North Eastern Regional Power Committee

Agenda for

62nd Protection Coordination Sub-Committee Meeting

Date: 20/12/2023 (Wednesday)

Time: 12:00 hrs

Venue: NERPC conference Hall, Shillong

C O N F I R M A T I O N O F M I N U T E S

1. CONFIRMATION OF MINUTES OF THE 61st PROTECTION SUB-COMMITTEE MEETING OF NERPC.

Minutes of the 61st PCC Meeting held on 20th November, 2023 (Monday) at hotel Royale De'casa, Guwahati was circulated vide no. No.: NERPC/SE (O)/PCC/2023/2986-3027 dated 11th December, 2023.

No comment(s)/observation(s) were received from the constituents.

The Sub-committee may confirm the minutes of 61st PCCM of NERPC

B. ITEMS FOR DISCUSSION

B.1 Protection Audit of NER:

As per the protection code of IEGC 2023 following roles and responsibilities, related to the subject mentioned, of constituents have been defined–

Description		Constituent	Responsibility	Timeline
Audit	Internal Audit	All users (132kV and above)	Shall conduct internal audit of protection system	Annually
			Audit report to be shared with RPC	Within 30 days of Audit
			Action plan for rectification of deficiencies to be shared with RPC	Within 30 days of Audit
	Third party Audit	All users (132kV and above)	Shall conduct audit for each SS	Once in five years
			Shall conduct audit on advice of RPC	Within three months of advice of RPC
			Audit report* to be submitted to RPC and NERLDC/SLDC	Within a month of submission of third-party audit report
			Action plan for rectification of deficiencies	Same as above
		RPC	Compliance to audit reports to be followed up regularly	Not specified
		RPC	After analysis of any event, shall identify substations where audit is required to be carried out	Conditional responsibility
	Annual audit plan	All users	Annual audit plan to be submitted to RPC by ***31st October***	Annual

In 60th PCCM the following points were discussed-

Member Secretary NERPC informed that third party protection audit has to be generally conducted by the utilities on their own. However, the 3rd party audit will be carried out by team constituted by NERPC at selected substations based on the criticality, analysis and requirement. In this regard, NERPC has already circulated an audit calendar and audit formats for reference of the constituents.

The nodal officers of respective State/power utilities have to fill the audit formats and submit to the NERPC secretariat within 1 week.

The forum decided that compliance to audit reports will be followed up regularly in PCC meeting of NERPC. NERLDC to submit a list of all 132 kV and above substations of the States to NERPC.

Information regarding substations that have already been audited will be provided by states to NERPC & NERLDC.
Forum agreed that all users (132 kV and above) have to conduct Internal Audit annually and submit audit report to RPC with action plan for rectification of deficiencies within 30 days of Audit.

AEGCL requested for a uniform guideline for maintenance of bay elements. Member Secretary requested POWERGRID to share their maintenance guideline with the states so that Assam and other utilities may adopt it after customizing to suit local requirement.

In 61st PCCM following points were discussed -

1. Audit of substations of Assam (Sarusajai, Kahilipara, BTPS) will tentatively be carried out on 18-20 December 2023
2. Regarding nominations for the audit team, NERPC requested all the utilities to nominate persons for the audit and intimate NERPC through email.

Status of compliance of IEGC 2023 –
List of utilities that have submitted the audit plan for FY 2024-25 –
1.DoP Arunachal Pradesh
2.Indigrid
3.NEEPCO
4.Sterlite

Sub-committee may deliberate

B.2 Submission of Protection performance indices by utilities

As per the protection code of IEGC 2023 following roles and responsibilities, related to the subject mentioned, of constituents have been defined–

Description		Constituent	Responsibility	Timeline
Performance indices **	1.Dependibility index (D) 2.Security index (S) 3.Reliability index (R	All users (132kV and above)	Shall submit the indices for previous month to RPC and RLDC	Monthly (by 10th of Next month)
		All users	Shall submit he reason for indices less than unity (element wise) and action plan for corrective measures	Not specified
		RPC	Action plan to be regularly followed up in RPC	

**definition of indices

(a) The Dependability Index defined as $D = \frac{Nc}{Nc+Nf}$

where,

N_c is the number of correct operations at internal power system faults and

N_f is the number of failures to operate at internal power system faults.

(b) The Security Index defined as $S = \frac{Nc}{Nc+Nu}$

Where,

N_c is the number of correct operations at internal power system faults

N_u is the number of unwanted operations.

(c) The Reliability Index defined as $R = \frac{Nc}{Nc+Ni}$

Where,

N_c is the number of correct operations at internal power system faults

N_i is the number of incorrect operations and is the sum of N_f and N_u

In 60th PCCM it was decided that all users have to submit Performance indices (Dependability-D, Security-S, Reliability-R) to NERPC & NERLDC by 10th of every month for previous month indices. Users also have to submit reason for indices being less than unity and corrective action plan. Action plan will be regularly followed up in PCCM.

In 61st PCCM, regarding submission of the report on performance indices, ISTS, ISGS and state utilities assured that they will start sending the report December'23 onwards.

Member secretary NERPC stated that if clarification is required on any index, utilities may communicate with NERLDC and NERPC

Status of compliance of IEGC 2023 –

i)No User has yet submitted the report on performance indices.

Sub-committee may deliberate

B.3 Protection protocol and protection philosophy of NER

In compliance with clause 12(2) and clause 13 of IEGC 2023, NERPC had prepared draft protection protocol for NER. The same was circulated to the constituents in 60th PCCM and all utilities were requested to provide comments within fifteen days. Comments were received form NERLDC only.

In 61st PCCM Arunachal Pradesh and NERTS raised some queries on B/U OC time settings. They requested the forum to coordinate Overcurrent pickup with ZIII instead of ZII settings. However, forum agreed to do this on case-to-case basis. NERPC requested them to send the comments through email by 30th Nov, 2023.

Also, NERPC stated that as per the protection protocol, utilities have to submit the relay settings of new/modified elements15 days prior to the proposed date of commissioning (FTC).

Subsequently, the comments were suitable incorporated in the protocol and the finalized Protection protocol was presented and approved in 25th TCC/RPC meeting and is hereby attached as **annexures B.3**.

It is mandatory to all the utilities to follow the Protocol. Any violation of the same has to be brought to the notice of NERPC by NERLDC.

However, NERTS have recently submitted their comments on the protocol. The same is attached as **annexure B.3.1.** The forum may deliberate upon the comments.

Sub-committee may deliberate

B.4 Analysis and Discussion on Grid Disturbances which occurred in NER grid in October and November'23 in compliance with IEGC 2023:

TABLE 8 : REPORT SUBMISSION TIMELINE

Sr. No.	Grid Event^ (Classification)	Flash report submission deadline (users/ SLDC)	Disturbance record and station event log submission deadline (users/ SLDC)	Detailed report and data submission deadline (users/ SLDC)	Draft report submission deadline (RLDC/ NLDC)	Discussion in protection committee meeting and final report submission deadline (RPC)
1	GI-1/GI-2	8 hours	24 hours	+7 days	+7 days	+60 days
2	Near miss **event**	8 hours	24 hours	+7 days	+7 days	+60 days
3	GD-1	8 hours	24 hours	+7 days	+7 days	+60 days
4	GD-2/GD-3	8 hours	24 hours	+7 days	+21 days	+60 days
5	GD-4/GD-5	8 hours	24 hours	+7 days	+30 days	+60 days

^*The classification of Grid Disturbance (GD)/Grid Incident (GI) shall be as per the* CEA Grid Standards.

Based on the draft reports prepared by NERLDC, GD/GI/Near miss events that occurred in October and November 2023 were discussed in detail in the sub-group meeting held on 15.12.2023 and remedial actions were suggested. List of remedial measures for the events is attached as **annexure B.4**. The forum may monitor the progress on the remedial actions.

Sub-committee may deliberate

Agenda items from NERLDC

B.5 <u>Status of submission of FIR and DR & EL outputs for the Grid Events for the month of October'2023</u>

In line with regulation 12 (1) of CEA Grid Standards Regulations and IEGC-23 provision under clause 37.2 (c), FIR and DR & EL Outputs for each grid events are required to be submitted by concerned utilities to NERLDC for detailed investigation and analysis.

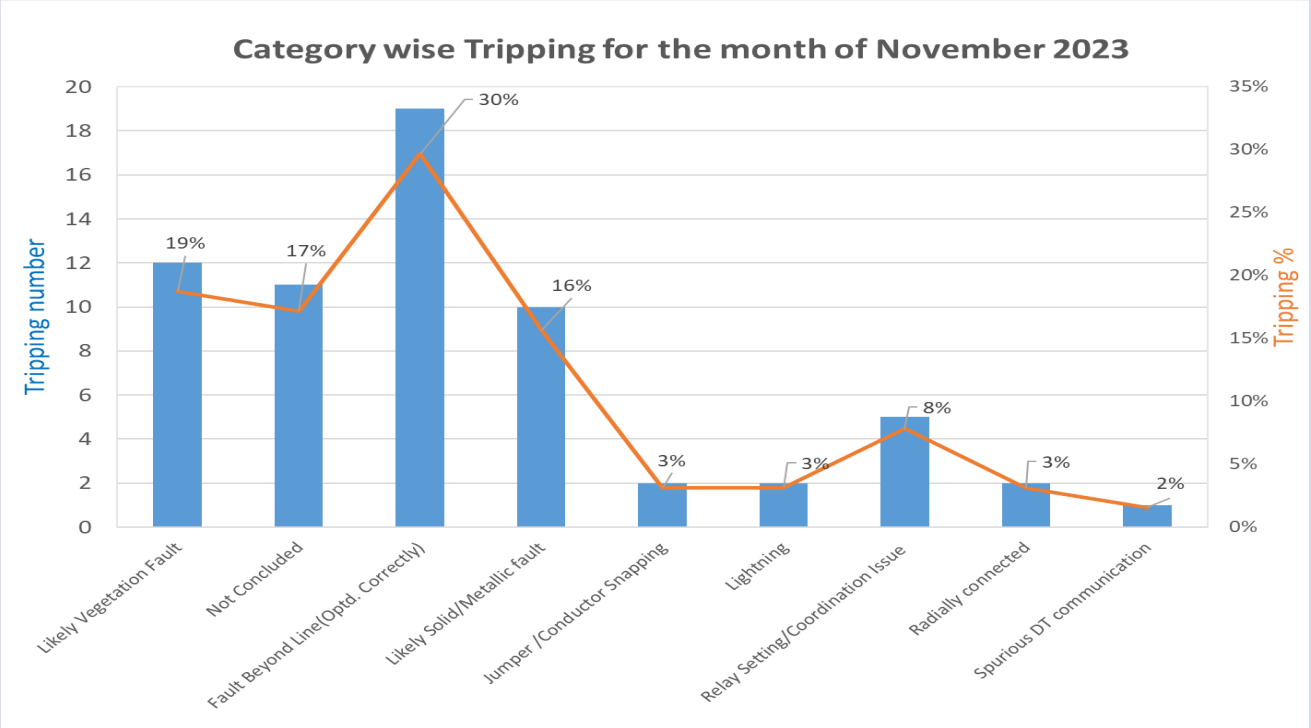
Status of uploading of FIR, DR & EL outputs in Tripping Monitoring Portal for events from 01-11-2023 to 30-11-2023 is given below:

Name of Utility	Total FIR/ DR/EL to be submitted	Total FIR, DR & EL submitted			Total FIR, DR & EL not submitted			% Submission of		
		FIR	DR	EL	FIR	DR	EL	FIR	DR	EL
DoP, Arunachal Pradesh	4	4	4	4	0	0	0	100	100	100
AEGCL	30	17	11	9	13	4	4	57	84	83
APGCL	1	0	0	0	1	1	1	0	0	0
MSPCL	18	18	4	4	0	10	10	100	29	29
DoP, Nagaland	9	9	7	7	0	0	0	100	100	100
TSECL	14	12	14	14	2	0	0	86	100	100
POWERGRID	25	24	23	23	1	1	2	96	96	92
NEEPCO	3	2	2	2	1	1	1	67	67	67
NHPC	9	1	6	1	8	1	5	11	89	44
IndiGrid	7	6	7	7	1	0	0	86	100	100
KMTL	2	2	2	2	0	0	0	100	100	100

Concerned Utilities are requested to upload Disturbance Recorder (DR), Event Logger (EL) outputs for grid events along with a First Information Report (FIR) in Tripping Monitoring Portal (https://tripping.nerldc.in/Default.aspx) for analysis purpose. In light of the cybersecurity measures implemented by Grid India to safeguard sensitive information, NERLDC has created the email address nerldcso3@gmail.com . This new account has been specifically set up to facilitate the secure exchange of DR and EL files that have previously faced blockage when sent to nerldcprotection@grid-india.in.

B.6 Category wise Tripping for the month of November 2023:

There were a total of 64 numbers of Line & ICT tripping during the month of November'23. A plot showing number of tripping and tripping percentage in each category such as Likely Vegetation, Solid/metallic fault and fault beyond the line etc. is shown below. It is observed that for around 17% of tripping, root cause could not be concluded due to non-submission or submission of improper DR/EL.



Sub-committee may deliberate

B.7 <u>Submission of Flash Report and Detailed Report by User/SLDC as per IEGC-2023:</u>

As per IEGC-2023, all User/SLDCs are requested to prepare and share **Flash Report** and **Detailed Report** with NERLDC and NERPC following any Grid Events.

Status of submission of the same for the month of November'23 is shown below:

Sl. No.	GD/GI/Near Miss	Affected Areas	Date & Time	Flash/Detailed report to be submitted by User/SLDC	Flash Report By User { IEGC section 37.2 (b)}	Detailed report by User within 7 Days { IEGC section 37.2 (e)}	Detailed Report submitted By NERLDC	Root Cause	Non Compliance observed
1	GD-I	Grid Disturbance at Tinsukia & Margherita	12:48 Hrs on 07-11-2023	Assam	Yes	Yes	17-11-2023	Flashover observed at Y-phase Transfer Bus-II Isolator of 220kV Tinsukia – Behaiting Line I	**IEGC section 37.2 (c) & CEA grid Standard 15.3- DR/EL provided within 24 Hours?**
2	NM	Near miss incident at Mariani	07:04 Hrs on 13-11-2023	Assam	Yes	Yes	29-11-2023	B phase CT of 12.5 MVAr Bus Reactor-I was damaged (burst)	IEGC section 37.2 (b)- Flash Report By User IEGC section 37.2 (c) and CEA grid Standard 15.3-DR/EL provided within 24 Hours?
3	GD-I	Near miss incident at Loktak	11:54 Hrs of 16-11-2023	Loktak	Yes	Yes (01-12-2023)	05-12-2023	Tripping of Bus Coupler Breaker prior to the Line breaker resulted in near miss event at Loktak	**IEGC section 37.2 (e)- Detailed Report By User** **MSPCL:** IEGC section 37.2 (c) and CEA grid Standard 15.3-DR/EL provided within 24 Hours?
4	GD-I	Grid Disturbance at Rokhia	14:12 Hrs of 17-11-2024	Assam	No	No	12-12-2023	Suspected fault in the 132 kV link feeder of Rokhia	**IEGC section 37.2 (b)- Flash Report By User** **IEGC section 37.2 (e)- Detailed Report By User** **TPTL and NEEPCO: IEGC section 37.2 (c) and CEA grid Standard 15.3-DR/EL provided within 24 Hours?** **Rokhia - IEGC section 17.3 -Time Synchronization Issues**
5	GD-I	Grid Disturbance at Kohima	11:51 Hrs of 25-11-2024	Assam	Yes	Yes	04-12-2023	DP time delay Issues at Dimapur(PG) and BU relay Directionality Issues at Kohima	**No violation**

Sub-committee may deliberate

B.8 Non-operation of auto recloser in Important Grid Elements for transient faults in November 2023:

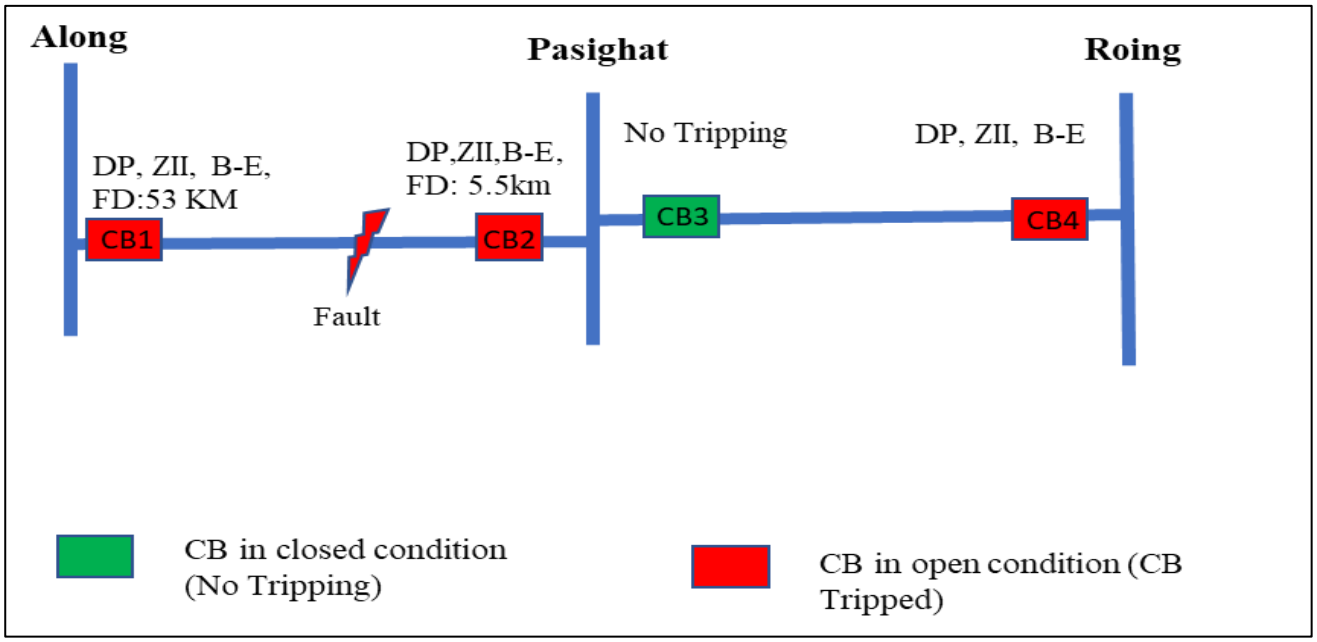
Sl No	Element Name	Time	Relay End1	Relay End2	A/R not Operated	Remarks from Utility
1	220 kV Azara - Sarusajai 2 Line	10-11-2023 15:34	DP, ZI, R-E	DP, ZI, R-E, AR successful	Azara	
2	132 kV Agartala - Surajmaninagar 2 Line	17-11-2023 15:10	DP,ZI,Y-B,FD:5.81 km, AR successful	DP,ZI,R-Y,FD:11.98 KM	Surajmaninagar	

3	132 kV AGTCCPP - PK Bari (TSECL) 2 Line	30-10-2023 12:47	DP, ZII, B-E, Carrier aided tripping	DP, ZI, B-E,FD: 0.9 KM	Both ends	
4	400 kV New Kohima - New Mariani 1 Line	26-11-2023 09:39	DP, ZI, Y-B-E,FD:30.3KM	DP, ZI, Y-B-E,FD:101.5KM	Both ends	
5	220 kV Mariani (AEGCL) - Samaguri Line	29-11-2023 15:10	DP, ZI, B-E	DP, ZI, B-E, FD: 16 km	Samaguri	

Sub-committee may deliberate

B.9 <u>Tripping of 132 kV Along-Pasighat and 132 kV Pasighat-Roing Line (GD at Pasighat) on 16th Nov 2023:</u>

At 03:47 Hrs of 16-Nov-2023, the following element tripped as shown below:-



Fault at a distance 5.5 KM from the Pasighat end cleared on operation of DP, ZII from Along & Pasighat end in 623 msecs & 557 msecs. Also, 132 kV Pasighat – Roing tripped at Roing end in 547 msecs leading to the blackout of Pasighat substation of the Arunachal Pradesh power system.

