भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
उत्तर क्षेत्रीय विद्युत समिति
Northern Regional Power Committee

दिनांक: 08.03.2024

सेवा में : संरक्षण उप-समिति के सदस्य एवं विशेष आमंत्रित (सूची के अनुसार) I
To: Members of Protection Sub-Committee and Special Invitees (As per mail list)

विषय: संरक्षण उप-समिति की 49 वीं बैठक की कार्यवृत्त |
Subject: Minutes for 49th Protection Sub-Committee Meeting.

संरक्षण उप-समिति की **49 वीं बैठक, दिनांक 25.01.2024 को 10:30 बजे** से **एनआरपीसी सचिवालय, कटवारिरया सराय, नई दिल्ली** में आयोजित की गयी थी | उक्त बैठक की कार्यवृत्त संलग्न है I यह उत्तर क्षेत्रीय विद्युत् समिति की वेबसाइट (http://164.100.60.165/) पर भी उपलब्ध है |

The **49th meeting** of Protection Sub-Committee was held on **25.01.2024** at **10:30 Hrs** at **NRPC Secretariat, Katwaria Saarai, New Delhi**. The minutes of the meeting is attached herewith. The same is also available on NRPC website (http://164.100.60.165/).

Signed by Reeturaj Pandey
Date: 08-03-2024 16:56:22
Reason: Approved
(ऋतुराज पाण्डेय)
(Reeturaj Pandey)
Executive Engineer (Protection)
कार्यपालक अभियंता (संरक्षण)

Contents

Minutes of
49th Meeting of Protection Sub-Committee (PSC) of
Northern Regional Power Committee

Date and time of meeting	:	***25.01.2024 10.30 Hrs.***
Venue	:	***Conference Hall, NRPC Secretariat, Katwaria Sarai, New Delhi***

Meeting was chaired by Member Secretary, NRPC. List of participants is attached as **Annexure-P**.

A.1. Confirmation of minutes of 48th meeting of Protection Sub-Committee

A.1.1 AEE (P), NRPC apprised that the 48th PSC meeting was held on 11.10.2023. Minutes of the meeting were issued vide letter dtd. 15.11.2023. No comment has been received till the date.

Decision taken by Forum:

Forum approved the minutes of 48th PSC meeting as issued.

A.2. Protection Philosophy of Northern Region (agenda by NRPC Sectt.)

A.2.1. AEE (P), NRPC apprised that revised Protection philosophy (**Annexure-I**) of NR was discussed and finalized in 48th Protection Sub-Committee Meeting (held on 11th October, 2023). The same was presented in the 48th TCC/ 70th NRPC meeting held on 17-18 November 2023 wherein POWEGRID submitted comments for discussion. CTUIL also raised concern over differential protection on LILO lines. Accordingly, NRPC forum referred the draft protection philosophy to PSC for discussion on new comments received.

A.2.2. CTUIL representative apprised that differential protection for short line depends on dedicated fibre availability which is matter of concern on LiLOed portion of main line due to separate ownership of main and LiLOed part.

A.2.3. Fibre owners are not likely to share the available fibres to others due to business avenues. He suggested to address this issue by suitably including it in philosophy.

A.2.4. DTL representative commented that they are using current differential protection by dedicated fibre and it is preferable method. However, concerned parties may go for differential protection by using bandwidth if fibres are not available.

A.2.5. CTUIL representative submitted to include the mandate of providing of adequate dark fibres by owner of main line to the owner of LiLOed portion for differential protection.

A.2.6. POWERGRID representative informed that PGCIL has been using SDH for differential protection at Bina and the same has also been utilized in other lines of around 200km length as pilot project.

A.2.7. UPPTCL representative highlighted that dedicated dark fibre has no issue of latency to exchange the signal as per requirement of differential protection.

A.2.8. CTUIL representative asked utilities about maintaining redundancy of differential protection by using multiple channels.

A.2.9. POWERGRID representative stated that in case of failure of dark fibre or SDH channel, distance protection will be applicable instead of differential protection. Multiple channels may be implemented if extra fibres are present.

A.2.10. Subsequently, it was gathered that available dark fibres shall be shared by parent line owner to owner of Liloed part for differential protection. Further, forum finalized that for very short line (less than 10 km) differential protection may be done using dark fiber (preferably), or using bandwidth.

A.2.11. Further, comments of POWERGRID on protection philosophy were deliberated as below-

i) POWERGRID representative recommended to allow range in time setting for zone-2 protection of long line followed by short line. He suggested to implement 0.5 – 0.6 sec. time range depending upon requirement of utility to have better coordination. Forum agreed upon the same.

ii) POWERGRID representative submitted that POWERGRID is using 1 sec. time setting for zone-3 protection in 765kV and 400kV line. However, when zone- 3 reach encroaches to different voltage level then 1.5 sec. time setting has been observed better for proper coordination.

