies carried out to check the possibility of current inversion due to series compensation	<input type="checkbox"/> YES <input type="checkbox"/> NO
10.	Whether any system studies conducted to find the impact of series compensation on the performance of protections installed on adjacent lines? If yes, how many lines were found to be affected. Pl. specify _____	<input type="checkbox"/> YES <input type="checkbox"/> NO
11	If YES, are the affected protections on adjacent lines changed / setting revised after the introduction of series compensation?	<input type="checkbox"/> YES <input type="checkbox"/> NO
12.	Is dynamic simulation done to fine tune settings of distance relay installed on series compensated double circuit lines?	<input type="checkbox"/> YES <input type="checkbox"/> NO
13.	Whether performance of directional earth fault relay verifies by simulation studies	<input type="checkbox"/> YES <input type="checkbox"/> NO
14.	When is flashover of spark gaps expected?	<input type="checkbox"/> For protected line Faults up to _____ ohms <input type="checkbox"/> For external faults an adjacent lines
15.	Whether measures taken for under/overreach problems at sub-harmonic oscillations?	<input type="checkbox"/> YES <input type="checkbox"/> NO
16.	Whether MOV influence considered while setting the distance relay reach	<input type="checkbox"/> YES <input type="checkbox"/> NO
17.	Have you experienced any security problems (Relay mal-operation) with high frequency transients caused by <input type="checkbox"/> Flashover of spark gaps <input type="checkbox"/> Line energisation Other, specify:	<input type="checkbox"/> YES <input type="checkbox"/> NO
18.	If YES, how the above problem has been addressed?	

List of important transmission lines in ER which tripped in November-2021

Sl. No.	LINE NAME	TRIP DATE	TRIP TIME	RESTORATION DATE	RESTORATION TIME	Relay Indication LOCAL END	Relay Indication REMOTE END	Reason	Fault Clearance time in msec	Remarks	PMU Location	DR CONFIGURATION DESCRIP	DR/EL RECEIVED FROM LOCAL END	DR/EL RECEIVED FROM REMOTE END	LOCAL END UTILITY	REMOTE END UTILITY
1	400 KV FSTPP-DURGAPUR-2	04-11-2021	09:44	04-11-2021	12:55	FSTPP: B_N, Zone-1, 104 km, 3.5 kA	Durgapur: B_N, Zone-1, 56.94 km, 4.59 kA	B-Earth	200	Main bay LBB operated at Farakka. 400 KV Bus-1 tripped	Durgapur		Yes	Yes	NTPC FSTPP	PGER-2
2	400 KV FSTPP-BAHARAMPUR-1	04-11-2021	09:44	04-11-2021	12:11		DT received	No fault	NA	Bus-1 at Farakka tripped	FSTPP		Yes	Yes	NTPC FSTPP	PGER-2