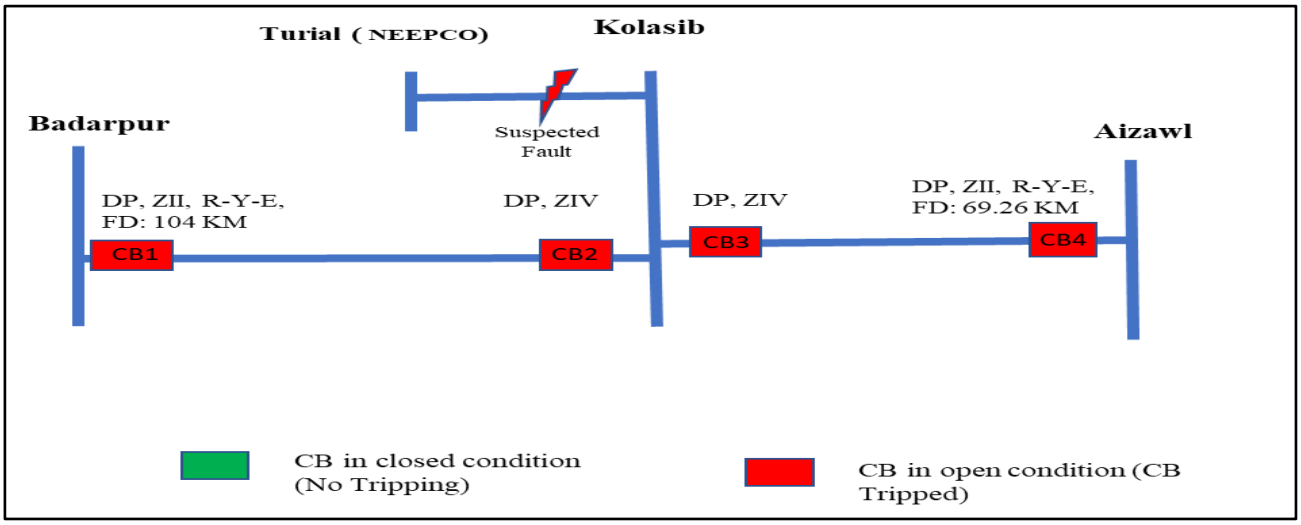
Reason for tripping is suspected relay setting issues at the distance relay of Pasighat end for Along line.

DoP, Arunachal Pradesh is requested to share the root cause for ZII tripping at Pasighat and remedial measures taken.

Sub-committee may deliberate

B.10 Tripping of 132 kV Badarpur-Kolasib and 132 kV Aizawl- Kolasib Line(GD at Kolasib & Turial) on 16-Nov-2023:

At 15:10 Hrs of 16-Nov-2023, the following element tripped as shown below:-



Tripping at Badarpur & Aizawl end on ZII and tripping of both the line at Kolasib end on ZIV indicates the fault in the downstream of Kolasib substation.

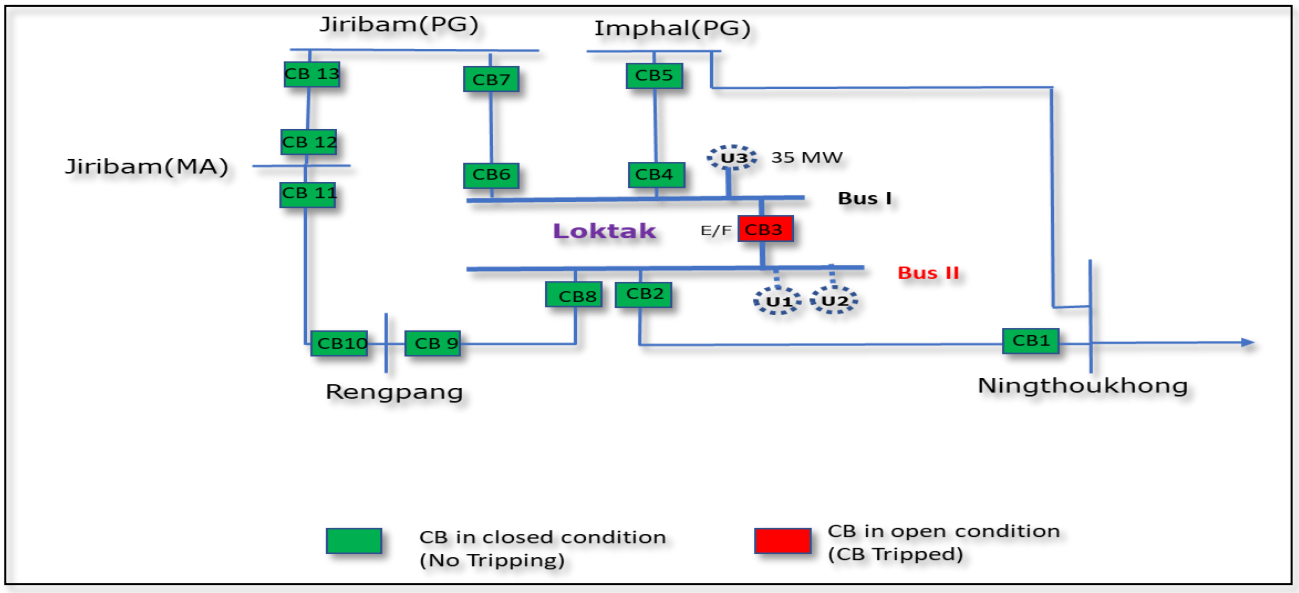
Also, as per Outage report submitted by NERTS, both the ISTS lines tripped while charging of 132 kV Kolasib- Turial state feeder.

P&ED, Mizoram is requested to share the root cause and remedial measures taken to avoid tripping of healthy ISTS elements.

Sub-committee may deliberate

B.11 Tripping of 132 kV Bus Coupler Loktak on 10th,16th and 17th Nov'2023

As per regular practice, 132 kV Loktak – Jiriabm(PG) & 132 kV Loktak – Imphal(PG) are connected in **Bus I** and 132 kV Loktak – Rengpang & 132 kV Loktak – Ningthoukhong are connected in **Bus II**



The blackout of Bus II at Loktak observed in the 3 occasions due to the tripping of Bus Coupler at Loktak are listed below:

Sl No.	Element Name	Tripping Date and Time	Restoration Date and Time	RELAY_A	RELAY_B
Event I	132 kV Loktak - Ningthoukhong Line	10-11-2023 11:15	10-11-2023 12:02	**No tripping**, Only Earth fault initiated at Loktak	Earth Fault
	132 kV Loktak Bus Coupler	10-11-2023 11:15	10-11-2023 11:40	EF	-
Event II	132 kV Loktak - Ningthoukhong Line	16-11-2023 11:54	16-11-2023 12:53	**No Tripping**, Only Earth fault initiated at Loktak	Earth Fault
	132 kV Loktak Bus Coupler	16-11-2023 11:54	16-11-2023 12:16	EF	-
Event III	132 kV Loktak - Rengpang Line	17-11-2023 02:52	17-11-2023 03:41	Not Furnished	No Tripping
	132 kV Loktak Bus Coupler	17-11-2023 02:52	17-11-2023 03:42	Not Furnished	-

As per detailed report submitted for Event II:

B-E fault in 132 kV Loktak - Ningthoukhong feeder cleared by the Bus Coupler at Loktak before opening the line CB at Loktak. Remedial measures taken at Loktak by changing Bus Coupler EF relay setting to Pick up Current of 100A from 80A and TMS-0.25 (Unchanged).

Loktak HEP is requested to provide the root cause for the Event I & Event III at Loktak. Also, requested to upgrade the Bus Coupler relay from Electromechanical to Numerical for proper analysis of the Grid Events.

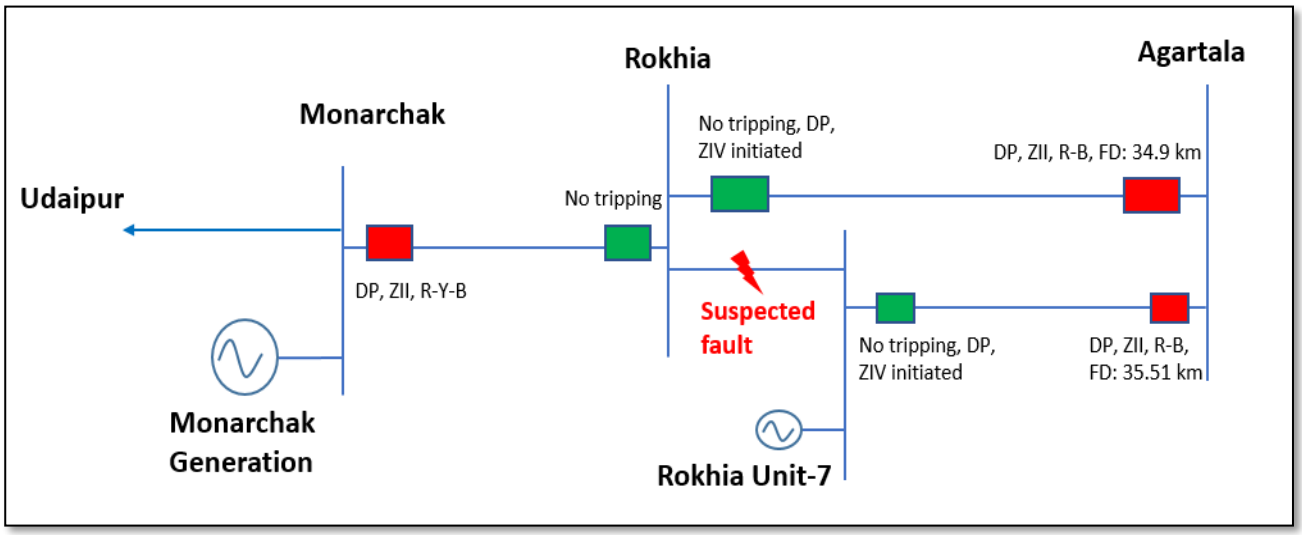
Sub-committee may deliberate

B.12 <u>Blackout of the 132 kV Rokhia Generating Station of Tripura power system on 17th Nov 2023</u>

Rokhia area of Tripura Power station is connected with the rest of the grid by 132 kV Rokhia-Agartala D/C & 132 kV Rokhia-Monarchak lines.

At 14:12 Hrs of 17th Nov'23, 132 kV Rokhia-Agartala D/C & 132 kV Rokhia-Monarchak lines tripped. Due to tripping of these elements, 132 kV Rokhia S/S of Tripura Power System got separated from rest of NER grid.

There was generation loss of 20 MW and load loss of 6 MW occurred in Rokhia.



As per DR analysis, suspected fault is suspected in 132 kV Rokhia-Rokhia link feeder which was cleared by tripping of 132 kV Rokhia-Agartala D/C & 132 kV Monarchak-Rokhia lines from remote end on operation of Z-II. Also, ZIV initiated at Rokhia end for 132 kV Rokhia-Agartala D/C & 132 kV Rokhia-Monarchak lines indicates that fault is in reverse direction.

Several violations observed related to the event:

a) No Flash Report and Detailed report submitted by TPGCL and SLDC Tripura (Violation of IEGC section 37.2 (b) & (e).

b) Time synch issues observed in **Rokhia** end for all 3 feeders and **Agartala** end for 132 kV Rokhia – Agartala Line I (Violation of IEGC section 17.3)

c) No DR & EL file received from Monarchak(NEEPCO) (Violation of IEGC section 37.2 (c))

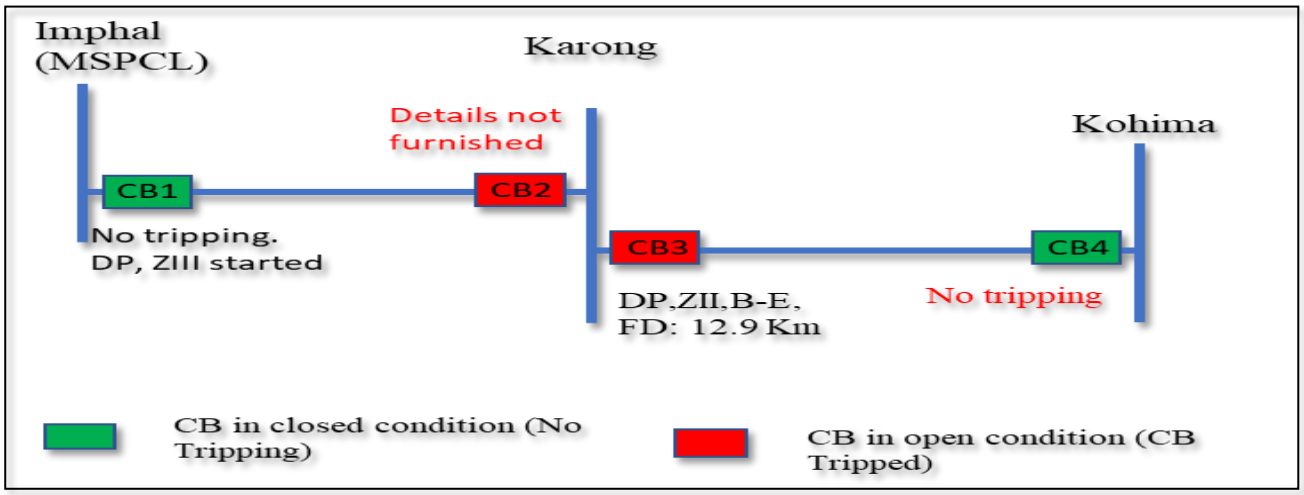
TPGCL/TSECL is requested to intimate the root cause for blackout at Rokhia generating station. Also intimate the status for the CBs to be installed at both ends of link feeder at Rokhia as the link feeder having no protection system.

Sub-committee may deliberate

B.13 Blackout of Karong on 19th Nov 2023

Karong area of Manipur power system is connected with rest of the grid via 132 kV Imphal – karong and 132 kV Karong – Kohima lines.

At 08:19 Hrs of 19-Nov-2023, the following element tripped as shown below:-



As per DR analysis of karong end, High resistive vegetation fault in 132 kV Karong – Kohima line with fault current increasing gradually upto 1 kA and phase voltage reduces to 47 kV.

MSPCL and DoP, Nagaland is requested to share the root cause of the tripping and GD at Karong area.

Time synch issues observed in the submitted DR of Karong and Imphal end which violates clause 17.3 of IEGC-2023.