UPPTCL representative stated that depending upon requirement time setting may be configured in these cases. Therefore, he recommended to define an upper limit within that utility may consider setting.

Subsequently, it was decided that if zone-3 reach transcends to other voltage level, time may be taken upto 1.5 sec.

iii) POWERGRID representative emphasized that practical difficulties are coming in applying 80% reach of protected line with 100msec. delay for lines with Series and other compensations due to sub synchronous phenomena in FSCs. Therefore, he proposed to apply 60% of protected line with instantaneous time setting for local end (FSC end) and 60% of the protected line with 100msec time delay for remote end. After deliberation forum agreed upon the same.

GM, NRLDC asked that protection settings status in compensation off cases. POWERGRID representative replied that there is use of overreach scheme in compensated lines and carrier exchanges through zone-2. Therefore, applied settings are applicable in both cases of compensation on and off.

iv) POWERGRID representative proposed to extend the delay for alarm as 3-20 sec. in case protection for broken conductor instead of 3-5 sec. UPPTCL representative stated that they have applied 5 sec. in their substations. Further, it was gathered to extend the range as 3-20 sec.

v) POWERGRID representative highlighted that due to CT ratio variation, the 0.1-0.2 A current setting may be adopted for local breaker backup (LBB) instead of 0.2 A.

DTL representative advised that current setting may be kept more than 0.2A depending on cases. He mentioned that when CTs are earthed in yard, a circulating current remains and its value gets increased during earth fault. Therefore, more current rating may be used for LBB. Further, he informed that DTL has applied 0.8A.

BBMB representative supported to have 0.2 A as current setting for the LBB.

UPPTCL representative suggested that in case of transformer the pick-up current may be kept 0.2A as lightly loaded transformer when gets overexcited then LBB can be triggered at low setting. However, for transmission line greater than 0.2A may be kept.

Subsequently, Forum decided that in case of variation in CT ratio, setting may be done accordingly for this case.

vi) POWERGRID representative requested to utilize PSDF fund for replacement of existing Main-1 and Main-2 relays by line differential. He highlighted that nos. of short lines are also increasing due to LILO.

EE (P), NRPC suggested that PSDF fund may be explored under renovation, upgradation activities.

Forum recommended that PSDF fund may be utilized for replacement of main -1 and main-2 relays in short lines.

vii) POWERGRID representative suggested to mention direct inter trip send during manual tripping for 400kV and above.

viii) POWERGRID representative suggested NRLDC to identify potential lines so that power swing blocking protection may be applied effectively. NRLDC assured to identify such lines.

A.2.12. Further, comments of UPPTCL on protection philosophy were deliberated as below-

i) UPPTCL representative stated that in radial feeder zone -1 setting may be extended to 110%. After having 80% coverage of zone – 1 setting, in remaining 20% portion fault current will sustain for 350 msec. and lead to stress the transformers unnecessarily. In view of above, Forum decided to keep the zone -1 setting as 110% of the protected line in case of radial feeders.

ii) UPPTCL representative stated that Zone – 4 reverse reach setting shall be considered as 50% of shortest line connected to the local bus and time delay would only need to co-ordinate with busbar main protection fault clearance and with Zone-2 time of line i.e. 350 msec. He recommended not to keep setting open ended.

POWERGRID representative advised to keep the zone - 4 settings as per utility based on coordination. Since short line may be of varying length and reach may not be covered by UPPTCL recommendation.

Forum decided to keep the same setting for zone-4 as earlier i.e. the Zone-4 reverse reach must adequately cover expected levels of apparent bus bar fault resistance. Forum agreed that utilities may prepare and circulate an internal philosophy for its substations, however, the same shall not be in conflict of protection philosophy of Northern Region.

iii) UPPTCL representative proposed that tripping may be considered for radial lines to protect single phasing of transformer under broken conductor protection. Forum agreed upon the same. Further, UPPTCL representative conveyed that alarm time setting will be used for tripping also.

iv) Forum also guided that high set shall not be applied in line setting.

v) UPPTCL representative recommended to include CB Pole discrepancy relay time as 1.5 sec and 2.5 sec for tie breaker. Forum agreed upon the same.

vi) UPPTCL representative informed that there are some old circuit breakers in UP where pole discrepancy time can not be set more than 1.0 sec as there is no option to set more than 1.0 sec. In newly commissioned substations circuit breakers are available with Pole discrepancy time as 1.5 sec. BBMB representative informed that they are also using circuit breakers with lesser pole discrepancy time.

vii) Further, UPPTCL representative stated that for second circuit of double circuit lines, slightly higher setting may be considered for over voltage protection. AEE (P), NRPC informed that the same matter was discussed in the 48th Protection- Sub Committee meeting wherein it was advised to use both voltage and time grading in case of overvoltage protection depending upon no. of circuits, length of lines, reactive power calculation and other operational characteristics.

viii) NHPC representative recommended to apply over voltage protection for 220kV lines emanating from its generating yards. It was decided that decision will be taken during preparation of philosophy for generator protection.