3	220 KV NEW PURNEA-MADHEPURA-1	06-11-2021	10:58	06-11-2021	11:16	New Purnea: R_N, 78.54 km, 2.49 kA		R-Earth	350	Carried received at New Purnea but tripped in Zone-2 time. A/r successful from Madhepura only	New Purnea		Yes	Yes	PGER-1	BSPTCL
4	400 KV PPSP-BIDHANNAGAR-2	06-11-2021	12:03	06-11-2021	12:25	PPSP: R_N, Zone-1, 144.2 km	Bidhannagar: R_N, Zone-1, 36.4 km, 6.1 kA	R-Earth	100	Three phase tripping at Bidhannagar	Durgapur	DR length less	No	Yes	WBSETCL	WBSETCL
5	400 KV PPSP-BIDHANNAGAR-1	06-11-2021	14:21	06-11-2021	14:42	PPSP: R_N, Zone-1, 105.1 km	Bidhannagar: R_N, Zone-1, 85.65 km, 6.9 kA	R-Earth	100	Three phase tripping at Bidhannagar	Durgapur		No	Yes	WBSETCL	WBSETCL
6	220 KV CHANDAUTI-SONENAGAR-1	07-11-2021	23:20	08-11-2021	00:23	Chandauti: R_N, 50.8 km, 3.2 kA	Sonenagar: R_N, 20.17 km, 2.195 kA	R-Earth	250	A/r successful from Chandauti only. No A/r attempt at Sonenagar	Gaya		Yes	Yes	PMTL	BSPTCL
7	400 KV MERAMUNDALI-LAPANGA-2	08-11-2021	12:54	08-11-2021	13:03	Tripped while checking VT fuse	Didn't trip	No fault	NA	No fault in line however, distance relay operated at Meramundali	Meramundali		Yes	NA	OPTCL	OPTCL
8	400 KV BARH-PATNA-1	08-11-2021	13:57	08-11-2021	14:49		Didn't trip	No fault	NA	Reason maybe shared by Barh	Barh		No	NA	NTPC Barh	PGER-1
9	220 KV RANGPO-NEW MELLI-1	08-11-2021	16:29	08-11-2021	17:15	Bus-1 at Rangpo tripped		No fault	NA	LBB at Rangpo operated	Rangpo		Yes	No	PGER-2	PGER-2
10	400 KV RANGPO-DIKCHU-1	08-11-2021	22:24	08-11-2021	22:43	DT received	Didn't trip	No fault	NA	DT received at Rangpo. Reason maybe shared by Dikchu	Rangpo		Yes	NA	PGER-2	Dikchu
11	400 KV TEESTA-III- DIKCHU-1	09-11-2021	14:27	09-11-2021	15:34	Teesta III: Y_B, 13 km, Iy=Ib=3.2 kA	Dikchu: Y_B, 1.4 km, Iy=Ib=7.2 kA	Y-B-Earth	100	Phase-to-phase fault	Rangpo		Yes	Yes	TUL	Dikchu
12	220 KV CHANDAUTI-SONENAGAR-2	11-11-2021	14:15	11-11-2021	15:02	Chandauti: R_N, Zone-1, 52.6 km, 3.41 kA	Sonenagar: R_N, Zone-1, 21.6 km, 2.1 kA	R-Earth	100	A/r successful from Chandauti only. No A/r attempt at Sonenagar, other two phase tripped after 1 second	Gaya		Yes	Yes	PMTL	BSPTCL
13	400 KV PATNA-BALIA-2	12-11-2021	14:58	12-11-2021	16:24	Problem in PLCC at Balia		No fault	NA	No fault observed	Patna		No	NA	PGER-1	NR
14	400 KV PATNA-BARH-1	13-11-2021	04:09	13-11-2021	04:45	Didn't trip	DT received	No fault	NA	Reason maybe shared by Barh	Patna		NA	No	PGER-1	NR
15	400 KV PATNA-BARH-1	13-11-2021	08:36	13-11-2021	09:58	Didn't trip	DT received	No fault	NA	Reason maybe shared by Barh	Patna		NA	No	PGER-1	NTPC Barh
16	400 KV MEDINIPUR-NEW CHANDITALA-1	15-11-2021	00:30	15-11-2021	01:06	Didn't trip	Master relay operated	No fault	NA	Relay replaced	New Chanditala		NA	No	PMJTL	WBSETCL