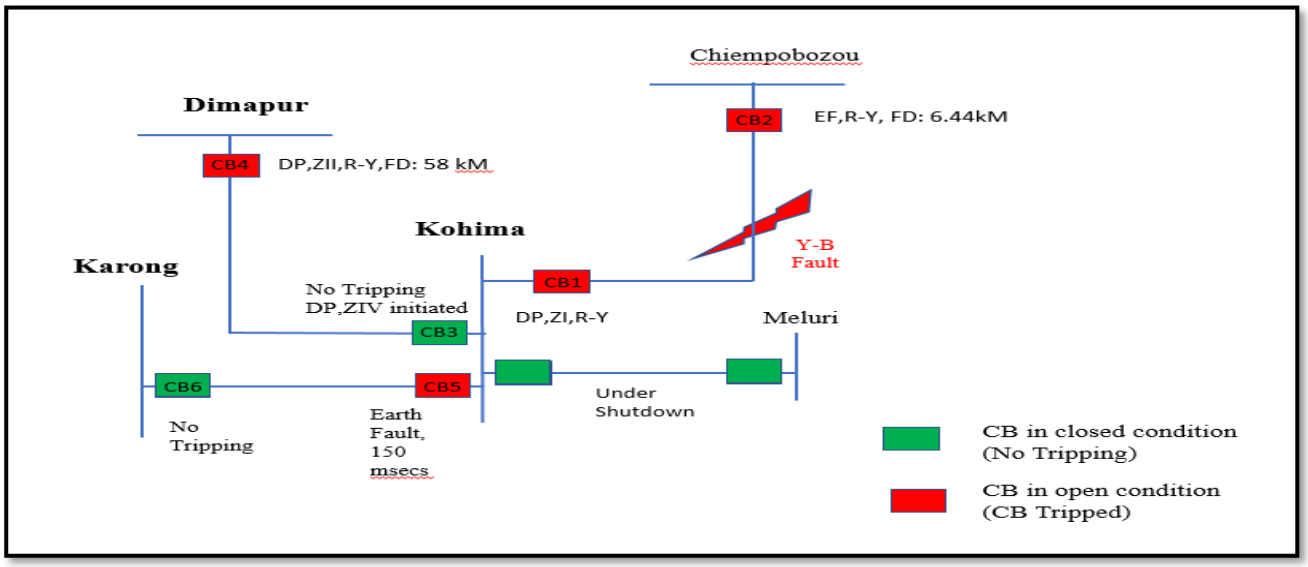
Sub-committee may deliberate

B.14 Blackout of Kohima area of Nagaland on 25-Nov-2023

Kohima Substation of Nagaland Power System is connected with the rest of the grid by 132 kV Kohima-Dimapur(PG), 132 kV Kohima-Karong, 132 kV Kohima-Meluri & 132 kV Kohima-Chiephobozou lines.

At 11:51 Hrs of 25.11.2023, 132 kV Kohima-Chiephobozou, 132 kV Dimapur(PG)-Kohima & 132 kV Kohima-Karong lines tripped. Due to tripping of these elements, 132 kV Kohima S/S of Nagaland Power system got separated from rest of the grid due to no source available in this area. 132 kV Kohima-Meluri line was under planned shutdown prior to the event.

Load loss of 17 MW at Kohima



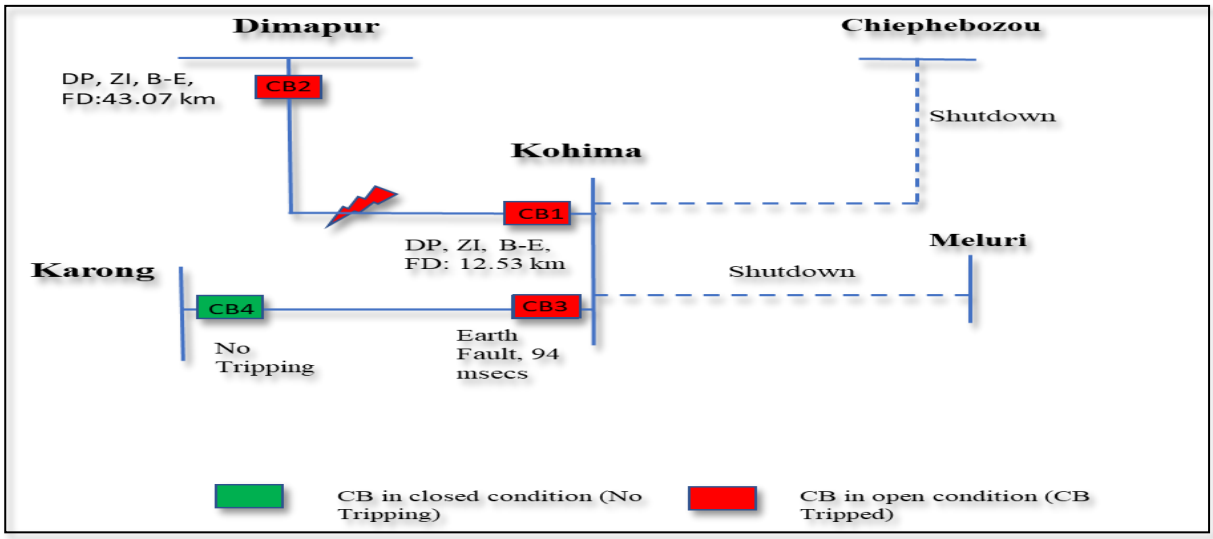
DoP, Nagaland may share the reason for tripping of 132 kV Kohima-Karong on Backup relay in 150 msecs.

Sub-committee may deliberate

B.15 Blackout of Kohima area of Nagaland on 11-Dec-2023

132 kV Kohima-Chiephobozou and 132 kV Kohima-Meluri line was under planned shutdown.

At 09:52 Hrs of 11-Dec-2023, 132 kV Dimapur (PG)-Kohima & 132 kV Kohima-Karong lines tripped. Due to tripping of these elements, 132 kV Kohima S/S of Nagaland Power system got separated from rest of the grid.Load loss of **20 MW** observed in the capital area of Nagaland.



As per DR analysis, Metallic fault in 132 kV Dimapur (PG) – Kohima line successfully cleared from the Kohima end in 77 msecs on operation of DP, ZI, B-E, FD: 12.53 km. Fault current of 940 A observed in neutral.

However, 132 kV Karong – Kohima line tripped at Kohima on operation of Direction Earth Fault (i.e. Backup Relay) in 91 msecs seems unwanted and leads to the grid disturbance at Kohima area.

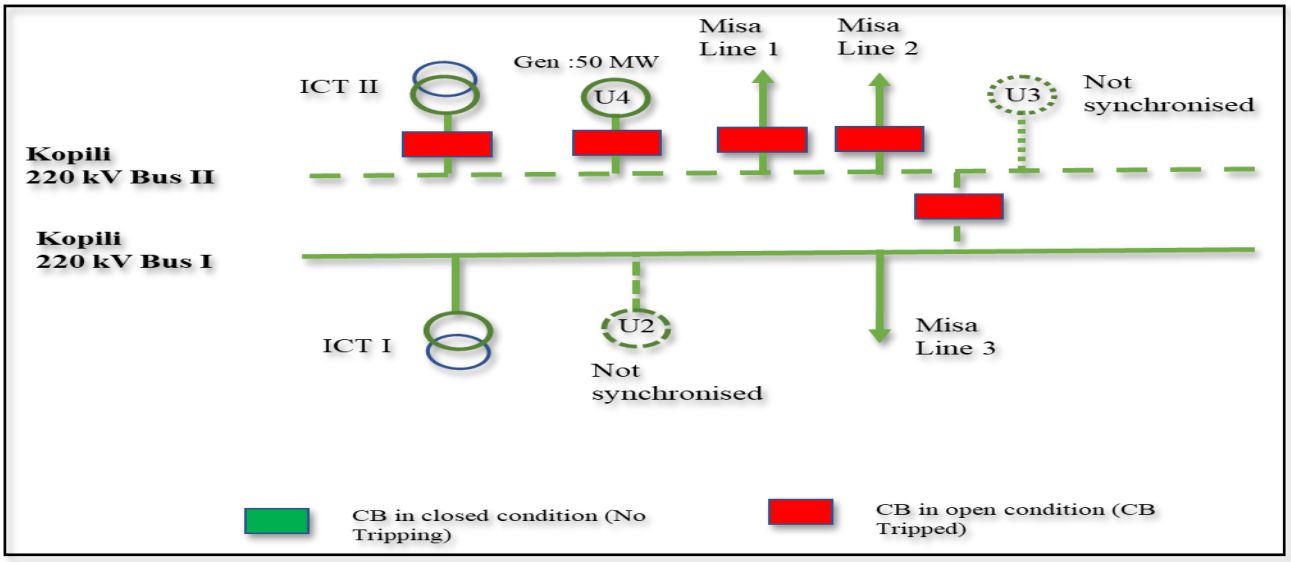
DoP, Nagaland is requested to ensure the directionality of Backup relay at Kohima for 132 kV Karong feeder. Also, the tripping time of the earth fault relay need to be coordinated with the ZIII time of the Distance (i.e. Main protection) at Kohima end.

Sub-committee may deliberate

B.16 Grid Events at Kopili power station of NEEPCO in 13th and 14th Nov'23

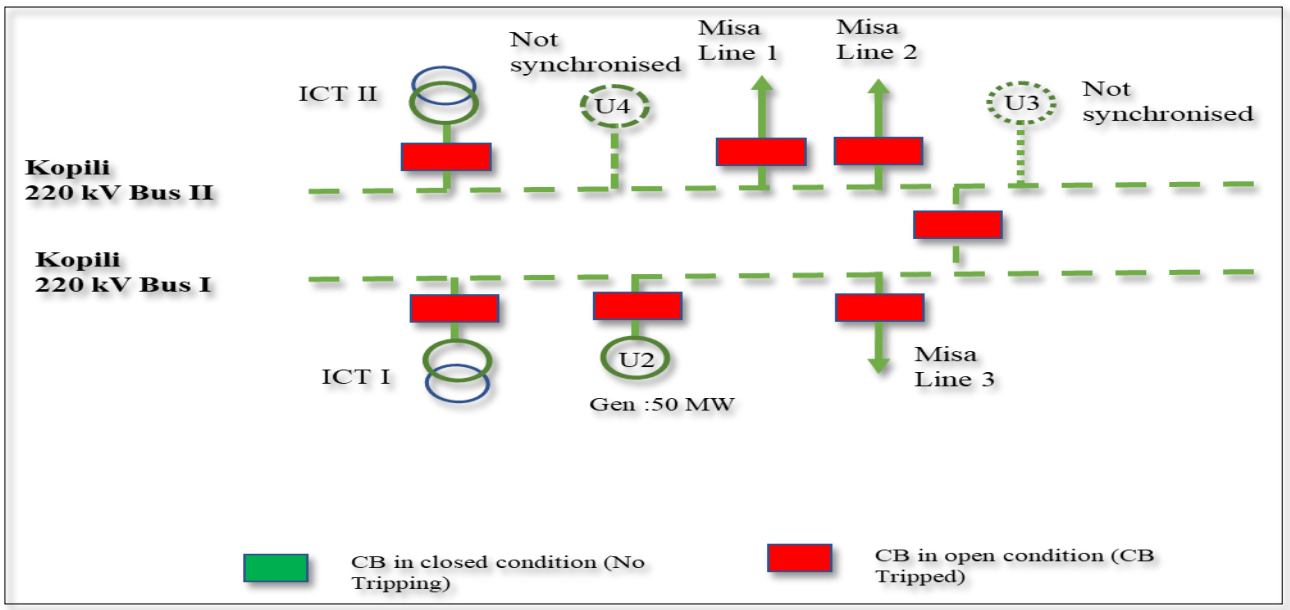
Kopili power station of NEEPCO is connected with rest of the grid with the 220 kV Misa – Kopili 1, 2 and 3 and 132 kV Kopili – Khandong & 132 kV Kopili – Khleihriat (PG).

Event 1: At 16:58 Hrs of 13th Nov'2023



Summary: Bus bar protection operated at 220 kV Kopili Bus II and DT received at Misa end leads to the generation loss of 50 MW.

Event 2: At 16:31 Hrs of 14th Nov'2023



Summary: LBB protection operated at 220 kV Kopili Bus I & II and DT received at Misa end leads to the generation loss of 50 MW.

NEEPCO is requested to take the following actions:-

1. Intimate the root cause and remedial actions taken for these 2 events.
2. Submit the Flash report & Detailed Report to NERLDC & NERPC for these 2 events as per IEGC-2023.

Sub-committee may deliberate

C. Follow-up Agenda items

C.1 Non-Operation of A/R at Doyang HEP for 132 kV Dimapur- Doyang 1&2 line:

Sl. No.	Element Name	Time	Relay End1	Relay End2	Remarks
1	132 kV Dimapur - Doyang 1	19-09-2023 14:53	DP, ZI, R-Y-E, FD: 86.192 Kms, AR Successful	DP, ZI, R-Y-E, AR Not Operated	Lightning
2	132 kV Dimapur - Doyang 2	07-08-2023 19:35	DP, ZI, B-E, FD:23.84 kms, AR Successful	DP, ZI, B-E, AR Not Operated	Lightning
3	132 kV Dimapur - Doyang 2	19-08-2023 02:19	DP, ZII, Y-E, FD: 91.14 Kms; carrier aided, AR Successful	DP, ZI, Y-E, AR Not Operated	Lightning

Numerous instances of tripping have been noted, primarily attributed to the transient nature of the fault. The Autorecloser at the Dimapur (PG) end has consistently performed successfully. Nevertheless, it is apparent that no Autorecloser operation was recorded in the submitted Disturbance Recorder (DR) from the Doyang end, indicating that there is need of checking of Autorecloser function at Doyang HEP.

In 60th PCCM NERLDC updated the forum that CBs at Doyang are spring closed and air operated (pneumatic type). As soon as breaker gets open, air pressure goes down below 15Kg/cm2 and the breakers goes to non-operative mode. After running the compressor when air pressure is achieved to 15Kg/cm2, that condition goes off, by that time AR time becomes over. They have called CGL, OEM of the breakers, to attend the problem. The OEM has assured that they will report within this month. In case, OEM is not able to resolve this matter, all the CBs of Doyang SY needs to be replaced (CBs were procured during commissioning of the Plant i.e., 2000).
In 61st PCCM NEEPCO intimated that the OEM will visit on 08th December, 2023 and suggest the resolution. If resolution not possible then NEEPCO will replace CB.

The forum requested NEEPCO to resolve the issue at the earliest.

Sub-committee noted as above

C.2 Requirement of SPS for 132 KV Khliehriat (PG)-Khliehriat D/C line

With expected availability of at least two machines of Kopili and one machine of Khandong during peak hours of the coming winter months of 2023-24 and considering the anticipated increase in demand, it is expected that total power flow along 132 KV Khliehriat (PG)-Khliehriat D/C line would be between 90-110 MW under different conditions. Load flow studies had been carried out by SLDC and shared with NERLDC. The matter had also been discussed with DGM, NERTS since 132 KV Khliehriat (PG)-Khliehriat line 1 is under POWERGRID. The scheme envisages shedding of 20-25 MW load at 132 KV Mustem substation in the event of tripping of any circuit of 132 KV Khliehriat (PG)-Khliehriat D/C line.

The above requirement was agreed in principle during the 205th OCC meeting and NERLDC and MePTCL were requested to develop the tripping logic and to present it in the next PCC meeting. The schematics of the SPS is attached for reference.

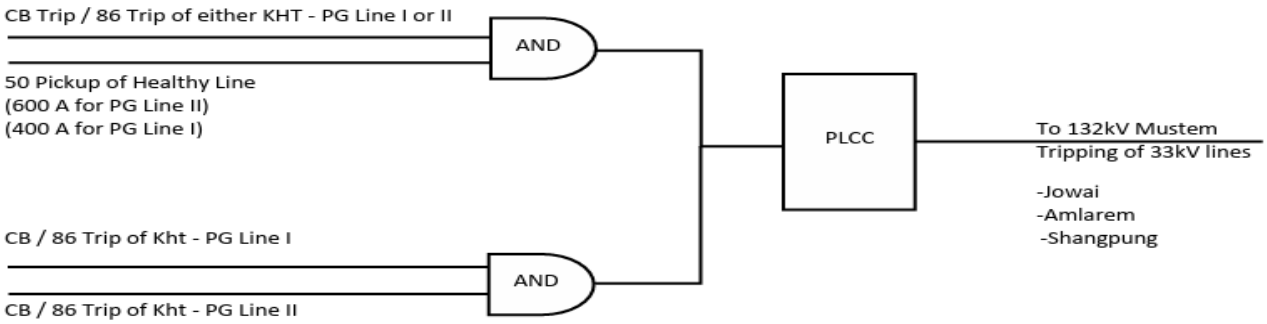
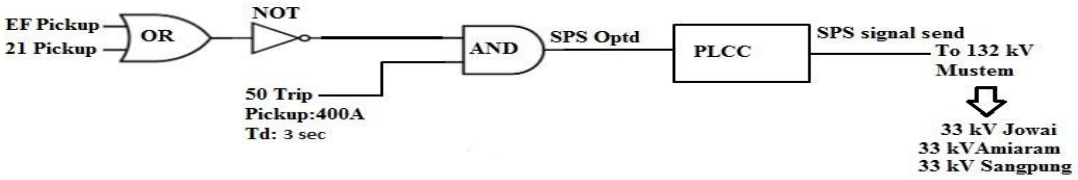


Fig: SPS Schematics at 132kV Khliehriat S/S for 132kV PG Line I & II

In 60th PCCM, NERLDC provided the modified logic (as below) and same need to be implemented by MePTCL. MePTCL agreed the same.

SPS Logic Diagram



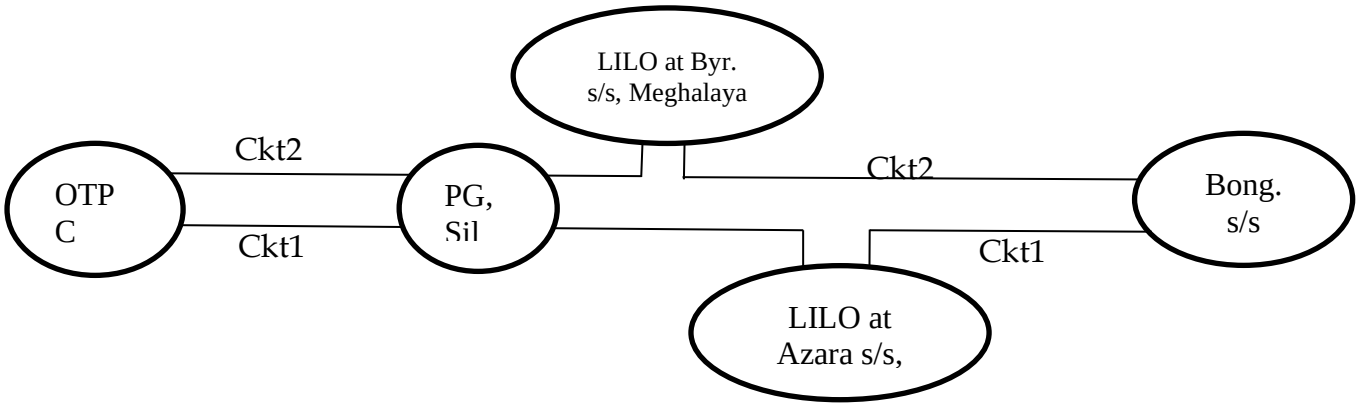
In 61st PCCM SLDC, Meghalaya informed that the scheme has been put up for approval of higher authorities and the logic will tentatively be implemented by December'23 end.