A.2.13. DTL representative informed that direct Inter-trip is being sent in DTL for composite lines. Therefore, he recommended to include direct inter trip sending for cable fault in composite lines. Forum agreed upon the same.

A.2.14. RVUNL representative highlighted that in generating end, tripping is kept active for power swing in zone-1. THDC representative informed that they have also deblocked power swing in zone-1 and kept tripping on as per third party audit recommendation. BBMB representative supported that in different to transmission line setting for power swing blocking, generators may be allowed to have tripping for power swing in zone-1 with some delay or instantaneously as per requirement. EE (P), NRPC conveyed that the same matter shall be taken during preparation of philosophy for generator protection.

A.2.15. Further, comments of BBMB on protection philosophy were deliberated as below-

i) Deliberation was already done on zone -4 setting and decided that zone-4 reverse reach must adequately cover expected levels of apparent bus bar fault resistance. Time may be coordinated accordingly. Where Bus Bar protection is not available, time setting: 160 msec. is to be adopted.

ii) BBMB representative opined to specify setting for Power Swing Detection Band. He suggested to use a) 20% of zone-3 phase to phase resistive reach or b) as suggested by OEM relay manual.

POWERGRID representative informed that they derive the setting from swing equation and may vary on case basis. Therefore, he suggested that utility may derive based on its case.

iii) BBMB representative added that mandate for resistive reach setting to prevent load point encroachment may be adopted in line with "*manual on transmission planning Criteria 2023" (published by CEA), 6.4.1 (**Annexure -I**)*, wherein the per phase value of load point encroachment is obtained with formula as below-

Zmin= (0.9* Vphase)/(1.732*1.2*Imax)

POWERGRID representative commented that as per above calculation, setting will be more conservative and line may get tripped with reduced overloading. Therefore, he suggested to take clarification from CEA for this variation from Ramkrishna committee report.

Subsequently, Forum decided to discuss the matter with CEA and finalized the following criteria for deciding load point encroachment till then as below-

- Maximum load current (Imax) may be considered as 1.5 times the thermal rating of the line or 1.5 times the associated bay equipment current rating (the minimum of the bay equipment individual rating) whichever is lower. (Caution: The rating considered is approximately 15minutes rating of the transmission facility).
- Minimum voltage (Vmin) to be considered as 0.85pu (85%).

iv) BBMB representative presented setting calculations for zone wise resistive reach. Forum agreed that relay specific calculation for resistive reach need not to be incorporated in the protection philosophy.

v) Further, BBMB representative proposed that based on line length permissive under reach trip and permissive over reach trip may be specified in philosophy. He added that in short lines BBMB is using blocking scheme by using carrier communication to avoid tripping up to sometime delay due to fault in other line. Therefore, he recommended to include blocking setting criteria in the philosophy.

DTL representative highlighted that in blocking scheme, absence of carrier signal may lead to false tripping.

BBMB representative supported that communication needs to be healthy for blocking criteria. He suggested that in absence of communication, one relay be used as differential and another may be used for inter tripping.

EE(P), NRPC suggested that utilities need to implement inter-tripping and forum agreed to include permissive Inter-trip to be sent on operation of Distance Protection.

Decision taken by Forum:

After detailed deliberation on suggestions from members Protection Philosophy of Northern Region was finalized and attached as ***Annexure-II****.*

A.3. Furnishing and approval of protection setting by NRPC (agenda by NRPC Secretariat)

A.3.1 AEE (P), NRPC informed that the agenda was discussed in 48th PSC meeting held on 11.10.2023. Followings were decided in the 48th PSC meeting:

a) To send nomination(s) of nodal officer to NRPC Secretariat for furnishing the protection settings implemented for each element.

b) To intimate NRPC Secretariat two weeks advance about proposal for revision in existing setting as well as new settings.

c) To inform NRPC Secretariat about implementation of approved settings within a fortnight.