17	400 KV MALDA-NEW PURNEA-2	15-11-2021	07:59	15-11-2021	14:41	Malka: Y_N, 6.74 kA, 42.68 km	New Purnea: Y_N, 4.1 kA, 76.2 km	Y-Earth	100	Insulator decapped at loc. 995. A/r unsuccessful at both ends	Malka		Yes	Yes	PGER-2	PGER-1
18	400 KV JEERAT-BAKRESWAR-1	17-11-2021	16:20	17-11-2021	17:49	Didn't trip	Pole discrepancy at Bakreswar end			Y_ph CB at Bakreswar tripped without any fault. 1.5 seconds later other two phase tripped on PD	Jeerat		No	Yes	WBSETCL	WBSETCL
19	400 KV PPSP-BIDHANNAGAR-2	21-11-2021	12:39	21-11-2021	12:50	PPSP: R_N, 141.5 km, Zone-1	Bidhannagar: R_N, Zone-1, 47.09 km, 6.275 kA	R-Earth	100	Three phase tripping at Bidhannagar. A/r not in service	Durgapur		No	Yes	WBSETCL	WBSETCL
20	400 KV MOTIHARI-BARH-2	22-11-2021	11:31	22-11-2021	11:46	DT sent while availing bus shutdown	DT received	NA	NA	Details maybe shared by Barh	Barh		No	No	DMTCL	Barh
21	220 KV SITAMARHI-MOTIPUR-1	23-11-2021	03:23	23-11-2021	20:21	Sitamarhi: Y_B, 42.1 km, Iy=3.39 kA, Ib=3.35 kA	Motipur: Y_B, 3.86 km	Y-B-Earth	100	Phase-to-phase fault	Muzaffarpur		Yes	Yes	PMTL	BSPTCL
22	400 KV ALIPURDUAR-BONGAIGAON-1	23-11-2021	11:13	23-11-2021	12:53	Alipurduar: R_B, Ir=6.003 kA, Ib=6.19 kA, 49.3 km, Zone-1		R-B-Earth	100	Phase-to-phase fault	Alipurduar		Yes	NA	PGER-2	NER
23	220 KV CHANDAUTI-SONENAGAR-1	26-11-2021	20:07	26-11-2021	20:17	Chandauti: Didn't trip	Sonenagar: R_N, Zone-1, 19.14 km, 2.445 kA	R-Earth	100	Insulator damaged. A/r successful from Sonenagar but tripped again in reclaim time	Gaya		NA	Yes	PMTL	BSPTCL
24	220 KV PUSAULI-SAHUPURI-1	26-11-2021	22:08	27-11-2021	00:29	Didn't trip	Tripped while working with PLCC	NA	NA	No fault observed	Pusauli		NA	NA	PGER-1	NR
25	400 KV MERAMUNDALI-BOLANGIR-1	30-11-2021	22:33	30-11-2021	23:12	Meramundali: B_N, Zone-2, 230.12 km, 2.48 kA	Bolangir: B_N, Zone-1, 36.7 km, 2.8 kA	B-Earth	500	DR length small at Meramundali. AR couldn't be ascertained Bolangir DR not uploaded	Bolangir		Yes	No	OPTCL	PG Odisha Projects

SI No.	Name of the incidence	PCC Recommendation	Latest status
106th PCC Meeting			
1.	Tripping of Bus-1 at 220 kV Ramchandrapur on 20/08/2021 at 20:24 Hrs.	<p>In 106th PCC Meeting, PCC advised JUSNL following:</p> <ul style="list-style-type: none"> ➤ To restore the busbar protection at 220 kV Ramchandrapur S/s within a month. 	<ul style="list-style-type: none"> ➤ In 108th PCC Meeting, Regarding Bus Bar Protection, JUSNL informed that the same could not be restored as the visit of OEM engineers get delayed. PCC advised to take up the issue with higher authority for early restoration of the busbar protection.