Meghalaya may update

C.3 Correction of the settings of the relays associated with NETC transmission line elements and installation of TWFL in connected S/S.

North East Transmission Company Limited (NETC) is currently operating the 400 kV D/C Palatana-Silchar and Silchar-Bongaigaon T/L with connectivity through LILO line at Byrnihat (Meghalaya) and at Azara (Assam) for evacuation of power from OTPC power plant located at Palatana, Tripura to NER States.

A Single line diagram showing the connectivity of the 400 kV Palatana-Bongaigaon Transmission system is as follows:



During the last financial year (FY 2022-23), there were instances of tripping in the 400 kV D/C Palatana-Bongaigaon Transmission System. Due to inaccurate fault calculations of the relays, difficulties were faced in detection of fault location. In normal scenarios, we expect to locate the faults within a range of +/- 5 km from the relay distance measurement. However, during post-fault patrolling, we discovered fault locations approximately 10-15 km away from the relay's calculated distance.

The same issue persisted for the tripping instances during the current Financial Year (2023-24) as well. Here is a brief overview of such tripping instances:

SL. No.	Name of line element	No. of tripping occurred during		Remarks
		FY 2022-23.	FY 2023-24 till Sept 2023	
1	Palatana-Silchar line 1	12	2	During the all these tripping(s), the distance indications of the relay were wrong.
2	Palatana-Silchar line 2	4	4	
3	Silchar-Azara	7	2	
4	Silchar-Byrnihat	10	8	
5	Byrnihat-Bongaigaon	2	1	
6	Azara-Bongaigaon	0	0	

In view of above, we propose the following for detail deliberation by the forum:

i) A comprehensive review of the relay setting arrangements and implementation of the modified setting in conformity with the actual line parameters at all the connecting substations.

ii) Installation of the travelling Wave-Based Fault Locators (TWFL) at all the aforementioned connecting substations to ensure smooth and effective operation of the lines by precisely locating faults in cases of the line tripping.

In 60th PCCM, following decisions were taken

AEGCL representative stated that there is no issue with relay settings and line parameters. Further he stated that some error in fault distance is inevitable in case the fault involves the ground. He suggested to adopt some kind of methodology by which such error may be minimized.

Forum decided that RPC, NERLDC, NERTS, AEGCL and NETC will jointly discuss to address the issue as suggested by AEGCL. A comprehensive review of the line parameters and relays settings will also be undertaken jointly by NERPC, NERLDC NETC and concerned bay owners.

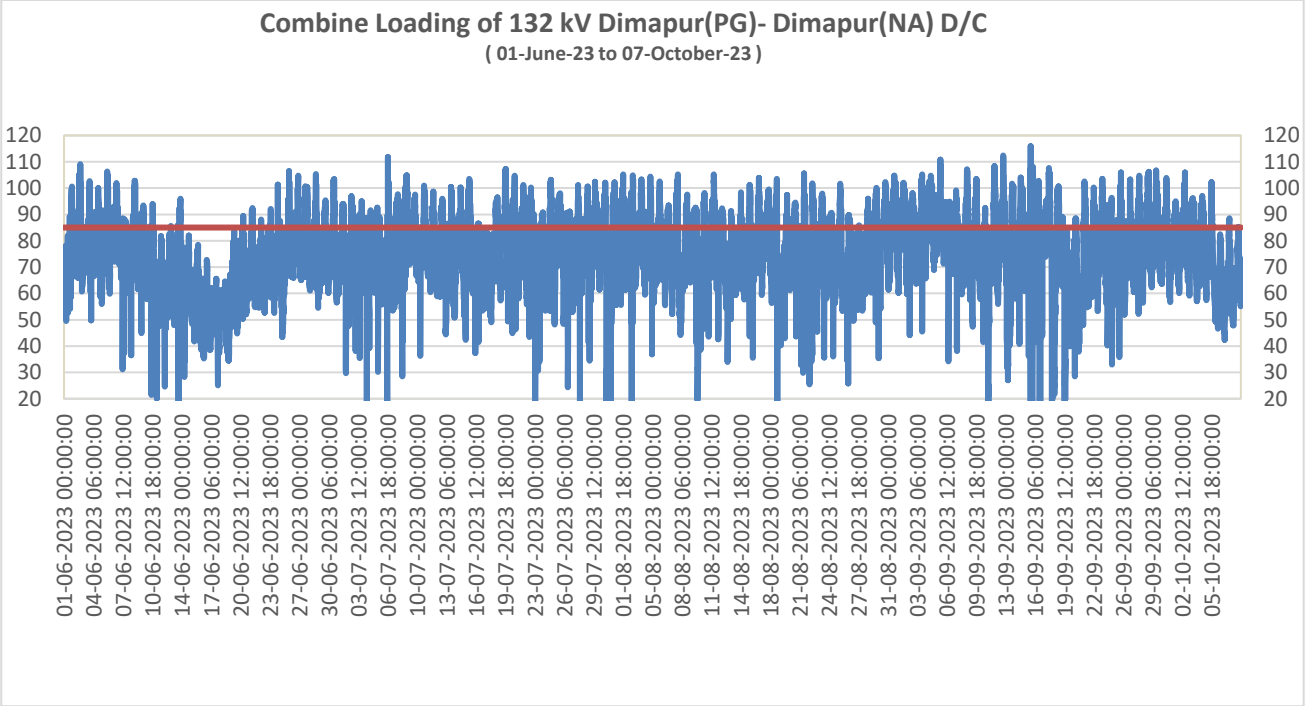
To research the fault location, DR data from Azara/Byrnihat needs to be reviewed by AEGCL/NERLDC during tripping of any one line of 400 kV Azara-Silchar and Byrnihat-Silchar line as there is no mutual compensation wiring at LILO Azara & Byrnihat SS.

Regarding TWFL, the forum decided that proposal may be considered only after the measures, as suggested above are not fruitful.

In 61st PCCM, The forum decided that a special online meeting of NERPC, NERLDC, NERTS, AEGCL and NETC to be held in the month of December 23 to address the issue.

Sub-committee may deliberate

C.4 Requirement of SPS implementation at Dimapur to for ensuring reliable power in Dimapur area of Nagaland:



Loading profile of Dimapur shows N-1 contingency of any one circuit not satisfied most of the time as the combine loading was above 85 MW for 22% of times and above 80 MW for 35% of times.

Hence, to satisfy the N-1 contingency at Dimapur (NL) and to avoid load loss in the Dimapur area, DoP, Nagaland is requested to implement suitable System Protection Scheme (SPS) with following criteria-

If the loading of any one circuit current exceeds more than 415A, the SPS will trigger and it will shed 25-30 MW load at Nagarjan area, which will increase the reliability of Nagarjan area of Nagaland system.

In 60th PCCM, DoP Nagaland updated that reconductoring of the line is under process, DPR is in final stage.

Regarding the SPS, forum requested DoP Nagaland to identify 25-30 MW load at Nagarjan area for the implementation of the SPS scheme at the earliest.

In 61st PCCM, Nagaland stated that feeders have been identified to cut around 40MW in 66kV Power House and 33kV Metha Further he stated that internal approval for the same has also been taken.

DoP Nagaland and NERLDC may update on SPS

C.5 Providing PLCC in State owned lines /bays:

a. 132kV Dimapur Kohima line (Length – 58 km): DoP informed that currently PLCC ABB, ETL-41 is working at Kohima which supports Speech & data only. OPGW has already been laid. Nagaland will implement carrier scheme through DTPC (Digital tele-protection coupler).

b. 132 kV Melriat-Zemabawk line (Length – 10.12 km): Mizoram not present. However, the forum requested DoP Mizoram to arrange the 48V dc supply at Zemabawk to commission the PLCC link.

c. 132 kV Nirjuli-Lekhi line (Length – 11 km): Forum requested DoP Ar. Pradesh to implement the PLCC link on the said line and the option of PSDF funding under reliable communication may be explored. Ar. Pradesh informed that it will be installed in the next FY 2024-25.

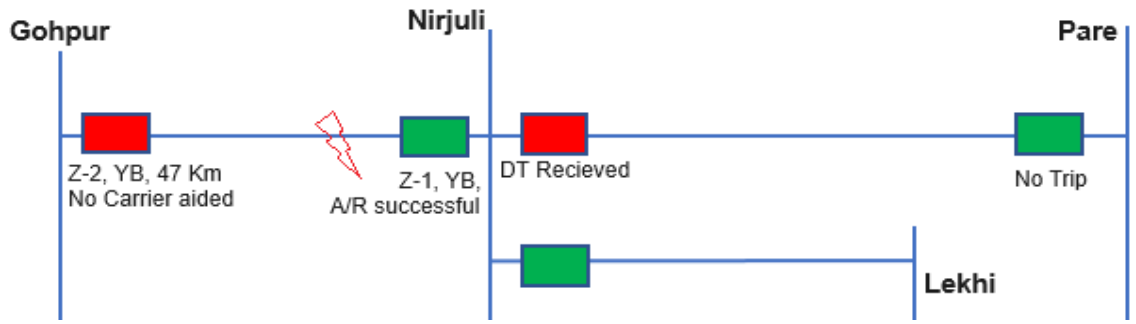
In 61st PCCM -

a. DoP Nagaland stated that DPR is being prepared for implementation of DTPC for tele-protection. Also, DoP Nagaland will explore the possibility of MPLS for carrier communication.
b. Mizoram stated that 48V DC supply is present at the substation. NERTS to commission the link soon.
c. DoP Ar. Pradesh stated that OPGW is available on the line. Forum requested DoP Ar. Pradesh to implement DTPC on the line

Utilities may update on corrective action

C.6 Tripping of 132 kV Gohpur - Nirjuli-Pare Line on 09.11.2023 :

At 15:28 Hrs of 09-Nov-2023, the following element tripped as shown below:-



Preliminary Event Analysis:

As per Relay indication, at 15:28 Hrs, Ph to Ph fault occurred in 132 kV Nirjuli-Gohpur Line at a distance of 0.98 Km from Nirjuli and it was cleared from Nirjuli on Z-1(within 80 msec as per PMU) and Gohpur on Z-2 within 600 msec (As per PMU data).

At the same time healthy 132 kV Pare line tripped on DT received at Nirjuli only which is the matter of serious concern.

Due to the non-submission of FIR, DR (Disturbance Recorder), and EL (Event Logger) data by the relevant parties, a comprehensive analysis of the event could not be conducted.

In 61st PCCM -

1. AEGCL updated that Carrier aided tripping and Auto- reclosure have to be configured in the relay at Gohpur which will be completed by mid-December'23
2. Regarding DT sent from Pare end, NEEPCO stated they will coordinate with M/s MUML to rectify the issue

AEGCL and NEEPCO may update

C.7 Non-operation of auto recloser in Important Grid Elements for transient faults in October 2023:

As updated by the utilities in 61st PCCM -

Sl No	Element Name	Time	Relay End1	Relay End2	A/R not Operated	Remarks from Utility

1	220 kV NTPS - Tinsukia 1 Line	26-10-2023 16:37	DP,Z1,Earth fault,39km	B-Eph, Z-1, LA burst	No details provided	AEGCL updated that AR has not been configured at both ends, will be completed in next scheduled shutdown
3	220 kV Jawaharnagar - Samaguri Line	25-10-2023 11:11	DP, ZI, B-E, FD: 35.9 km	DP, ZI, R-E, FD: 71.8km, AR successful	Jawahar nagar	GIS work underway. Waiting for OEM support, will complete by Dec'23
4	132 kV Jiribam - Pailapool Line	30-10-2023 12:47	DP, ZI, R-Y, FD: 6.49 km, AR successful	DP, ZI, R-Y	Pailapool	By Dec'23

Utilities may update

D. Items for Status Update

D.1. Status of auto-reclosure on *z*-1 operation for important lines:

In the discussions of the Sub-group on 12-04-2021 the following points were noted:

a. Auto-Reclosure is very much required for maintaining system stability, reliability and uninterrupted power supply.

b. Presently it will take some time for the state utilities to implement the PLCC and establish carrier communication between stations.

c. The operation of Auto-Reclosure on Z-I operation at the local end independent of carrier healthiness is required.

In the 57th and 56th PCC meeting the forum approved the implementation of Auto-Reclosure on Z-1 without carrier check for all lines except the lines with generating stations at both the ends and requested the utilities to implement the AR scheme at the earliest.

Status as per 61st PCCM-

Sl no	State	Important Transmission lines where AR has to be enabled at the earliest	Lates status
1.	Arunachal Pradesh	132kV Balipara-Tenga, 132kV Ziro-Daporijo-Along-Pashighat link	For Balipara-Tenga and Along-Pasighat PLCC will be implemented under PSDF. However SPAR have been enabled on the lines without PLCC and 3-Ph AR will be enabled soon.
2.	Assam	All 220kV and 132kV lines	For 220kV sub stations- At Sonapur, GIS work underway, support of OEM required At Kathalguri, procurement of relays underway At Jawaharnagar, WIP All works at three substations to be completed by DEC'23 For 132kV substations-

			80% work completed, by Dec'23 90% to be completed Assam informed all work at three substations will be completed by Jan/Feb 2024.
3.	Manipur	132kV Imphal-Ningthounkong	-
4.	Meghalaya	**Annexure (D.1)**	AR put in place for 5 lines but approval of MERC is still awaited. MePTCL agreed to do double jumpering and improve strength at critical locations to ensure integrity of the old lines Meghalaya requested MS, NERPC to write a letter to higher authorities to expedite the commissioning of the AR in the intra-state lines
5.	Mizoram	132kV Turial-Kolasib line	AR implemented (OPGW not available, PLCC available)
6.	Nagaland	132kV Dimapur-Kohima line (from Kohima end)	AR enabled
7.	Tripura	132kV Agartala-S M Nagar (TSECL), 132kV Agartal-Rokhia DC, 132kV, 132kV Agartala-Budhjungnagar	Will complete by Dec'23

Utilities may update

D.2. <u>Installation of line differential protection for short lines:</u>

As per sub-regulation3 of Regulation 48 of Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022-

"For short line (less than 10 km) or cable or combination of overhead line and cable, line differential protection shall be used with built-in backup distance protection."

As per discussion in 61st PCC meeting the status for different STUs/ISTS licensees are as follows:

Name of utility	**Last updated status**	**Latest status (61st PCCM)**
AEGCL	DPR sent back by PSDF secretariat. Third party protection audit reports have to attached with the DPR	DPR being prepared as per new format and will be done by Nov, 2023
MSPCL	Revised DPR for 132kV Imphal-Imphal-III to be submitted.	To be submitted soon
MePTCL	Work completed Aug'21, but not commissioned yet. Report on line-wise status on progress of LDP commissioning work submitted to NERPC and NERLDC	OPGW to be installed on some lines. LDP will be commissioned after OPGW link is established. Line with OPGW commissioned the protection
P&ED Mizoram	Lines identified viz. 132kV Aizawl - Luangmual and 132kV Khamzawl - Khawiva. DPR submitted. PSDF approval awaited.	For Aizawl – Luangmual line Power grid will complete the task by Dec'23 and for other PSDF approval still awaited,
DoP Nagaland	LDP on Dimapur-Dimpaur lines completed. Regarding Doyang-Sanis line, NEEPCO to install LDR at Sanis end.	Regarding Doyang-Sanis line, NEEPCO to install LDR at Sanis end will be done by Jan'24.
TSECL	132kV 79 Tilla-Budhjungnagar. DPR to be prepared. Cost estimate submitted to TIDC to arrange for ADB funding.	TIDC approval is awaited for fund.