A. Furnishing the protection settings implemented for each element.

A.3.2 AEE (P), NRPC apprised that as per clause 14 (2) of IEGC 2023:

All users connected to the grid shall:

- *furnish the protection settings implemented for each element to respective RPC in a format as prescribed by the concerned RPC;*

A.3.3 Further, as per clause 14 (3) (a) of IEGC 2023:

RPCs 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 220 kV and above (132 kV and above in NER).

A.3.4 Some of the utilities have sent the nominations of nodal officers to NRPC Secretariat. List of received nomination till date is attached as **Annexure-III.**

A.3.5 MS, NRPC addressed utilities to send the details of nodal officers at the earliest.

A.3.6 Further, AEE (P) presented the status of Protection Settings Data received from utilities at NRPC Secretariat (**Annexure-IV). He highlighted that data from NTPC, HPGCL, THDC, & Kashmir is awaited.**

A.3.7 CE, JKPTCL informed that Protection setting data of Jammu transmission system has been sent.

A.3.8 PSTCL representative conveyed that PSTCL has sent the Protection setting data. EE (P), NRPC highlighted that data should be in excel format (circulated) and PSTCL needs to submit again the same.

A.3.9 THDC representative ensured to submit the Protection setting data within a week.

B. Approval of protection settings by RPC

A.3.10 AEE (P) apprised that as per clause 14 (2) of IEGC 2023:

All users connected to the grid shall:

- obtain approval of the concerned RPC for (i) any revision in settings, and (ii) implementation of new protection system;
- intimate to the concerned RPC about the changes implemented in protection system or protection settings within a fortnight of such changes;

A.3.11 Further, he informed that NRPC Secretariat has received no application for approval of settings till the date.

Decision taken by Forum:

Forum requested concerned utilities to kindly send the details of nodal officer and revision of protection settings (if any) to NRPC Secretariat in the issued formats timely.

A.4. Procedure and flow chart for approval of Protection Settings by NRPC Secretariat (agenda by NRPC Secretariat)

A.4.1 AEE (P), NRPC apprised that as per clause 14 (2) of IEGC 2023:

All users connected to the grid shall:

- *obtain approval of the concerned RPC for (i) any revision in settings, and (ii) implementation of new protection system;*
- *intimate to the concerned RPC about the changes implemented in protection system or protection settings within a fortnight of such changes;*

A.4.2 The agenda for approval of protection settings was discussed in 48th PSC meeting held on 11.10.2023 wherein it was decided that utilities may send their application 2 weeks in advance to NRPC Secretariat.

A.4.3 In view of above, the procedure and flow chart for getting approval of revision in the setting was discussed.

A.4.4 EE (P), NRPC highlighted that during approval of setting by NRPC Sectt., discussion with the concerned utility will be done along with NRLDC, if required.

A.4.5 POWERGRID representative asked to send the documents of FTC having protection settings data to NRPC directly.

A.4.6 Subsequently, it was gathered that the FTC procedure will remain same as being done by NRLDC. However, approval of protection settings shall be required from NRPC.

A.4.7 MS, NRPC opined that NRPC secretariat will scrutiny the proposal for protection setting within 10 days after receiving request.

A.4.8 EE (P), NRPC suggested to form a committee of experts related to protection domain that will work upon the proposal of change in protection settings or approval of new element protection settings.

A.4.9 Further, AEE (P), NRPC added formats have already been issued in the minutes of 48th PSC meeting to intimate NRPC Secretariat two weeks advance about proposal for revision in existing setting as well as new settings and to inform NRPC Secretariat about implementation of approved settings within a fortnight.

Decision taken by Forum:

*Forum finalized the procedure for approval of protection settings by NRPC as attached as **Annexure- V.***

A.5. Annual protection audit plan for FY 2024-25 (agenda by NRPC Secretariat)

A.5.1 AEE (P), NRPC apprised that as per clause 15 of IEGC 2023;

- *All users shall conduct internal audit of their protection systems annually, and any shortcomings identified shall be rectified and informed to their respective RPC. The audit report along with action plan for rectification of deficiencies detected, if any, shall be shared with respective RPC for users connected at 220 kV and above (132 kV and above in NER).*

- *Annual audit plan for the next financial year shall be submitted by the users to their respective RPC by 31st October. The users shall adhere to the annual* *audit plan and report compliance of the same to their respective RPC.*

A.5.2 Further, he informed that the agenda was discussed in 48th PSC meeting held on 11.10.2023 wherein utilities were requested to submit annual audit plan for FY 2024-25 latest by 31.10.2023 to NRPC Secretariat. The same was also discussed in 48th TCC/ 70th NRPC meeting held on 17-18 November 2023 and requested each utility to submit the same latest by 30.11.2023.