2.	Repeated Tripping of 132 kV Sultanganj- Deogarh D/C	<p>In 106th PCC Meeting, PCC advised BSPTCL to resolve all clearance issues in the line and complete the insulator replacement work at the earliest.</p>	
3.	Total Power Failure at Dumka S/s on 15/05/2021 at 12:01 Hrs	<p>Regarding 220 kV Maithon-Dumka-1, JUSNL intimated that there was card issue in PLCC panel. The OEM (M/s ABB) had been communicated regarding the issue and the same would be resolved by September' 21.</p> <p>In 108th PCC Meeting, JUSNL informed that work order would be placed after receiving the cost estimate from OEM. They stated that the PLCC link would be restored by December 2021.</p>	
4.	Grid event at 132 kV Motihari (DMTCL) S/S on 21-04-2021 at 20:19 hrs	<p>In 106th PCC Meeting, PMTL informed that offers received from OEM i.e., M/s TBEA regarding restoration of the damaged GIS section is under examination.</p> <p>Regarding timeline to complete the work, PMTL informed that since all materials required for restoration work are to be imported from China, it would take 40-50 days for</p>	

		<p>restoration after placing the supply order.</p> <p>In 108th PCC Meeting, PMTL representative informed that an internal committee of Powergrid had visited site on 12th Nov 2021. PCC advised to submit the restoration plan of the damaged bus extension module.</p>	
107th PCC Meeting			
5.	Disturbance at 220 kV Hajipur S/S on 28.09.2021 at 17:18Hrs	In 107 th PCC Meeting, PCC advised BSPTCL to submit action taken report for this disturbance in coordination with BGCL.	
6.	Islanding Performance and Observations during recent Islanding incidents in CESC system.	In 108 th PCC Meeting, CESC informed that a preliminary meeting was held with ERLDC. Based on the feedback, islanding events are being analyzed and the report would be submitted after completion of the analysis.	
7.	Tripping of DALTONGANJ – GARWA D/C lines.	<p>In 108th PCC Meeting, JUSNL informed that patrolling was carried out and vegetation issues were found at location no. 89, 90, 91. The same would be cleared within two weeks.</p> <p>Regarding auto-recloser scheme at Garwah end, they updated that scheme is being reviewed by the CRITL wing.</p>	
8.	Repeated Tripping of 220 kV Joda- Ramchandrapur	<p>In 108th PCC Meeting, JUSNL informed that line patrolling was carried out for however no vegetation or clearance issues were found in the line.</p> <p>Regarding PLCC, they updated that issue had been communicated to OEM but they were facing difficulty in</p>	

		getting the availability of service engineers at site.	
108th PCC Meeting			
9.	Total Power Failure at 220 kV Ronginchu HEP on 20.10.2021 at 12:42 Hrs	PCC advised Rongnichu HEP to review the overcurrent relay settings at their end. It was suggested to review the directional feature and definite time settings of the O/C relay.	
10.	Total Power Failure at 220/132 kV Chatra(JUSNL) S/s on 09.10.2021 at 12:44 Hrs	PCC advised JUSNL to resolve the carrier related issue at Chatra end and to ensure healthiness of PLCC for 220 kV Daltonganj-Chatra line. PCC further advised JUSNL to implement weak in-feed protection at Chatra end for 220 kV Daltonganj-Chatra lines.	
11.	Tripping of 400/220 kV 500 MVA ICT-1 &2 at Darbhanga (DMTCL) S/s on 25.09.2021	PCC advised DMTCL to revise the ICT earth fault setting at Darbhanga end in line with the guidelines at the earliest.	