Utilities may update

D.3. Status for SPS

Status (61st PCCM) as provided by utilities –

	Name of SPS	SPS Trigger/Action	Utility	Latest Status/Discussion points
1.	SPS related to secure & reliable operation of Leshka HEP	Upon tripping of one circuit of 132kV Leshka-Khliehriat D/C, Leshka generation	MePGCL	Meeting held last week with M/s Hitachi and M/s Andritz. Hitachi to give price details soon

		to be reduced		

MePGCL may update

D.4. Status against remedial actions for important grid events:

Sl No	Details of the events(outage)	Remedial action suggested	Name of the utility & previous update	Latest status
1.	132 kV Balipara-Tenga line in May and June	Carrier aided inter-tripping to be implemented for 132kV Balipara-Tenga-Khupi at the earliest (PLCC has to be installed on the link. Under consideration of the higher authorities)	DoP, Arunachal Pradesh. As per previous updates, PLCC Work covered under PSDF. In progress	
2.	132 kV DoyangMokokchung line 132 kV Mokokchung - Mokochung (DoP, Nagaland) D/C lines on 30th July	Carrier inter-trip for 132kV DHEP-Mokokchung to be implemented by DoP Nagaland (NO PLCC on the line. Matter under consideration of Higher authorities)	DoP Nagaland (Work under progress. Will be completed soon.)	
3.	Leshka-Khleihriat DC multiple tripping in April to September	TLSA installation along the line to be done by MePTCL	MePTCL (DPR submitted, Approval pending.)	
4.	132 kV Loktak-Jiribam line, 132 kV Loktak-Imphalline,132 kV Loktak-Ningthoukhong line, 132 kV Loktak-Rengpang line &Loktak Units 1,2 and 3 on 3rdAug	> 5MVA TRAFO (Aux. Transformer) to be repaired ->5MVA Auxiliary TRAFO panel to be repaired by NHPC	NHPC (Order to be placed soon. Will take 6months after placing the order)	
5.	Grid disturbance of category GD-1 (Load loss: 13MW) occurred at Karong areas of	MSPCL to check the following1. Protection setting at Karong along with circuit	MSPCL	

	Manipur Power System at 07:41 Hrs on 4th August'22	wirings from DPR to CB mechanism 2. Z-III setting at Imphal and its healthiness of correct operation by relay testing.		
7.	Grid Disturbance at Loktak HEP on 03rd Aug'22	NHPC-Loktak informed that LBB has been included under R&U scheme and the same shall be commissioned by Mar'23	NHPC (LBB to be commissioned under R&U project and by the end of Nov'23)	
10.	Review of SPS at Monarchak (item 2.22 of the sub-group held on4th May 23)	NERLDC requested NEEPCO and Tripura to implement the revised logic at Monarchak (as provided by NERLDC) and Udaipur Rokhia ends respectively	NEEPCO, TSECL (SLDC TSECL intimated that logic 1(to be configured at Udaipur and Rokhia to send DT to Monarchak) could not be implemented as there is no PLCC/OPGW connectivity in the LILO portion of Monarchak. NERLDC requested TSECL to explore installation of PLCC/FO for smooth functioning of SPS scheme for the reliability of Monarchak system)	
13.	132 kV Aizawl - Tipaimukh Line tripped at Aizawl end only on received of spurious DT	rectification of PLCC issues at Tipaimukh end by MSPCL	MSPCL 48V DC battery issue. WIP	

	signal on 16th and 26th Feb'23			
14.	Outage of 220 KV Bus Bar Protection Scheme at 400/220/132 KV Killing SS	Bus-Bar protection of 220kV bus at Killing SS	MePTCL M/S ABB has given offer. Board's approval awaited. To be completed in 3-4 months	
15.	Retrip configuration in LBB scheme in AEGCL Hailakandi station:	In previous sub group meeting The forum opined that the retrip scheme in the LBB protection will increase reliability of the protection system and will help in preventing mal operations in connecting feeders. AEGCL agreed to the suggestion and assured that the Retrip scheme, with time delay of 100msec will be configured in the LBB scheme in Silchar-Hailakandi Ckt 1 & 2 at Hailakandi end.	AEGCL Logic finalized, need to be tested. Whole work may be completed within Nov23	
16	Non-operation of AR for various lines at Byrnihaat end on 25th and 26th June'23	Rectification of PLCC issues by MePTCL Consultation with OEM underway for resolution	MePTCL	
17	Non-operation of AR for various lines at Sonapur end in July and August	GIS related issues, coordination with OEM required	AEGCL Coordination with OEM underway. WIP	
18	Grid disturbance in Umtru & New Umtru areas of Meghalaya Power System on 23th July'23	O/C and E/F high set settings for Umtru and EPIP-II lines at New Umtru to be disabled	MePGCL Matter to be discussed in next OCC	

19	On 02-08-2023 at 16:35 Hrs, 132 kV Dimapur (PG)- Dimapur (NL) II line tripped on Zone I due to snapping of Y-Phase jumper	DoP, Nagaland to make B/U OC direction forward from non-directional, for Dimapur-Dimpaur line from state end NERTS to set the OC pick up setting to 600A (100%) at their end	DoP Nagaland NERTS	
20	Tripping of 132kV Kahilipara- Sarusajai 1, 2 and 3 line, 132kV Kahilipara Main bus 1, 132kV Kahilipara transfer Bus 1 and 132kV Kahilipara-Kamalpur line on 2.08.2021	BB protection to be implemented at Kahilipara with procurement of 5 core CTs	AEGCL (will be done by April23)	

DATE AND VENUE OF NEXT PROTECTION SUB- COMMITTEE MEETING

The next Protection Sub-Committee meeting will be held in the month of January, 2024. The date and venue will be intimated separately.

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North East Regional Power Committee

PROTECTION PROTOCOL OF NORTH EAST REGION

Prepared in Compliance to

Clause 12(2) and Clause 13 of Central Electricity Regulatory Commission Indian Electricity Grid Code Regulations, 2023

By

NERPC Secretariat

(Effective from 01.10.2023)

Contents

PROTECTION PROTOCOL OF NORTH EAST REGION

1. Background

1.1. The Protection Protocol of North East region is prepared in accordance with Clauses 12(2) & 13 of the Indian Electricity Grid Code, 2023 (IEGC 2023) notified by the Central Electricity Regulatory Commission.

1.1.1. The clause 12(2) of the IEGC 2023:

"There shall be a uniform protection protocol for the users of the grid:

a) for proper co-ordination of protection system in order to protect the equipment/system from abnormal operating conditions, isolate the faulty equipment and avoid unintended operation of protection system;

b) to have a repository of protection system, settings and events at regional level;

c) specifying timelines for submission of data;

d) to ensure healthiness of recording equipment including triggering criteria and time synchronization; and

e) to provide for periodic audit of protection system."

1.1.2. The clause 13 of the IEGC 2023:

"13. Protection protocol

(1) All users connected to the integrated grid shall provide and maintain effective protection system having reliability, selectivity, speed and sensitivity to isolate faulty section and protect element(s) as per the CEA Technical Standards for Construction, the CEA Technical Standards for Connectivity, the CEA (Grid Standards) Regulations, 2010, the CEA Technical Standards for Communication and any other applicable CEA Standards specified from time to time.

(2) Back-up protection system shall be provided to protect an element in the event of failure of the primary protection system.

(3) RPC shall develop the protection protocol and revise the same, after review from time to time, in consultation with the stakeholders in the concerned region, and in doing so shall be guided by the principle that minimum electrical protection functions for equipment connected with the grid shall be provided as per the

CEA Technical Standards for Construction, the CEA Technical Standards for Connectivity, the CEA Technical Standards for Communication, the CEA (Grid Standards) Regulations, 2010, the CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, and any other CEA standards specified from time to time.

(4) The protection protocol in a particular system may vary depending upon operational experience. Changes in protection protocol, as and when required, shall be carried out after deliberation and approval of the concerned RPC.

(5) Violation of the protection protocol of the region shall be brought to the notice of concerned RPC by the concerned RLDC or SLDC, as the case may be."

1.2. The Protection Protocol of North Eastern Region stipulates General Protection Philosophy of Protection System, Protection Schemes for Generators & various Transmission Elements in Power System, Protection Settings & their Coordination among entities, Disturbance Monitoring, Analysis and Reporting, Time Synchronization of Protection Systems, Protection Audit Plan, Performance of Protection Systems & Compliance Monitoring.

2. Applicability

The Protection Protocol of North Eastern Region shall be applicable to all North Eastern Regional entities, State/Central/Private Generating Companies/ Generating Stations including REGs, RHGS, integrated RE with Pumped Storage Plant (PSP), SLDCs, NERLDC, CTU, STUs, Transmission Licensees and NERPC.

3. Definitions

Words and expressions used in this Protection Protocol are defined in the Act or any other regulations specified by the Central Commission or Central Electricity Authority shall, unless the context otherwise requires, have the meanings assigned to them under the Act or other regulations specified by the Central Commission, as the case may be.

4. General Philosophy of Protection System

4.1. Protection philosophy shall be in accordance with below mentioned objectives, design criteria and other details. However, protection design in a particular system may vary depending upon judgment and experience in the broad contours of the protection philosophy. Consideration must also be given to the type of equipment to be protected as well as the importance of this equipment to the system. Further, protection must not be defeated by the failure of a single component.

4.1.1. **Objectives**:

The basic objectives of any protection schemes should be to:

(i) Automatically isolate the faulty element.

(ii) Mitigate the effect of short circuit and other abnormal conditions in minimum possible time and area.

(iii) Indicate the location and type of fault and

(iv) Provide effective tools to analyse the fault and decide remedial measures.

4.1.2. Design Criteria:

To accomplish the above objectives, the four design criteria for protection that should be considered are:

(i) fault clearance time/speed;
(ii) selectivity;
(iii) sensitivity and
(iv) reliability (dependability and security)

4.1.2.1. **Fault clearance time/speed**: In order to minimize the effect on customers and maintain system stability, Fault clearance time shall be as per CEA Grid Standard Regulations 2010, as amended to date.

4.1.2.2. **Selectivity:** To ensure Selectivity, coordination shall be ensured with the adjacent protection schemes including breaker failure, transformer downstream relays, generator protection and station auxiliary protection.

4.1.2.3. **Sensitivity**: To ensure Sensitivity, the settings must be investigated to determine that they will perform correctly for the minimum fault current envisaged in the system, yet remain stable during transients and power swings from which the system can recover.

4.1.2.4. **Reliability**: To ensure Reliability, two independent auxiliary direct current-supplies shall be provided for Main-I and Main-II relays. The Main-I and Main-II relays should be from two different makes or operating with different algorithm. The CB´s shall have two independent trip coils and two independent trip circuits. Each protection device should trip at least one of them by independent auxiliary DC- supplies.

4.1.2.5. **Security**: To ensure Security, the protection shouldn't limit the maximum transmission capacity of the element. Distance protection in particular could

cause spurious tripping due to specific grid conditions, in case of high load operation. Therefore, any special topologies must be known and considered for protection parameterization. For parallel Over Head Lines it is necessary to consider the rapid increase of load current in the healthy line when the faulty line trips and the protection operation must allow such conditions The load encroachment detection function of the relays must be used, when the highest distance zone resistance reach conflicts with the maximum transmitted load on the protected element.

4.2. All generating units shall have standard protection system to protect the units not only from faults within the units and within the Station but also from faults in sub-stations and transmission lines.

4.3. The generator, generator transformer, unit auxiliary transformer shall be provided with protection systems connected to two independent channels or groups, such that one channel or group shall always be available for any type of fault in the generator and these transformers;

4.4. Protection relays shall be configured in such a way that digital input points shall not pick up due to stray voltages.

4.5. Protective relays shall be used to detect electrical faults, to activate the alarms and disconnect or shut down the faulted apparatus to provide for safety of personnel, equipment and system.

4.6. Electrical faults shall be detected by the protective relays arranged in overlapping zones of protection.

4.7. The protection relays for the generators, motors, transformers and the transmission lines shall generally be of numerical type.

4.8. The protection system for 400kV and higher voltage transmission line and the line compensating equipment shall have one hundred percent back up communication channels i.e. two channels for tele- protection in addition to one channel for speech plus data for each direction. Provided that, for 220 kV, 132 kV, 110 kV and 66 kV lines, the channel for speech plus data can also be used for tele-protection

4.9. All relays used shall be suitable for operation with CTs secondary rated for one ampere or five amperes as per relevant Indian Standards or International Electrotechnical Commission or Institute of Electrical and Electronics Engineers standards.

4.10. Relevant Indian Standards or International Electrotechnical Commission or Institute of Electrical and Electronics Engineers standards shall be applied for protection of generators, transformers and motors.

5. Protection Schemes

The electrical protection functions for equipment connected with the grid shall be provided as per the Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022 amended to date, the CEA (Technical Standards for connectivity to the Grid) Regulations 2007 amended to date, the CEA

(Technical Standards for Communication System in Power System Operation) Regulations 2020 amended to date, the CEA (Grid Standards) Regulations 2010 amended to date, the CEA (Measures relating to Safety and Electric Supply) Regulations 2023 amended to date, and any other CEA standards specified from time to time.

5.1. Thermal Generating Units

The electrical protection functions for generator, generator transformer, unit auxiliary transformer and station transformer shall be provided in accordance with but not limited to the list given in **SCHEDULE-I** of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022 amended to date.

For the generating units with a rating of more than one hundred megawatt, protection system shall be configured into two independent sets of protection (Group A and B) acting on two independent sets of trip coil fed from independent

DC supplies, using separate sets of instrument transformers, and segregated cables of current transformers and voltage transformers

5.2. Hydro Generating Units

The protection functions for Generator, Excitation Transformer, Generator Transformer, Generator and Generator Transformer, Unit Auxiliary Transformer, and Station Auxiliary Transformer shall be provided in accordance with but not limited to the list given in SCHEDULE-IV of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022 amended to date except for variable speed units which will have specialized protection functions.

5.3. REGs/RHGS/BESS

Protection Schemes for Renewable Energy (RE) Power Plants of Solar power generation, Wind power generation, Battery Energy Storage System (BESS) and Hybrid of these connected with grid at voltage level above 650 volts shall be in accordance with the Central Electricity Authority (Technical Standards for Construction of Renewable Energy Power Plants) Regulations, 2023 from the date as & when these regulations are notified (Presently the finalization of these Standards by CEA is under progress).

5.4. Substations & Transmission System Elements

5.4.1. All major protection relays for the Voltage levels 66 kV and above shall be of numerical type.

5.4.2. Grouping of Protection systems for the voltage level 66 kV and above:

i. The protection circuits and relays shall be electrically and physically segregated into two groups each being independent and capable of providing uninterrupted protection even in the event of one of the protection group fails or taken out for maintenance.

ii. Interconnection between these two groups shall not generally be attempted.

However, such interconnection shall be kept to the bare minimum, if found absolutely necessary.

5.4.3. The protections required in respect of transmission lines, transformers, reactors and bus bars but not limited to shall be in accordance with **SCHEDULE-V** of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022 amended to date.

5.4.4. Bus Bar Protection and Local Breaker Backup Protection (breaker failure protection):

i) Bus bar protection and local breaker backup protection shall be provided in 220 kV and higher voltage interconnecting sub- stations as well as in all generating station switchyards.

ii) Duplication of bus bar protection shall be done for all main buses of 400kV and above voltage class.

iii) The bus bar protection scheme shall be centralized or distributed type and have provision for planned future expansion.

5.5. HVDC Terminals/ Stations

5.5.1. Classical HVDC Terminals/ Stations

i) HVDC system protection shall consist of two parts:

(A) AC side protection:

AC side protection function shall cover the zone for converter transformer, AC filters, shunt capacitors, shunt reactors, and bus bars. These protections shall generally follow the same philosophy as in a typical substation i.e. detection of fault by relay and tripping of circuit breaker.

(B) DC side protection:

DC side protection shall cover the zones consisting of the valve hall, DC switchyard including smoothing reactor and DC filters, DC line, DMR line / electrode line and ground electrode. The protection equipment shall be designed to be fail safe and shall ensure high security to avoid mal-operation/ unwanted shutdown due to protection equipment failures.

ii) Following a DC Line fault, the HVDC System shall have the facility to restart, one or more times, the faulted pole at a variable pre-selected DC voltage level(s), not below 80% of the nominal voltage rating. The DC transmission system shall be capable of recovery in a controlled and stable manner without commutation failures during recovery following ac and dc system faults. The post fault power order shall be equal to the pre-fault power order unless AC/ DC systems dictate otherwise.

iii) Protection system required in respect of Classical HVDC Terminals/ Stations but not limited to shall be in accordance with 13 (b) of Part A of **SCHEDULE-VI** of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines)

Regulations 2022 amended to date.

iv) Software based controls and protection shall be used to permit flexibility in effecting modifications. Protection and controls shall be duplicated for reliability. The control & protection shall provide fast controllability of the HVDC system.

5.5.2. Voltage Source Converter (VSC) based HVDC Terminals/Stations

i) The protection equipment shall be designed to be fail-safe and shall ensure high security to avoid mal-operation/ unwanted shutdown due to protection equipment failures.

ii) Protection system required in respect of Voltage Source Converter (VSC) based HVDC Terminals/ Stations but not limited to shall be in accordance with 8 (b) of Part B of **SCHEDULE-VI** of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022 amended to date.

iii) Software based controls and protection shall be used to permit flexibility in effecting modifications. Protection and controls shall be duplicated for reliability. Protection shall be provided by numerical relays to suit the requirement of the HVDC system.

5.6. Philosophy of Transmission Line Protection

5.6.1. Transmission circuit construction can be considered in three main categories viz.: Overhead construction, Underground cable construction and Composite (overhead plus underground) construction.

5.6.2. Transmission circuit Main protection is required to provide primary protection for the line and clear all type of faults on it within shortest possible time with reliability, selectivity and sensitivity. Transmission circuit back-up protection shall cater for failure of any main protection system to clear any fault that it is expected to clear. A protection function that offers back-up for most faults may also provide main protection for some fault conditions. Combinations of main and back-up protection systems should be used to address the main and application specific requirements for transmission circuits.