A.5.3 Some utilities have submitted their annual audit plans (enclosed as **Annexure-VI**).

A.5.4 BBMB representative conveyed that the same will be shared with NRPC Secretariat shortly.

A.5.5 RPSCL (Rosa Power) representative was informed that they have submitted external audit protection plan. Annual internal protection audit plan is yet to be received.

A.5.6 INDIGRID representative asked whether annual internal protection audit is required when external audit has already been done in the same year. It was decided that as per IEGC 2023, external protection audit is to be done once in a 5 years and internal audit is to be done yearly. Therefore, both audit needs to be completed in single year also if both audits coincide in a year.

Decision taken by Forum:

Forum requested utilities to submit substation wise annual audit plan for FY 2024-25 latest by 15.02.2024 to NRPC Secretariat.

A.6. Furnishing of details of non-compliant Disturbance Recorder (agenda by NRPC Secretariat)

A.6.1 AEE (P), NRPC apprised that as per clause 17 of IEGC 2023;

The time synchronization of the disturbance recorders shall be corroborated with the PMU data or SCADA event loggers by the respective RLDC. Disturbance recorders which are non- compliant shall be listed out for discussion at RPC.

A.6.2 He informed that in the 48th PSC meeting, it was decided that concerned utilities shall do the needful for time synchronization of disturbance recorders with PMU data or SCADA event loggers and shall share the list of DRs which are non-complaint within one month's time.

A.6.3 In view of above, only BBMB has provided the required data.

A.6.4 MS, NRPC addressed all utilities to share the required details and do comply.

A.6.5 Utilities were again requested to share list of DRs which are non-complaint.

Decision taken by Forum:

Utilities may share list of non-compliant DRs and do the needful for the compliance.

A.7. Furnishing requirements of number of licenses by utilities for protection setting calculation tool (agenda by NRPC Secretariat)

A.7.1 AEE (P), NRPC apprised that in 48th TCC & 70th NRPC Meeting (held on 17-18 Nov 2023), NRPC Committee has approved for development of a portal through PSDF for Centralized database containing details of relay settings for grid elements connected to 220 kV and above. Portal shall have other features including protection setting calculation tool. Approved scope of portal is attached as **Annexure-VII**.

A.7.2 In above meeting, utilities were requested to give their requisition for number of licenses latest by 30.11.2023 required for calculation tool for preparation of estimate of work as project cost will depend on number of licenses required in Northern Region.

A.7.3 He informed that the same was discussed in the 215th OCC held in Varanasi on 12.01.2024 wherein utilities were apprised that there are two modules of the project:

i) **Database module** (shall be used for storage of protection settings, audit reports, DR/EL etc): License is not required for this module and login shall be made available to utilities based on requirement

ii) **Protection Setting Calculation Tool** (shall be used for protection settings co-ordination study based on database available): License is required for this tool.

A.7.4 Further, a draft of tentative number of licenses was presented in above OCC meeting and utilities were requested to send their comments/requirement regarding number of licenses for finalization in next PSC meeting.

A.7.5 EE (P), NRPC mentioned that data for relays for 220kV and above elements will be asked from SLDCs/NRLDC in order to figure out the approximate cost estimate for tendering the Database portal by POWERGRID.

A.7.6 MS, NRPC highlighted that prepared draft for tentative no of licensees may be considered as final since most of the utilities have sent their requisition.

A.7.7 Subsequently, finalized list of numbers of licensees for protection setting calculation tool is attached as **Annexure- VIII.**

Decision taken by Forum:

*List for numbers of licensees for protection setting calculation tool has been finalized as **Annexure-VIII.***

A.8. Status of remedial actions recommended during 48th PSC meeting (agenda by NRLDC)

A.8.1 NRLDC representative apprised that the list of tripping events along with remedial actions points recommended during 48th PSC meeting was attached as Annexure-IX of agenda**.** It is expected that necessary actions would have taken place. In view of the same, constituents were requested to share the status of remedial actions taken. The followings were discussed-

a) Frequent tripping in J&K control area:

48 PSC recommendations: PSC forum requested J&K to expedite the work related to PLCC/DTPC installation and implementation of A/R function in relays. J&K was requested to submit internal protection audit report of their sub-stations.