Annexure C.4

ISTS	
Name of the element	Length (km)
400 kV Durgapur-Bidhannagar D/c	11
400 kV Rangpo-Teesta V-D/c	11.6
400 kV Teesta-III- Dikchu	15.1
400 kV Gaya-Chandauti D/c	17.36
220 kV Subhashgram-Subhashgram (WB) D/c	1
220 kV Dalkhola-Dalkhola (WB)-D/c	1.1
220 kV Alipurduar-Alipurduar (WB) D/c	6.34
220 kV Rajarhat-NewTown D/c	7.5
220 kV Binaguri-NJP D/c	9
220 kV Rourkela-Tarkera D/c	15.3
Odisha	
Name of the element	Length (km)
400 kV Indravati-Indravati (Gridco)	3.7
400 kV Meramundali GMR T/c	8
400 kV New Duburi-TSL D/c	8.65
220 kV Chandka-Chandka B	1
220 kV Rengali-Rengali D/c	1
220 kV Balimela-Balimela T	1.38
220 kV Meramundali-BSL D/c	2.4
220 kV Bolangir-New Bolangir D/c	2.8
220 kV Tarkera-RSP D/c	4.07
220 kV Sterlite-Vedanta D/c	4.15
220 kV New Duburi-Jindal Steel D/c	4.8
220 kV Rengali-Rengali PH D/c	5
220 kV Mendhasal-Infocity	5.5
220 kV Katapalli-Hindalco D/c	5.5
220 kV Jaynagar-Upper Kolab D/c	6
220 kV Mendhasal-Chandaka D/c	7
220 kV Keonjhar-Keonjhar D/c	7.48
220 kV Jeypore-Jaynagar D/c	7.7
220 kV New Duburi-TSL D/c	8.65
220 kV Jeypore-Jaynagar D/c	8.8
220 kV Tarkera-RSP D/c	10.2
220 kV Bidansi-Cuttack D/c	10.42
220 kV Jaypatna-Indravati	11.13
220 kV Meramundali-TTPS D/c	11.2
220 kV Meramundali-NALCO D/c	11.5
220 kV Joda-Jindal	14.6
220 kV Mendhasal-Atri	15
220 kV TSTPP-Rengali PH	16.78
West Bengal	
Name of the element	Length (km)
400 kV PPSP-New PPSP D/c	2
220 kV Kasba-Eastern Metropolitan	1
220 kV New Haldia-IPCHL D/c	2.7
220 kV Bidhannagar-DPL D/c	8
220 kV Bakreswar-Sadaipur D/c	8
220 kV Eastern Metropolitan-Princep Street	8.2
220 kV Domjur-New Chanditala D/c	8.32
220 kV New Cossipore-Princep Street	8.8
220 kV NewTown-CLC Bantala	13
220 kV Sagardighi-New Sagardighi D/c	14.38
220 kV Subhashgram-CLC Bantala	15
220 kV Domjur-Foundry Park D/c	15
220 kV New Cossipore-Eastern Metropolitan	16.2
220 kV Jeerat-Dharampur D/c	17

Bihar	
Name of the element	Length (km)
220 kV Patna-Sipara-3	0.3
220 kV Patna-Sipara-D/c	0.45
220 kV Purnea-New Purnea D/c	2
220 kV Darbhanga-Darbhanga (DMTCL) D/c	2.9
220 kV Kishanganj-Kishanganj Q/c	4.4
220 kV Pusauli-New Sasaram (Nadokhar) D/c	6.98
220 kV Gaya-BodhGaya D/c	8.5
220 kV Barauni (BTPS)-Mokama D/c	11.65
220 kV Barauni (BTPS)-Begusarai D/c	15
220 kV Muzaffarpur-MTPS D/c	17
220 kV Gaya-Chandauti D/c	18
DVC	
Name of the element	Length (km)
220 kV Durgapur-Parulia (DVC) D/c	1
220 kV Burnpur-IISCO D/c	1.2
220 kV Chandrapura-Chandrapura-1	1.5
220 kV Chandrapura-Chandrapura-2	3.5
220 kV Parulia (DVC)-Taml DSP T/c	6
220 kV Maithon-Kalyaneshwari D/c	7.6
220 kV Chandrapura-BSL	9
220 kV Chandrapura-MSMDBSL D/c	10
220 kV Waria-DSTPS D/c	11.14
220 kV Parulia (DVC)-Muchipara D/c	14.75
220 kV Mejia-Barjora D/c	16.7
220 kV Waria-Bidhannagar D/c	17.2
220 kV Parulia (DVC)-DSTPS D/c	17.34
Jharkhand	
Name of the element	Length (km)
220 kV Chaibasa-Chaibasa (JUSNL) D/c	0.7
220 kV Ranchi-Hatia	6
IPP	
Name of the element	Length (km)
400 kV Adhunik (APNRL)-Jamshedpur D/c	0.3
400 kV Sterlite-Lapanga D/c	18.64
220 kV Rangpo-Rongnichu D/c	7.26