5.6.3. Protection system of Transmission line shall have following features:

i) The systems applied must be capable of detecting all types of faults, including maximum expected arc resistance that may occur at any location on the protected line.

ii) The protection should be set not to trip under system transient conditions, which are not short circuits. Conversely where the short circuit current is low due to local grid conditions (weak network) or due to high resistance of the arc, this must be taken into consideration to trip the relay by using the most appropriate criterion, without jeopardizing the unwanted tripping during heavy load conditions.

iii) The design and settings of the transmission line protection systems must be such that, with high probability, operation will not occur for faults

external to the line or under non-fault conditions.

iv) Distance relay shall be capable to protect the series compensated lines from voltage inversion, current inversion phenomenon. Special measures must be taken to guard against these phenomenon

v) On 220kV and above transmission lines, 2 Main Protections (Main I and Main II), Inverse Definite Minimum Time (IDMT) directional back up Earth Fault protections alone to be provided. No back up over current protection to be applied.

vi) The Main-I and Main-II protection shall be numerical relays of different makes or employ different fault detection algorithm. They should be provided carrier aided tripping and powered by two separate DC sources

vii) Both Main-Main-II and I shall send initiation signal to Breaker Failure Relay (BFR) /LBB protection system.

viii) Internal DEF (Directional earth fault) function shall be set to trip the line in case of high resistive earth fault.

ix) The internal overvoltage function shall be used to protect the line against over voltages. Two stage over voltage protection for the transmission lines (Stage-I as Voltage and Time graded & Stage-II @ 140% of Nominal Voltage with time delay 100 ms) shall be implemented for the transmission lines of voltage levels 400kV and above only. The lines emanating from same substation shall be provided with pick-up as well as time grading to avoid concurrent trippings. The overvoltage relay shall have better than 98% drop-off to pick-up ratio (the ratio of the limiting values of the characteristic quantity at which the relay resets and operates). For over voltage detection, though Ph-to-N voltage is preferable to Ph-to-Ph voltage, to achieve required discrimination for OVR grading because of limitation imposed by voltage resolution of the relay, Ph-to-Ph voltage to be used for Over Voltage detection.

x) On 132kV and lower voltage transmission lines, only one Main protection and Back up protection by Inverse definite Minimum time (IDMT) directional O/C and E/F to be applied. Main protection should be suitable for single or three phase tripping. Additionally, auto-reclose relay suitable for 1 ph or 3 ph (with dead line charging and synchro-check facility) reclosure shall be provided.

xi) For very short lines less than (10) ten kilometers (any voltage level 132kV and above), cables, and combination of cable and overhead line, Differential protection (segregated phase type) has to be provided as Primary protection with distance protection as back up protection (built-in Main relay or standalone). Zone-I protection feature shall get automatically enabled in case of communication failure observed by the

differential relay for built in Main and in case of LDP relay failure/communication failure for stand alone The current differential protection should a reliable type (preferably digital). The protection should be of the segregate phase type, i.e. it should be able to detect the phase in fault and therefore for the case of single line-ground (SLG) faults to trip only the phase in fault (also to establish single phase A/R). The synchronization of the measured values is done via a communication system. The communication system for differential line protection should be based on fibre optic and any equipment should comply with the IEC 60834.

5.6.4. 33kV OUTGOING FEEDER SETTING PHILOSOPHY

Note: Trend analysis (observation of events over a period) should also be incorporated during calculation of time gradient settings with Distribution Substations at Grid Substation end.

1. The protection functions to be activated are:

   a. Non-directional Overcurrent Protection (IDMT Normal Inverse Curve)

   b. Non-directional Earth fault Protection (IDMT Normal Inverse Curve)

   c. Non-directional Definite Time Overcurrent and Earthfault Protection

   d. Local Breaker Backup Protection

   e. Under/Over-frequency, df/dt, Under/Over voltage should only be enabled if there is any case special case of system requirement

2. The TMS for overcurrent and earthfault may be kept at 0.1 (fixed). The downstream DISCOM Substations should maintain a time gradient with respect to observed average fault current and TMS kept at Grid Sub-station end.

3. If long network of LILO DSS (Distribution SS) are present, extreme inverse, very inverse curve may be followed at DSS end.

4. The Highset for OC and EF at Grid SS (GSS) side should be kept at 50ms. The Distribution SS (DSS) should keep their Highset at instantaneous. This would allow a time gradient of 50ms in case of Highset pickups at both GSS and DSS ends. The Highset delay at GSS may be increased only in case when Highset overlapping is observed in the feeders. (This may arise when the CB opening time and arc extinguishing time at DSS end is increased due to wear and tear)

5. The Highset may be kept between 3A to 5A (As per trend analysis).

6. Harmonic Restraint feature is to be enabled.

7. The pickup of overcurrent should be kept at least 1.1 times the CT ratio. Basically, 400/1A ratio is adopted at 33kV Level outgoing feeders. (The maximum demand being 20MW). The OC pickup should be kept at 440A

8. The pickup for earth fault protection is normally kept at 80A. However, the special

case may be taken into account:

If a 33kV Feeder is kept at less load most of the times (say, 2MW). The maximum load current in the line will be 40A (Approx.) In case of open circuit fault (no earth path), the feeder will not trip, as the zero-sequence current read by the relay will be 40A and the pickup of earth fault is kept at 80A. Such cases may be hazardous in case the line travels through city area. In that case, the earthfault pickup should be kept at a lower value (say 35 to 40A). Open circuit fault in such cases, will lead the relay to issue a trip on earth fault IDMT.

The Time gradient between 33kV Feeder at GSS end and Transformer LV side should also be maintained at 300ms.

5.6.5. Philosophy for protection settings:

Sl. No.	Protection setting		Reach and time
1.	Distance protection	Zone 1(Forward)	80% of the protected line, instantaneous
		Zone 2(Forward)	120% of the protected line (150% in case of D/C line). Time delay: 350msec (generally) and 500msec in case 20% of the protected line is greater than 60% of the shortest line at remote end
		Zone 3(Forward)	120% of the protected line + 100% of the longest line emanating from the far end bus bar. Time delay: 800msec
		Zone 4 (Reverse)	• For lines < 100 km 10% of the protected line or 50% of adjacent shortest line, whichever is lower • For lines > 100 km 20% of the protected line or 50% of adjacent shortest line, whichever is lower Time delay: 500mesc
2.	Line differential protection		Primary protection for lines less than 10KM. Time delay: instantaneous
3.	LBB protection and Bus Bar Protection (for 220kV and above as well as all Generating stations)		Two stage: Stage-I: (Re-Trip) time delay of 100 msec to trip own CB Stage-II: LBB time delay: 200msec to trip all CBs connected to the respective bus, LBB Current sensor I >20% In Bus bar protection time delay: instantaneous

4.	**O/C back up protection (for 132kVand below)**	**IDMT**	**<u>For I>1</u> Ib = 150% of current rating of the line. Time delay: to be coordinated with Z2 for three phase fault at remote bus (500msec). Forward directional Proviso- For networks involving long radial feeders, fault currents may not be sufficiently high and following the above rule may not be practically feasible. So, in such cases constituents may adopt settings as required, on case-to-case basis, with the prior approval of RPC <u>For I> 2 (and above)</u> Generally disabled unless decided otherwise by NERPC for special scenario**
5.	**E/F backup protection(for 132kV and above lines)**	**IDMT**	**<u>For In>1</u> Ib= 20 % of current rating of the line. Time delay: to be coordinated with Z3 for single phase to ground fault at remote bus (900msec). Forward directional <u>For In>2 (and above)</u> Generally disabled unless decided otherwise by NERPC for special scenario**
6.	**Broken conductor protection (alarm only)**		**Negative Sequence current to Positive Sequence current ratio more than 0.2(I2/I1 ≥ 0.2) Only for alarm: Time delay = 3-5 sec**
6.	**Allowable Load impedance encroachment**		**Imax = 150% of current rating of line Vmin = 0.85pu (85%) 30 degrees for load blinder**
7.	**Power swing Blocking function**		**Block all zones except Zone-1 or Block all zones and trip with OOS function**
8	**Carrier Aided Protection**		**To be provided on 132kV and above lines (PLCC or DTPC)**
9.	**Single/Three phase auto reclosure**		**To be provided on 132kV and above lines on Zone 1 or differential relay operation Dead time = 1.0s for Main CB, 1.5 to 2 sec for Tie CB. Reclaim time = 25.0s**
10.	**Over voltage protection (two stage, for 400kV and above only)**	**Stg I***	**V>110%. Time delay: 5 seconds**
		Stg II	**V>140%. Time delay: 100msec**

11.	**Carrier Aided Protection**	**Mandatory for Distance protection**
12.	**Antitheft Charging of line**	**Distance setting: Time delay for Z-1/2/3 should be made instantaneous which will help to trip immediately during fault and would not disturbed the upstream elements** **Dir EF: Pickup to be 20 % of rated current and TMS as minimum as possible.** **O/V setting: Stage-1 pickup should be minimum of that of all lines connected from the charging substation with minimum time delay and grading as possible.**
13.	**Switch on to fault (SOTF)**	**SOTF function to be provided in distance relay to take care of line energization on fault**
14.	**VT fuse fail detection function**	**VT fuse fail detection function shall be correctly set to block the distance function operation on VT fuse failure**
15.	**Direct inter-trip**	**To be sent on operation of the following:** **Overvoltage protection** **LBB** **Busbar protection** **Manual Trip**

*** The OVR grading, Voltage and Time graded, for the Stage-I over voltage protection shall be as recommended by NERPC/NERLDC**

6. Protection Settings, coordination and approval

The purpose is to ensure system protection is coordinated among the grid connected entities. The Protection systems coordination comprises the following:

i) Each Transmission licensee shall coordinate its Protection System schemes with concerned transmission system, sub-transmission system and generators.

ii) Each Generating Company shall coordinate its Protection System schemes with concerned transmission system and station auxiliaries.

iii) Utilities may seek assistance of NERPC and NERLDC also for ensuring coordination

iv) Each Transmission Licensee and Generation Company shall be responsible for settings calculations for protection of elements under its ownership. It shall be the responsibility of the respective asset owner to obtain the inputs (adjacent line settings, infeed values etc.) from STU/Generating Company/ Transmission Licensee necessary for calculation of the settings.

v) STU/Generating Company/Transmission Licensee shall provide the infeed values/latest network model to the requesting entity, within one week of receipt of such a request from the entity.

vi) Each user, for voltage levels 132kV and above, shall submit the protection settings as per the format prescribed, along with the calculation sheets, co-ordination study reports and input data, in advance, to NERPC/NERLDC for every new/modified element to be commissioned. The mentioned information shall be submitted to the NERPC/NERLDC **fifteen** days in advance for all the elements proposed to be commissioned. The user has to obtain relay setting approval by NERPC before FTC can be provided.

vii) FTC will only be issued after complete relay setting coordination is ensured by the applicant. It is the responsibility of the utility, which is applying for the FTC of any element, to coordinate with concerned utilities to ensure that they complete the relay coordination before applying for FTC

viii) The PCCM of NERPC shall review the settings to ensure that they are properly coordinated with adjacent system and comply with the existing guidelines. The forum may issue proper directions to utilities in this regard.

ix) All users connected to the grid shall obtain approval of the NERPC for any revision in settings, and implementation of new protection system

x) All users connected to the grid shall ensure correct and appropriate settings of protection as specified by the NERPC and intimate to the NERPC about the changes implemented in protection system or protection settings within a fortnight of such changes

xi) In case of failure of a protective relay or equipment failure, the Generating Company and Transmission Licensee shall inform appropriate LDC/NERLDC/NERPC. The

Generating Company and Transmission Licensee shall take corrective action as soon as possible.

xii) NERPC in consultation with the NERLDC & Regional entities shall undertake review of the protection settings, assess the requirement of revisions in protection settings and revise protection settings, from time to time and at least once in a year. The necessary studies in this regard shall be carried out by the NERPC & NERLDC. The modifications/changes, if any, in protection settings shall be advised to the respective users and STUs.

xiii) NERPC shall maintain a centralized database and update the same on periodic basis in respect of their respective region containing details of relay settings for grid elements connected to 132 kV and above. NERLDC also shall maintain such database.

xiv) Respective entities are responsible for ensuring to make available the implemented protection settings in the centralized database before obtaining FTC.

xv) If System Protection Schemes (SPS) is recommended to be implemented by the appropriate forum/Sub-Committee of NERPC on account of operational & system constraints, the same shall be implemented by the concerned Transmission licensee/ Generating Company/Entities within the specified timelines.

7. Disturbance Monitoring, Analysis and Reporting

The Purpose is to ensure that adequate disturbance data is available to facilitate Grid event analysis. The analysis of power system disturbances is an important function that monitors the performance of protection system, which can provide information related to correct behaviour of the system, adoption of safe operating limits, isolation of incipient faults,

7.1. The Disturbance Monitoring Requirements include the following:

i) Each Transmission Licensee and Generating Company shall provide Sequence of Event (SOE) recording capability by installing Sequence of Event recorders or as part of another device, such as a Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU), a generator plants Digital (or Distributed) Control System (DCS) or part of Fault recording equipment. This capability shall be provided at all substations and at locations to record all the events in accordance with CEA Grid Standard Regulations, 2010 amended to date.

ii) Each line shall be provided with facility for distance to fault locator.

iii) Each Transmission Licensee/Generating Company/Users shall provide Disturbance recording capability for the following Elements at facilities:

- All transmission lines (Each line shall be provided with facility for distance to fault locator)
- Autotransformers or phase-shifters connected to busses.
- Shunt capacitors, shunt reactors.
- Individual generator line interconnections.
- Dynamic VAR Devices.
- HVDC terminals.
- Bus Bars

iv) The Disturbance recording feature shall be enabled and configured in all the numerical relays installed. Disturbance recording system shall have minimum recording time of 3 seconds (0.5 seconds for pre-fault and 2.5 seconds for post fault).

v) Each Transmission Licensee and Generating Company shall record for Faults, sufficient electrical quantities for each monitored Element to determine the following:

- Three phase-to-neutral voltages. (Common bus-side/line side voltages may be used for lines.)
- V sync(for Three phase Auto reclose scheme)Three phase currents and neutral currents.
- Mutual compensation current (in case of double circuit line)
- Polarizing currents and voltages, if used (As applicable).

- Frequency (As applicable).
- Real and reactive power (As applicable).

The Minimum parameters to be monitored in the Fault record shall be specified by the PCC of NERPC.

vi) Each Transmission Licensee and Generating Company shall provide Disturbance recording with the following capabilities:

- The Disturbance recorders shall have time synchronization and a standard format for recording analogue and digital signals (DR labels to be standardized as per the Report of **FOLD Working Group - 3 on DR Parameter Standardization as per 59th PCCM**). The data files shall be capable of being viewed, read, and analyzed with a generic COMTRADE analysis tool as per the latest revision of IEEE Standard C37.111.
- Each Fault record duration and the trigger timing shall be settable and set for a minimum 3 second duration including 0.5 seconds for pre-fault and 2.5 seconds for post fault
- Each Fault recorder shall have sampling frequency of 1 kHz or better.
- Each Fault recorder shall be set to trigger for at least the following:

  Internal protection trip signals, external trigger input and additional triggers may be assigned as necessary.

vii) Each Transmission Licensee and Generating Company shall keep the recording instruments (disturbance recorder and event logger) in proper working condition and shall establish a maintenance and testing program for Disturbance Recorder (DR) that includes

- Maintenance and testing intervals and their basis.
- Summary of maintenance and testing procedures.
- Monthly verification of communication channels used for accessing records remotely (if the entity relies on remote access and the channel is not monitored to a control centre staffed around the clock, 24 hours a day, 7 days a week (24/7)).
- Monthly verification of time synchronization (if the loss of time synchronization is not monitored to a 24/7 control centre).
- Monthly verification of active analog quantities.
- A requirement to return failed units to service within 90 days. If a Disturbance Recorder (DR) will be out of service for greater than 90 days, the Transmission Licensee and Generating Company shall keep a record of efforts aimed at restoring the DR to service.

viii) The time synchronization of the disturbance recorders shall be corroborated with the PMU data or SCADA event loggers by NERLDC. NERLDC shall list out for

Disturbance recorders which are non- compliant for discussion in PCC meetings of NERPC.

ix) Each Transmission Licensee and Generating Company shall submit the data files to the NERLDC conforming to the following format requirements:

- The data files shall be submitted in COMTRADE and PDF format.
- File shall have contained the name of the Relay, name of the Bay, station name, date, time resolved to milliseconds, event point name, status.

The DR archives shall be retained for a period of **three years**.

x) A separate work-station PC, powered through UPS (Uninterrupted Power Supply) shall be identified with access to all the relays for extraction of DR. Auto-Download facility shall be established for automatic extraction of the DR files to a location on the work- station PC.

xi) Time Synchronization Equipment

a) Time Synchronizing Equipment complete with antenna, all cables and processing equipment shall be provided to receive synchronizing pulse through Global Positioning System or Indian Regional Navigation Satellite System Navic compatible for synchronization of event logger, disturbance recorder, Phasor Measurement Units, and Supervisory Control and Data Acquisition System or Substation Automation System.

b) Each substation shall have time synch equipment to synchronize all the numerical relays installed. Before any extension work, the capability of the existing Time-sync equipment shall be reviewed to ensure the synchronization of upcoming numerical relays.

c) The status of healthiness of the time-sync device shall be wired as "Alarm" to SCADA and as an "Event" to Event Logger.

d) The time synch status of all the installed numerical relays and event logger shall be monitored monthly and recorded. The Monthly records for relays not in time-sync shall be reported to NERLDC and NERPC. This record shall be archived for a period of three years by each concerned agency.

e) Remedial action shall be taken by the concerned substation/ Protection department immediately to make the relays in time synchronization with reference to external time source.

f) All the new Grid elements/Bay extension shall have accurate and precise Time synchronization equipment.

7.2. Disturbance Analysis and Reporting

i) Immediately following an event (grid disturbance or grid incidence as defined in the CEA Grid Standards) in the system, the concerned user or SLDC shall inform NERLDC through voice message.

ii) Written flash report shall be submitted to NERLDC and appropriate SLDC by the concerned Transmission Licensee/Generating Company/User within eight (8) hours from Grid event.

iii) Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted by the respective Transmission licensee and Generating Company within twenty-four (24) hours from Grid event. These records shall be uploaded by the respective Transmission licensee and Generating Company in the Web Based Tripping Portal of NERLDC.

iv) NERLDC shall classify the grid incidents and grid disturbances according to CEA (Grid Standards) Regulations, amended to date. NERLDC shall report the event (grid disturbance or grid incidence) to CEA, NERPC and all regional entities within twenty-four (24) hours of receipt of the flash report.

v) After a complete analysis of the event, the Transmission licensee and Generating Company/User shall submit a detailed report in the case of grid disturbance or grid incidence within one (1) week of the occurrence of event to NERLDC and NERPC.

vi) NERLDC shall prepare a draft report of each grid disturbance or grid incidence including simulation results and analysis which shall be discussed and finalized in the PCC meetings of NERPC as per the timeline specified in Table below.