J&K representative informed that protection system at major affected substations in J&K control area has been reviewed, necessary corrective actions has been taken and there is reduction in incidents of tripping events in J&K control area. On A/R scheme in lines, it was informed that proposal to implement A/R scheme in lines of J&K will be initiated during next financial year on priority.

b) Multiple elements tripping at 400/220kV Moga (PG):

POWERGRID representative informed that relay inspection and necessary material has been procured and bus bar protection will be implemented within next 1-2 months.

c) Multiple elements tripping at 400/220kV Bareilly (UP):

UP representative informed that bus bar relay panel has been procured, cable and other hardware are in the process of procurement, bus bar protection will be made operational by June 2024.

d) Multiple elements tripping at 400/220kV Gumma(HP) and 220kV Kunihar(HP):

HP representative stated that protection review of Gumma S/s will be done in February 2024 and report of the same will be submitted. Regarding Kunihar S/s, it was informed that protection review at Kunihar was done, report of the same will be submitted within 01 week.

Decision taken by Forum:

Members were requested to share their inputs via mail within one (01) week.

A.9. Status of Bus bar protection (agenda by NRLDC)

A.9.1 NRLDC representative apprised that Clause - 4 in schedule - V of Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 reads as

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

A.9.2 During analysis of many grid incidents/disturbances, it has been found that the Busbar protection at the affected substation was not present or non-operational which resulted in considerably increasing both the number of affected elements and fault clearance time. Accordingly, it becomes critical to monitor and keep Busbar protection at all the 220 kV and above voltage level substations healthy and operational.

A.9.3 Constituents were requested vide NRLDC letter dated 28th Dec 2022 to furnish status of Busbar protection in prescribed format in their control area. Deliberation on this subject has already been done during previous OCC and 48th PSC meeting.

A.9.4 Details are yet to be received from J&K.

A.9.5 Constituent wise status of bus bar protection where bus bar protection is either not installed or installed but not operational along with present status as per detail received from constituents is attached as Annexure-X of agenda.

A.9.6 Constituents were requested to share the status of remedial action taken/to be taken regarding commissioning and healthiness of bus bar protection at 220kV & above substations and also expedite the implementation of bus bar protection.

A.9.7 NRLDC representative asked members to appraise about the status of bus bar protection in their respective control areas.

A.9.8 BBMB representative shared the updated sheet of the status of bus bar protection in their control. Details of the same is available in **Annexure-IX**.

A.9.9 UP representative shared the updated sheet of the status of bus bar protection in their control. Details of the same is available in **Annexure-IX**.

A.9.10 HP representative informed that bus bar protection at Chamba has been made operational in January 2024 itself and bus bar protection at Mattasidh S/s will be commissioned by March 2024.

A.9.11 Uttarakhand representative informed that bus bar protection at Pantnagar and Kashipur S/s will be commissioned and made operational by March 2024.

A.9.12 Punjab representative informed that bus bar panels has been procured, cabling has also been done. There is delay due to availability of OEM engineer, tentatively bus bar protection at all the stations will be commissioned and made operational by March 2024.

A.9.13 Representative from Rajasthan were not present during the meeting. Rajasthan was requested to share the details via mail.

A.9.14 NRLDC representative stated all the concerned members to share the updated details via mail and also take necessary actions to expedite the commissioning/restoration of bus bar protection at 220kV & above substations. Constituents agreed for the same. Constituent wise status of bus bar protection as per details received from respective members is attached as **Annexure-IX**.

Decision taken by Forum

Forum requested all the constituents to update the status of bus bar protection at S/s of their control area and also expedite the commissioning and implementation work of bus bar protection system.

A.10. Replacement of electromechanical relays with numerical relays (agenda by NRLDC)

A.10.1 NRLDC representative apprised that Clause-37.2(c) of IEGC, clause-15(4) of CEA Grid standards and clause-48(4) of CEA Construction Standards 2022 mandates that ‘’each line or transformer or reactor or any other bay shall be provided with facility for disturbance recording, event logging and time synchronizing equipment’’.

A.10.2 During analysis of grid incidents/disturbances, it has been found that there are few stations where electromechanical relays are still in use and thus disturbance recorders are not available there which accounts for violation of Clause-37.2(c) of IEGC, clause-15(4) of CEA Grid Standards and clause 48(4) CEA Construction Standards 2022.

A.10.3 In addition, clause-3 in part III (Grid Connectivity Standards applicable to Transmission Line and Sub-Station) of Standards for Connectivity to the Grid, 2007 reads as

‘’Two main numerical Distance Protection Schemes shall be provided on all the transmission lines of 220 kV and above for all new sub-stations. For existing sub-stations, this shall be implemented in a reasonable time frame’’

A.10.4 It is known that Disturbance recorder (DR) is essential for analysis of grid incidents/disturbances. Its non-availability eventually affects the proper analysis of grid incidents/disturbances and monitoring of protection system.

A.10.5 Deliberation on this subject has already been done during previous OCC and 48th PSC meeting. During the meeting, all the constituents/SLDC/STU were requested to review the same in their control area and take expedite actions to replace electromechanical relays with numerical relays.

A.10.6 Constituent wise details of static/electromechanical type protection relays at their respective substations along with its present status as per detail received from constituents is attached as Annexure-XI of agenda.

A.10.7 Constituents were requested to share the status of remedial action taken/to be taken regarding replacement of static/electromechanical relay with numerical relays at 220kV & above substations and also expedite the process of replacement of static/electromechanical relay with numerical relays.

A.10.8 NRLDC representative asked members to appraise about the status of electromechanical relays in their respective control areas.

A.10.9 Punjab representative informed that all the electromechanical relays have been replaced with numerical relays. Now, all the relays are of numerical type.

A.10.10 UP representative informed that most of the Main-I & II electromechanical relays have been replaced with numerical relays. Back up relays at some of the stations will also be replaced in near future.

A.10.11 Constituent wise status of bus bar protection as per details received from respective members is attached as **Annexure-X**.

Decision taken by Forum

Forum requested all the constituents to update the status of type of protection relays at S/s of their control area and also expedite the replacement work of static/electromechanical type protection relays with numerical relays.

A.11. SPS for 2X315 MVA, 400/220kV ICTs at Suratgarh Thermal Power Station (Agenda by RVPN)

A.11.1 NRLDC representative apprised that RVPN vide letter dated 21.12.2023 has proposed a SPS for 2X315 MVA, 400/220kV ICTs at Suratgarh Thermal Power Station attached as **Annexure-XI.**

A.11.2 Further, RVPN vide letter dated 10.01.2024 has proposed a revised scheme based on suggestions of NRLDC. The same is attached as **Annexure-XII.**

A.11.3 NRLDC representative shared following observations on revised logic:

i. The SPS seems to provide relief of 50-100MW as seen in simulation studies, therefore if ICTs are loaded beyond 400MW (on both ICTs), the SPS relief may not be able to provide the required relief.

ii. RVPN may confirm that there is no possibility of tripping any other feeders nearby for SPS operation i.e. 220kV Suratgarh-Suratgarh D/C and 220kV Suratgarh-Rawatsar etc.

iii. RVPN may make sure that the transformer overcurrent settings have delay of atleast 1.4 sec (as per logic proposed by RVPN) even if it is loaded to 150-180% of rated capacity.

iv. Since the signal is being transferred to other 220kV /132kV substations such as Udyogvihar/Halasar/Bhadra etc. it is requested to make sure that the signal is reaching and activating trip signal within the permitted time i.e. time required for communication of signal may be checked and it may be ensured that load relief is provided before tripping of ICTs on overloading.

A.11.4 RVPN was requested to share their confirmation on the aforementioned points.

A.11.5 RVPN representative informed that feeders considered for load relief have been made radial and will provide the desired load relief. On ICT tripping on overcurrent, it was informed that ICT will easily survive for 02 seconds in case of 200% overloading also. Hence, it won’t trip before operation of SPS. On communication of SPS signals, it was informed that communication team has reviewed the time delay in communication of SPS signals to feeders/transformers and ensured that SPS logic will work in order.

Decision taken by Forum

With the confirmation of RVPN on aforementioned observations, forum approved the SPS for 2X315 MVA, 400/220kV ICTs at Suratgarh Thermal Power Station and directed RVPN to proceed further to implement the approved SPS.

A.12. Analysis of the tripping events occurred during September-2023 to December-2023 and status of remedial action taken (agenda by NRLDC)

A.12.1 NRLDC representative apprised that the list of major tripping events occurred during September-2023 to December-2023 was attached as Annexure-XV of Agenda. Concerned constituents/utilities are requested to share the detailed analysis of the tripping elements along with status of remedial action taken/to be taken.

A.12.2 He highlighted that as per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event and as per IEGC clause 37.2 (e), the 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 RLDC and RPC.