Sl. No	Grid Event (GD/GI Classification as per the CEA Grid Standards)	Flash report submission deadline (Users/ SLDC)	Disturbance record and station event log submission deadline by Users/ SLDC)	Detailed report and data submission deadline by Users/ SLDC)	Draft report submission deadline by NERLDC	Discussion in PCC and final report submission deadline by NERPC
1	GI-1/GI-2	8 hours	24 hours	+7 days	+7 days	+60 days
2	Near miss event	8 hours	24 hours	+7 days	+7 days	+60 days
3	GD-1	8 hours	24 hours	+7 days	+7 days	+60 days
4	GD-2/GD-3	8 hours	24 hours	+7 days	+21 days	+60 days
5	GD-4/GD-5	8 hours	24 hours	+7 days	+30 days	+60 days

vii) The analysis reports submitted by NERLDC shall be discussed in the Protection Coordination Sub-Committee (PCC) meetings of the NERPC. The PCC shall identify the lessons learnt during the events being discussed. The PCC shall scrutinize the correctness of operation of subject protection systems put in place by the concerned Constituents and the final analysis repot along with the recommendations shall be concluded. It shall also recommend the appropriate remedial measures for system improvement.

viii) The implementation of the recommendations of the final report shall be monitored by the PCC of NERPC.

ix) Any additional data such as

- Single line diagram (SLD)
- Protection relay settings,
- HVDC transient fault record,
- Location of fault with distance
- Fault details with type & relay indications
- CT/PT/CVT rating details with location
- Bus-bar arrangement/ Configuration of feeders
- CB positions (OPEN/ CLOSE) at the time of fault
- Isolator & Earth-switch positions (OPEN/CLOSE)
- Voltage, frequency & power flows with direction at the time of fault
- DR&EL records
- switchyard equipment

and any other relevant station data required for carrying out analysis of an event by NERPC, NERLDC and concerned SLDC shall be furnished by the Users including NERLDC and respective SLDC, as the case may be, within forty- eight (48) hours of the request. All Users shall also furnish high-resolution analog data from various instruments including power electronic devices like HVDC, FACTS, renewable generation (inverter level or WTG level) on the request of NERPCs, NLDC, NERLDCs or SLDCs.

x) Triggering of STATCOM, TCSC, HVDC run-back, HVDC power oscillation damping, generating station power system stabilizer and any other controller system during any event in the grid shall be reported to the NERLDC and NERPC if connected to ISTS and to the concerned SLDC if connected to an intra-state system. The transient fault records and event logger data shall be submitted to the NERLDC or concerned SLDC within 24 hours of the occurrence of the incident. Generating stations shall submit 1 second resolution active power and reactive power data recorded during oscillations to NERLDC or concerned SLDC within 24hours of the occurrence of the oscillations.

xi) A monthly report on events of unintended operation or non-operation of the protection system shall be prepared and submitted by each user/owner of important elements in the regional grid, as identified by the appropriate forum of NERPC including those in the State grids that are critical for regional grid operation to NERPC and NERLDC within the first week of the subsequent month.

xii) The detailed analysis reports shall be archived periodically. The archive shall be retained for a period of three years by each concerned agency.

8. Protection Audit Plan

8.1 All Users/Entities connected at 132 kV and above, shall conduct internal audit, as per the prescribed audit checklist, of their protection systems annually, and any shortcomings identified shall be rectified and informed to NERPC. The audit report along with action plan for rectification of deficiencies detected, if any, shall be shared with NERPC.

8.2 All users shall also conduct third party protection audit of each sub-station at 132 kV and above once in five years or earlier as advised by the respective RPC.

8.3 After analysis of any event, PCC of NERPC may identify a list of substations / and generating stations where third-party protection audit is required to be carried out and accordingly advise the respective users to complete third party audit within three months.

8.4 The third-party audit report shall contain all the information as in Annexure-1(Third Party Protection System Checking & Validation Template for a Substation) of CERC (Indian Electricity Grid Code), Regulations 2023). The protection audit reports, along with action plan for rectification of deficiencies detected, if any, shall be submitted to the respective NERPC and NERLDC or respective SLDC, as the case may be, within a month of submission of third-party audit report. The necessary compliance to such protection audit report shall be followed up regularly in the PCC meetings of NERPC.

8.5 Annual audit plan for the next financial year shall be submitted by the users to NERPC by 31st October every year. The users shall adhere to the annual audit plan and report compliance of the same to NERPC.

9. Performance Monitoring of the Protection Systems

9.1. Users/Entities shall submit the following protection performance indices of previous month to NERPC and NERLDC on monthly basis for 132 kV and above by 10th of the subsequent month and the same shall be reviewed in the ensuing PCC meeting of NERPC.

a) The Dependability Index defined as: D=(NC+NF)

Where, NC is the number of correct operations at internal power system faults and

NF is the number of failures to operate at internal power system faults.

b) The Security Index defined as: S=(NC+NU)

Where, NC is the number of correct operations at internal power system faults and

NU is the number of unwanted operations.

c) The Reliability Index defined as: R=(NC+NI)

Where, NC is the number of correct operations at internal power system faults and

NI is the number of incorrect operations and is the sum of NF and NU

9.2. Users/Entities shall furnish the reasons for performance indices less than unity of individual element wise protection system to the NERPC and action plan for corrective measures. The action plan will be followed up regularly in the PCC Meeting of NERPC

10. Compliance Monitoring

10.1. The Protection Protocol of NER shall be reviewed as and when required, in consultation with the stakeholders of the North Eastern Region.

10.2. Violation of the Protection Protocol of the North Eastern Region shall be brought to the notice of NERPC by the NERLDC or concerned SLDC, as the case may be.

10.3. In case any User/Entity fails to comply with the Protection Protocol or fails to undertake remedial action identified by the PCC of NERPC within the specified timelines, the NERPC would approach the Commission with all relevant details for suitable directions.

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SCHEDULE- I

[See sub-regulation (10) of regulation 10]

List of Electrical Protection Functions for Thermal Generating Units

1. Generator

Sl. No.	Protection Function	Remarks
(a)	Generator differential protection (87G)	
(b)	100% stator earth fault protection (64G)	For units of 100 MW and above.
(c)	95% stator earth fault protection (64G1)	For units less than 100 MW.
(d)	Standby stator earth fault protection (64G2)	
(e)	Inter-turn fault protection (87TG)	Applicable where split winding in Stator is provided and if six terminals are available.
(f)	Loss of field protection (40G)	To be duplicated for units of 500 MW and above.
(g)	Negative phase sequence current protection (46G)	
(h)	Low-forward power and Reverse power interlock for steam turbine generator (37/ 32G)	Preferably 3-phase power relays shall be provided. Both the relays shall be duplicated for units of 500 MW and above.
(i)	Rotor earth fault protection - two stages (64F1/F2)	
(j)	Definite time over-voltage protection (59G)	
(k)	Generator under frequency protection (81G)	
(l)	Over-fluxing protection for generator (99G)	To be provided for units of 500 MW and above in duplicate.
(m)	Overload protection for generator (51G)	
(n)	Back- up impedance protection, 3 pole (21G)	
(o)	Overheating (winding and/ or bearing) (49G)	Alarm only.
(p)	Instantaneous and time delayed over current protection on high voltage side of excitation transformer (51)	
(q)	Generator pole slipping protection (98G)	
(r)	Accidental back energisation protection (50GDM)	
(s)	Generator circuit breaker failure protection (50ZGCB)	To be provided for GCB scheme only.

Note: In case digital multifunctional generator protection system is provided, the protection systems for generator shall be duplicated for units of one hundred mega watt and above. Each MGPS shall preferably be provided with individual inputs from CTs and VTs and connected to the independent set of hand-reset trip relays, such that one set is always available in case of testing and mal-operation of the other set. If the MGPS does not include any protection mentioned in the table above, separate discrete protection shall be provided for the same. The MGPS shall preferably have continuous self-monitoring and testing facilities.

2. Generator Transformer

Sl. No.	Protection Function	Remarks
(a)	Overall differential protection (87OA)	
(b)	Generator transformer differential protection (87GT) for single phase bank	
(c)	Restricted earth fault protection for generator transformer (87NGT)	
(d)	Over head line connection differential protection (87L)	For 3 single phase banks, if 87L

		includes HV winding, separate 87NGT is not mandatory.
(e)	Back- up earth fault protection on generator transformer HV neutral (51NGT)	
(f)	Over-fluxing protection for generator transformer (99GT)	To be duplicated for units of 500 MW and above.
(g)	Back- up non-directional over-current protection in all phases on HV side of generator transformer (51GT)	
(h)	Generator transformer oil temperature indicator (OTI) trip (49Q) and winding temperature indicator (WTI) trip (49T)	
(i)	Generator transformer Buchholz (63), Pressure relief valve (PRV)/ other mechanical protections	
(j)	Pole discrepancy protection of generator transformer breaker (162)	To be provided, if single pole breakers are used.
(k)	Breaker failure protection of generator transformer breaker (50Z)	
(l)	Start-up earth fault protection for LV and HV winding of generator transformer and UATs (64T)	To be provided for GCB scheme only.

3. Unit Auxiliary Transformer(s)

Sl. No.	Protection Function
(a)	Differential protection (87UAT)
(b)	LV back-up earth fault protection (51NUAT)
(c)	LV restricted earth fault (87NUAT)
(d)	Back-up over-current protection (51UAT)
(e)	OTI(49Q) and WTI (49T) trip
(f)	Buchholz (63), PRV/ other mechanical protections

4. Station- Transformer(s)

Sl. No.	Protection Function
(a)	Differential current protection (87)
(b)	Restricted earth fault protection for LV winding (87NLV)
(c)	Restricted earth fault protection for HV winding (87NHV)
(d)	Back-up over-current protection on HV side (51)
(e)	Back-up earth-fault protection (51N)
(f)	Over-fluxing protection (99)
(g)	Buchholz protection (63)
(h)	Winding temperature high (49T)
(i)	Oil temperature high (49Q)
(j)	Pressure relief valve trip (PRV)
(k)	Breaker failure protection (50Z)

SCHEDULE-II

[See sub-regulation (3) of regulation 12]

Design Requirements for Ash Handling System

A. Design Requirements for Ash Handling System of Pulverised Fuel Steam Generators

1. The capacity of ash handling systems, as a percentage of maximum ash generated corresponding to firing of worst coal or lignite at boiler maximum continuous rating, shall not be less than the following:

		-	100% standby blowers for intermediate and storage silos;
		-	50% standby for air compressors to be used for transporting ash.
(c)	Ash slurry disposal	-	One pump stream as operating standby and one pump stream as maintenance standby for wet slurry system;
		-	One standby stream for high concentration slurry system.

SCHEDULE-III

[See sub-regulation (7) of regulation 36]

The minimum Load for Continuous Operation for Various Types of Hydraulic Turbines

Sl. No.	Type of turbine	Minimum load for continuous operation (percent)
(a)	Pelton or Kaplan or Bulb	30
(b)	Deriaz	40
(c)	Francis	50
(d)	Propeller	85

SCHEDULE-IV

[See clause(f) of sub-regulation (12) of regulation 40]

Minimum Protections to be provided for Hydro- electric Generating Units

1. Generator

Sl. No.	Protection functions	Size of generating unit		
		Small (<10 MVA)	Medium (10-100 MVA)	arge (> 100 MVA)
(a)	Differential (87G)	Y	Y	Y
(b)	95 % stator earth fault (64G1)	Y	Y	Y
(c)	100 % stator earth fault (64G2)	N	Y	Y
(d)	Backup impedance (21G)	N	Y	Y
(e)	Voltage controlled over current (51)	Y	N	N
(f)	Negative phase sequence (46G)	Y	Y	Y
(g)	Loss of excitation (40G)	Y	Y	Y
(h)	Reverse power (37/32G)	Y	Y	Y
(i)	Pole slipping (98G)	N	N	Y
(j)	Stator overload (49S)	Y	Y	Y
(k)	Over voltage (59G)	Y	Y	Y
(l)	Under frequency (81G)	Y	Y	Y
(m)	Dead machine (27/50G)	N	N	Y
(n)	Rotor earth fault (64R)	Y	Y	Y
Note: Y- Required; N- Not required.				

2. Excitation Transformer

Sl. No.	Protection functions	Size of generating unit		
		Small (< 10 MVA)	Medium (10-100 MVA)	Large (> 100 MVA)
(a)	Restricted earth fault (64)	Y	Y	Y
(b)	Instantaneous and IDMT over current (50/ 51)	Y	Y	Y
(c)	Winding temperature (49)	Y	Y	Y
Note: Y- Required.				

3. Generator Transformer

(a) Generator transformer differential protection (87T)
(b) Restricted earth fault protection (64GT)
(c) IDMT over current protection (51)
(d) Neutral grounding back-up earth fault protection (51NGT)
(e) Over head line connection differential protection (87L)
(f) Overfluxing protection (99GT)
(g) Monitoring of Insulation of low voltage bushing (59T)
(h) Buchholtz relay (63)
(i) Winding temperature protection (49T)
(j) Oil temperature protection (49)
(k) Pressure relief valve (PRV)

4. Generator and Generator Transformer

(a) Overall differential protection (87OA)
(b) Breaker Failure Protection (50Z)

5. Unit Auxiliary Transformer

(a) Restricted earth fault protection (64)
(b) Instantaneous and IDMT over current protection on high voltage winding (50/51)
(c) Neutral grounding back-up E/F protection (51NGT)
(d) Winding temperature protection (49T)

6. Station Auxiliary Transformer

(a) Restricted earth fault protection (64)
(b) Instantaneous and IDMT over current protection on high voltage winding (50/51)
(c) Neutral grounding back-up earth fault protection (51NGT)
(d) Winding temperature protection (49T)

SCHEDULE-V

[See sub-regulation (3) of regulation 48]

Protection Details of Transmission Lines, Transformers, Reactors and Bus Bars

1. Transmission Line Protection

No.	Protection	765 kV	400 kV	220 kV/230 kV	132 kV/110 kV/ 66 kV
(a)	Main l- Distance protection*	Y	Y	Y	Y (for 132 kV/110 kV) Y/N (for 66 kV)
(b)	Main Il- Distance protection* or directional comparison protection or phase segregated line	Y	Y	Y/N 'N' if Directional IDMT over	N

	differential protection			current and earth fault back up protection is provided otherwise 'Y'	
(c)	Directional inverse definite minimum time (IDMT) type earth fault relay	Y	Y	'Y' if both Main-I & Main-Il are distance protections otherwise 'N'	N
(d)	Directional IDMT over current and earth fault back up protection	N	N	'Y' if Main-II is not provided otherwise 'N'	Y
(e)	Two stage over voltage protection	Y	Y	Y/N	Y/N
(f)	Auto reclosing#	Y (Single phase and three phase)	Y (Single phase and three phase)	Y (Single phase and three phase)	Y/N (three phase)

***For short line (less than 10 km) or cable or combination of overhead line and cable, line differential protection shall be used with built-in backup distance protection.**

 # For cable or combination of overhead line and cable, autoreclosing shall not be provided.

Note: (1) Y- Required; N- Not required; Y/N- Optional.

(2) Transmission lines with distance protection shall, in general, have carrier aided or fibre optic based inter-tripping or blocking feature.

(3) Separate cores of current transformer and voltage transformer shall be used for Main-I and Main-ll.

2. Transformer Protection

Sl. No.	**Protection**	**765 kV**	**400 kV**	**230 kV/220kV/ 132 kV/110 kV**	**66 kV**
(a)	Differential protection	Y	Y	Y	Y
(b)	Over fluxing protection	Y	Y	Y	N
(c)	Restricted earth fault (REF) protection	Y	Y	Y	Y
(d)	Backup directional over current and earth fault protection (HV and LV side) or impedance protection	Y	Y	Y	Y
(e)	Buchholz, WTI and OTI (for 1 MVA and above), MOG with low oil level alarm, OSR for OLTC, PRD, SA on both primary and secondary sides of transformers located outdoors and connected to over head lines	Y	Y	Y	Y
(f)	Tertiary winding protection	Y	Y	Y	N

Note: (1) Y- Required; N- Not required.

(2) WTI- winding temperature indicator; OTI- oil temperature indicator; OLTC- on load tap changer; PRD- pressure relieve device; OSR- oil surge relay; MOG- magnetic oil gauge; SA- surge arrester.

3. Reactor Protection

Sl. No.	Protection	765 kV	220kV /400 kV
(a)	Differential protection	Y	Y
(b)	REF protection	Y	Y
(c)	Reactor backup protection (impedance type or definite time over current (O/C) and earth fault (E/F) protection)	Y	Y
(d)	Buchholz, WTI, OTI, MOG with low oil level alarm, SA (if required)	Y	Y

Note: (1) Y- Required.

(2) WTI- winding temperature indicator; OTI- oil temperature indicator; MOG- magnetic oil gauge; SA- surge arrester.

4. Bus Bar Protection and Local Breaker Backup Protection (breaker failure protection)

Bus bar protection and local breaker backup protection shall be provided in 220 kV and higher voltage interconnecting sub- stations as well as in all generating station switchyards. Duplication of bus bar protection shall be done for all main buses of 400kV and above voltage class. The bus bar protection scheme shall be centralized or distributed type and have provision for planned future expansion.

SCHEDULE-VI

(See regulation 49)

PART-A

Technical Details of Classical HVDC Terminals/ Stations

1. **General:** The conventional Thyristor (Gate Turn On device) based HVDC converter technology or Line Commuted Converter technology or Current Source Converter technology shall be used for back to back and long distance bulk power HVDC transmission system. Gate Turn Off devices / other better devices capable of handling similar or higher quantum of power may also be considered.
2. **Design Consideration:** (a) The converter configuration and rating for HVDC installation shall be based on following considerations:
   (i) The amount of power to be transmitted
   (ii) The transmission distance
   (iii) Staging consideration of the project
   (iv) Location of converter station
   (v) The amount of power to be transmitted at the different stages of the project
   (vi) Reliability and availability requirements
   (vii) Loss evaluation
   (viii) Size and weight of the Converter transformers for transport
   (ix) Electrical characteristics of sending and receiving end power system to which HVDC transmission system is connected

Note: The DC power rating shall include nominal, reverse, forward and overload power levels, specific loading cycle and weightage factor to calculate load losses.

(b) Electric design of HVDC transmission lines shall take into account the following considerations:

(i) Corona performance (Corona loss, Radio Interference, Audible Noise, Electric field and ion current in the vicinity of the line)

(ii) Air Characteristic

(iii) Insulator performance

(c) The minimum conductor height above Ground level shall be selected mainly on the basis of ensuring human safety, Ground level electric field and ion current density level. The corona loss with I^2R losses

harmonic injection and self-excitation. Sub Synchronous Damping (SSD) Controller shall be provided for converter Stations near Generating stations.

(A) Load frequency controller (LFC)

(B) Current margin controller

(C) Excessive reactive power consumption controller

(D) AC system stability function, such as power swing damping function.

(E) Run back / Run up controller with provision to be linked to SPS of System Operator

(iv) The pole control, converter control, and valve control modules shall also be provided.

(v) The control shall be designed to give fast stable and proper response to normal control actions as well as during disturbances such as AC & DC faults.

(b) Protection System

(i) HVDC system protection shall consist of two parts:

(A) AC side protection:

AC side protection function shall cover the zone for converter transformer, AC filters, shunt capacitors, shunt reactors, and busbars. These protections shall generally follow the same philosophy as in a typical substation i.e. detection of fault by relay and tripping of circuit breaker.

(B) DC side protection:

DC side protection shall cover the zones consisting of the valve hall, DC switchyard including smoothing reactor and DC filters, DC line, DMR line / electrode line and ground electrode. The protection equipment shall be designed to be fail safe and shall ensure high security to avoid mal-operation/ unwanted shutdown due to protection equipment failures.

(ii) Following a DC Line fault, the HVDC System shall have the facility to restart, one or more times, the faulted pole at a variable pre-selected DC voltage level(s), not below 80% of the nominal voltage rating. The dc transmission system shall be capable of recovery in a controlled and stable manner without commutation failures during recovery following ac and dc system faults. The post fault power order shall be equal to the pre-fault power order unless AC/ DC systems dictate otherwise

(iii) Protection system shall have two redundant systems with following protections.

(A) Converter differential protection;

(B) DC over current protection;

(C) DC differential protection;

(D) AC conductor ground fault protection;

(E) Commutation failure protection;

(F) DC filter protection#;

(G) DC smoothing reactor protection;

(H) DC line ground fault protection with restarts#;

(I) DC line differential protection#;

(J) DC under voltage/ over voltage protection;

(K) Ground Return mode / Dedicated Metallic Return (DMR) protection#

(L) AC filter protections

(M) Electrode line monitoring and protection#

(N) Thyristor Failure Monitoring

not applicable for back to back schemes

(iv) DC online fault locators shall be provided to monitor the entire DC line length and give location of the fault with good accuracy in the range of $\pm$ 1000 meters

(c) Software based controls and protection shall be used to permit flexibility in effecting modifications. Protection and controls shall be duplicated for reliability. The control & protection shall provide fast controllability of the HVDC system. Operation of the HVDC bipole system shall be possible in the following modes:

(i) Balanced/ unbalanced bipolar operation;

(ii) Monopolar operation with pole metallic return:

(iii) Monopolar operation with ground return / with Dedicated Metallic Return (DMR) mode;

(iv) Reduced voltage operation;

(v) Power reversal mode.

(d) The 'Sequence of events' recorder, transient fault recorder, on-line DC Line fault locator, GPS system, visual display system, operator control protection and monitoring system shall be a part of the HVDC system.

14. Telecommunication- For smooth operation of the HVDC system, communication network with high reliability and availability shall be provided for transmission of control and protection signals between the two or more (in case of multi-terminal DC) HVDC terminals. There shall be main and back up communication link. The main communication link shall be through OPGW and back up communication link shall be either through OPGW or PLCC.

15. Valve Hall: The valve hall shall mainly contain thyristor valves, its associated structure, & cooling and arresters. No oil filled equipment shall be present inside the valve hall. In case the turret of converter transformers (having oil) is protruding inside the valve hall, suitable fire barrier matching with adjacent valve hall wall fire rating shall be provided. The valve halls shall be provided with interference screening. In addition, the control cable and cable termination rooms shall be suitably screened to minimize radio interference. Two nos. scissor lift for erection and maintenance of valve modules shall be provided per station. Proper cable sealing shall be provided for cable entry into valve hall and control room to avoid entry of water and moisture. Necessary measures shall be taken to take care of high frequency noise emission from valves.

16. Valve Hall Ventilation: Suitable ventilation systems and filters with adequate redundancy shall be provided in the valve hall. The valve hall shall be kept at a positive pressure under all conditions.

17. Grounding & Safety

(a) The design of the grounding system shall be based on relevant IS/ IEEE.

(b) In order to prevent adverse effect (overheating due to induced circulating current) of magnetic field of air core reactors, special care shall be taken such that no closed loops are formed by the earthing conductors and in reinforcement bars of the foundation. Air core reactor manufacturer's guidelines shall be followed.

(c) The electrical safety clearances for the dc side shall not be less than the clearances applicable for an ac switchyard at the equivalent BIL level.

(d) The total electric field excluding space charge at ground level shall be as prescribed in relevant standards.

(e) Fencing and electrical & mechanical key interlocking arrangements shall be provided for valve halls, smoothing reactor area, AC and DC filter areas, DC LFL Capacitor Area and for equipment mounted directly on ground without suitable height of steel structure.

18. Dedicated Metallic Return (DMR) / Earth Electrode

The current return path of a bipolar configuration shall be either via a Dedicated Metallic Return (DMR) conductor or via earth return using earth electrodes at both converter terminals. DMR mode shall be preferred if it is difficult to identify a suitable site for earth electrode station.

If earth electrodes are to be used the following requirements shall also be considered:

(a) The earth electrode station shall be connected to the terminal by means of an overhead transmission line. The earth electrode shall be located at a minimum distance of approximately 25 km (radial distance) away from the converter station. It shall be designed to operate continuously at nominal load and overload as per the requirement. The electrodes shall be designed for both types of operation, anodic and cathodic.

(b) The thorough soil investigation shall be carried out for shallow and deep resistivity, thermal conductivity and moisture content etc. at the proposed location.

(c) The earth electrode station shall have sub-electrodes. The maximum current density at the sub-electrode surface, i.e. the boundary between backfill (coke) and soil shall not exceed 0.5 A/m2 in clay soils. The number of sub-electrodes shall be determined considering that 30% of the sub-electrodes are not available. The amp hour rating for earth electrode shall be selected based on the study for duration of earth electrode current and the service life of the earth electrode station.

(d) The earth electrode station shall not affect the nearby electrical installation, buried metallic pipelines, oil & gas pipelines, and railway lines etc.

(ii): The above values of creepage distance are applicable for an altitude upto 1000m above sea level. For altitude above 1000m above sea level, necessary altitude correction factor as per relevant IS/IEC shall be considered.

(c) **DC wall bushing -**DC wall bushings, used for electrical connection between the equipment inside the valve hall and the outdoor DC yard shall be of polymer housing as per relevant standards.

(d) **DC Reactors -** The DC reactors (if used) shall be of air core type. The reactors shall generally comply with relevant standards and shall also have beensubjected to DCtests as pertheir application.

(e) **DC Voltage and Current Measuring Devices-** The DC voltage measuring equipment shall be installed at each pole. The DC measuring equipment at pole and neutral bus shall be suitably located based on the control philosophy and different protection zones such that complete pole and neutral equipment are protected.

(f) **DC Filters-** If required DC harmonic filters shall be provided in DC yard to limit harmonic voltages present on the DC lines (pole lines and electrode lines).

8. Control and Protection

(a) Control

(i) DC converter terminals shall be either manned by operator or controlled by remote Operation of SCADA system. The control system hierarchy shall be as follows:

(A) Station/ Bipole* Control (*only for bipolar arrangements, functionality offered as part of station control also acceptable);

(B) Converter /Pole Control;

(C) MMC control;

(ii) The HVDC converter shall have control features including but not limited to the following:

(D) Active power control

(E) Reactive power control;

(F) AC Voltage control

(G) DC Voltage control

(H) Frequency controller (if applicable);

(I) Power modulation control (if applicable);

(J) Runback and run-up functions (if applicable);

(K) Power Oscillation Damping (POD)

(L) Sub synchronous torsional interaction dampingcontrol (if applicable);

(b) Protection

(i) The protection equipment shall be designed to be fail-safe and shall ensure high security to avoid mal-operation/ unwanted shutdown due to protection equipment failures.

(ii) HVDC system protection shall consist of following protection zones:

(A) AC System Protection zone

(B) Converter or Interface Transformer Protection Zone

(C) Secondary Busbar Protection Zone

(D) Converter Protection Zone

(E) DC Busbar Protection Zone

(F) DC line & cable Protection Zone

(iii) Protection system shall have two redundant systems including the following protections.

(A) AC over- and under-voltage protection

(B)Over- and under-frequency protection

(C)AC busbar differential protection;

(D) Insertion resistor overload protection

(E)AC overcurrent protection

(F) Converter overcurrent protection

(G) Converter overload protection

(H) Converter module differential protection

(I) Converter current differential protection

(J) DC voltage imbalance protection

(K) DC busbar differential protection

(L) DC link differential protection

(M) DC over- and under-voltage protection

(N) Electrode line monitoring and protection (if applicable)

(O) DC filter protection (if applicable)

(P) AC filter protection (if applicable)

(Q) AC connection Harmonic protection

(R)Phase current unbalance

(S) Protection.Block Failure or Repetitive Blocking failure protection

(T)Converter arm harmonic protection

(U) DC Line + cable Overcurrent Protection

(V) DC Line + cable harmonic protection

(c) Software based controls and protection shall be used to permit flexibility in effecting modifications. Protection and controls shall be duplicated for reliability. Protection shall be provided by numerical relays to suit the requirement of the HVDC system.

(d) For bipolar schemes the following operation modes shall be possible:

(i) Balanced/ unbalanced bipolar operation;

(ii) Monopolaroperation with metallic return;

(iii) Monopolar operation with ground return / DMR

(e) The 'Sequence of events' recorder, transient fault recorder, on-line DC Line fault locator, GPS system, visual display system, operator control protection and monitoring system shall be a part of the HVDC system.

9. Telecommunication- For smooth operation of the HVDC system, communication network with high reliability and availability shall be provided for transmission of control and protection signals between the two or more (in case of multi-terminal DC) HVDC terminals. There shall be main and back up communication link. The main communication link shall be through OPGW and back up communication link shall be either through OPGW or PLCC.

10. Grounding & Safety

(a) The design of the grounding system shall be based on relevant IS/ IEEE.

(b) In order to prevent adverse effect (overheating due to induced circulating current) of magnetic field of air core reactors, special care shall be taken such that no closed loops are formed by the earthing conductors and in reinforcement bars of the foundation. Air core reactor manufacturer's guidelines shall be followed.

(c) The electrical safety clearances for the dc side shall not be less than the clearances applicable for an ac switchyard at the equivalent BIL level.

(d) The total electric field excluding space charge at ground level shall be as prescribed in relevant standards.

(e) Fencing and electrical & mechanical key interlocking arrangements shall be provided for valve halls, smoothing reactor area, AC and DC filter areas, DC LFL Capacitor Area and for equipment mounted directly on ground without suitable height of steel structure.

11. Dedicated Metallic Return (DMR) or Earth Electrode –The current return path of a bipolar configuration shall be either via a Dedicated Metallic Return (DMR) conductor or via earth return using earth electrodes at both converter terminals. DMR mode shall be preferred if it is difficult to identify a suitable site for earth electrode station. If earth electrodes are to be used the following requirements shall also be considered:

(a) The earth electrode station shall be connected to the terminal by means of an overhead transmission tine or underground cable. The earth electrode shall be located at a minimum distance of approximately 25 km (radial distance) away from the converter station. It shall be designed to operate continuously at full load as per the requirement. The electrodes shall be designed for both types of operation, anodic and

Observations on protection philosphy of NER		
Sl.No.	**Philosophy**	**POWERGRID comments**
5.6.4.1.d	LBB	LBB for 33kV is not required
5.6.4.7	Pick up of O/C should be 1.1 times of CT ratio	Pickup current varies on case to case basis.
5.6.4.8	Pickup of E/F is normally kept at 80A	Generally, pickup current is 0.2 of CT ratio. Pickup current may vary on case to case basis.
5.6.4.8	Time gardient between 33kV feeder at GSS & Transformer LV side should be maintained at 300 msec	Considering huge no. of downstream fault, an in order to save the transformer the setting shall be kept lesser also on case to case basis
5.6.4.1	Zone 1(Forward) - 80% of the protected line, instantaneous	**Reach** : If Line is series comp. = 60% at Local Bus Otherwise 80% **Trip time** : If (FSC at Remote bus), 0.1 sec otherwise 0.0 sec
5.6.4.1	Zone 2(Forward) - 120% of the protected line (150% in case of D/C line). Time delay: 350msec (generally) and 500msec in case 20% of the protected line is greater than 60% of the shortest line at remote end	120% of the protected S/C line
5.6.4.1	Zone 3(Forward) 120% of the protected line + 100% of the longest line emanating from the far end bus bar. Time delay: 800msec	**Reach** : 120% (principal section+Longest line at remote bus). Minimum 1.5 times of Principal Section **Trip time** : For 400 & 765kV Lines If Zlongest line at remote bus reach<90% of Eq. X-mer Impedance, 1.0 sec else 1.5 sec For 132kV & 220kV lines, 0.8 sec

5.6.4.1	Zone 4 (Reverse) : For lines < 100 km = 10% of the protected line or 50% of adjacent shortest line, whichever is lower For lines > 100 km = 20% of the protected line or 50% of adjacent shortest line, whichever is lower Time delay: 500mesc	**Reach** : If Line length<=100kM = 20% Otherwise 10% but not more than 50% of adjacent shortest line
5.6.4.3	LBB protection and Bus Bar Protection (for 220kV and above as well as all Generating stations) : Two stage: Stage-I: (Re-Trip) time delay of 100 msec to trip own CB Stage-II: LBB time delay: 200msec to trip all CBs connected to the respective bus, LBB Current sensor I > 20% In Bus bar protection time delay: instantaneous	LBB is required for 132kV bays also. LBB Current settings : For CT ratio < 1000 A, 0.2 & For CT ratio > 1000 A, 0.1
5.6.4.4	O/C back up protection (for 132kV and below) : For I>1 Ib = 150% of current rating of the line. Time delay: to be coordinated with Z2 for three phase fault at remote bus (500msec). Forward directional	Time delay: to be coordinated with Z3 for three phase fault at remote bus (800msec). Forward directional
5.6.4.7	Block All zones Except Zone 1 or Block all zones and trip with OOS function	Block All zones Except Zone 1 - For 400kV and above Block all zones - For 220kV and below lines OOS function - Location is to be provided by NERPC/NERLDC

5.6.4.9	Single/Three phase auto reclosure : To be provided on 132kV and above lines on Zone 1 or differential relay operation Dead time = 1.0s for Main CB, 1.5 to 2 sec for Tie CB. Reclaim time = 25.0s	To be provided on 132kV and above lines on Zone 1 and Zone 2 with Carrier Protection or Line differential relay operation Dead time = for 400kV and 220kV system: - 1.0s for Main CB, 2 sec for Tie CB For 132kV System - 1.5 sec to 2.5 sec on case to case basis Approval to be taken for any different settings on case to case basis.
5.6.4.6	Allowable Load impedance encroachment	Imax = 150% of current rating of line or 150% of terminal eqpt rating whichever is lower Vmin = 0.85pu (85%) 30 degrees for load blinder
8	Protection Audit Plan	Internal Audit- once in every year Should be changed to once in 2 years

Annexure C.1

Name of the line	Status as updated in 56/57th PCC meeting	Latest Status
132 kV Agia - Mendipathar	PLCC works completed. AR operation configuration to commence from March'22. Latest Status to be intimated.	
132 kV EPIP II - Byrnihat D/C		
132 kV EPIP II - Umtru D/C		
132 kV Kahilipara - Umtru D/C		
132 kV Khliehriat – Mustem		
132 kV Mustem - NEHU line		
132 kV Khliehriat (MePTCL) - Khliehriat (PG) Ckt#II		
132 kV Khliehriat- NEIGRIHMS		
132 kV NEHU – Mawlai		
132 kV Mawlai - Umiam Stage I		
132 kV Mawphlang - Nongstoin		
132 kV Mawphlang - Umiam Stg I D/C		
132 kV Mawphlang- Mawlai		
132 kV Mendipathar – Nangalbibra		
132 kV Myntdu Leshka - Khleihriat D/C		
132 kV Nangalbibra – Nongstoin		
132 kV NEHU – NEIGRIHMS		
132 kV NEHU – Umiam		
132 kV Sarusajai - Umtru D/C		
132 kV Umiam - Umiam St I	By March'22	
132 kV Umiam St I - Umiam St II		
132 kV Umiam St I - Umiam St III D/C		
132 kV Umiam St III -Umiam St IV D/C		
132 kV Umiam St III - Umtru D/C		
132 kV Umtru - Umiam St IV D/C		