A.12.3 Further the following tripping events were discussed as below-

A. Multiple elements tripping at 400/220kV Rosa (UP) on 07th Sept 2023, 12:37 hrs

1. **Discussion during the meeting:**
   a. **NRLDC representative raised following points during the meeting:**
      - 400/220kV Rosa (UP) S/s has double main transfer bus scheme as 400 & 220kV level.
      - During antecedent condition, 300 MW Rosa TPS – UNIT-2 (connected at 220kV side) was carrying approx. 282MW and 400/220kV 200MVA ICT-1&2 were carrying approx. 65MW each.
      - As reported, at 12:37 hrs, R-Y fault occurred on 220kV Rosa-Badaun (UP) Ckt-2. Rosa end distance protection sensed fault in Z-2 (93km). Line CB at Rosa end didn't open and LBB also failed to operate.
      - Further, adjacent 220kV feedres at Rosa and tripped from remote end and 400/220kV 200MVA ICTs at Rosa tripped on O/C E/F protection operation.
      - At the same time, 300 MW Rosa TPS - UNIT 2 tripped on standby earth fault protection operation and 220kV Shahjahanpur (PG)-Shahjhanpur (UP) Ckt also tripped from Shajhanpur(PG) end only. (as per SOE).
      - As per PMU at Bareilly (PG), R-Y phase to phase fault with delayed clearance in 1280msec is observed.
      - Generation loss of approx. 282MW occurred due to tripping of 300 MW Rosa TPS - UNIT 2. As per SCADA, no change in demand of Haryana control area is observed.
      - Major observations:
        - Reason of occurrence of fault?

- Why did breaker of the 220kV Rosa-Badaun(UP) Ckt-2 not open from Rosa end? Mechanical healthiness of CB needs to be ensured.
- Why did LBB of 220kV Rosa-Badaun(UP) Ckt-2 not operate? Necessary corrective actions need to be taken to avoid such events in future.
- On which protection 220kV Shahjahanpur (PG)-Shahjhanpur (UP) Ckt tripped from Shahjhanpur (PG) end?
- DR/EL of all the elements need to be shared for both the ends.
- Remedial action taken report need to be shared.

b. UPPTCL representative and others informed the following:

- R-Y fault occurred on 220kV Rosa-Badaun ckt-2 due to snapping of earth wire & R-ph conductor and damage of tower cross arm at distance ~93km from Rosa end, Z-2 from Rosa end.
- Line CB of 220kV Rosa-Badaun ckt at Rosa end didn't open. During investigation, both the trip coils along with DC supply fuses of the breaker found blown due to suspected mechanical jamming at the R pole.
- LBB protection also didn't operate. During investigation it was found that ''locked CZ'' alarm was found which means LBB check zone was in locked state due to communication issue.
- Further, fault cleared with the tripping of lines from remote end and Units at Rosa also tripped on standby earth fault protection.
- Communication issue of LBB relays has been rectified.
- Third party testing of M-1 and M-2 Relay of 220 KV Rosa Badaun Ckt-2 at Rosa end has been done. Detailed test report has already been submitted to UPSLDC on dated 17.10.2023.
- 220kV Rosa-Badaun ckt-2 tripped on 28th Dec-23 under Z-1 protection. No protection abnormality observed during the tripping incident.

NRLDC representative deliberated that alarm/flags within time can avoid further maloperation / misoperation of protection system. Alarms / flags coming in the stations need to be attended on priority. Frequent review of electrical and mechanical healthiness of switchgear elements needs to be done.

2. ***Forum Recommendations:***
   - *Attending the alarms/flags within time can avoid further maloperation / misoperation of protection system. Alarms / flags coming in the stations need to be attended on priority.*
   - *Frequent review of electrical and mechanical healthiness of switchgear elements needs to be done.*
   - *UP-SLDC may share the report of third-party protection review conducted at 220kV Rosa (UP).*

B. Multiple elements tripping at 220kV Kunihar(HP) on 06th Sept 2023, 06:44 hrs

1. **Discussion during the meeting:**
   a. **NRLDC representative raised following points during the meeting:**
   - As reported, at 06:44 hrs, 220 KV Kunihar-Baddi ckt-1&2 tripped on over current earth fault protection operation. (Exact reason and location of fault yet to be shared)
   - At the same time, 220 kV Jeori-Kunihar(HP) Ckt, 220 kV Kunihar-Pinjore(HP) Ckt also tripped on overvoltage.
   - With the tripping of aforementioned elements load of 220/132kV Kunihar (HP) got affected.
   - As per PMU, Y-B fault converted into three phase fault with delayed clearance in 880msec is observed.
   - As per SCADA, change in demand of approx. 150MW in HP control area and and HP hydro generation loss of approx. 40MW (Bhabha HEP) is observed.
   - Further at 07:22 hrs, while restoration again multiple elements tripping occurred at Kunihar S/s and 220/132kV Kunihar S/s became dead.
   - As per PMU & DR, no fault was in system at 07:22hrs.
   - As per SCADA, change in demand of approx. 250MW in HP control area and is observed at 07:22hrs.
   - Major observations:
     - Exact nature and location of fault need to be shared.

- Reason of delayed clearance of fault also need to be shared.
- Over voltage protection in 220kV lines need to be kept disabled.
- Details of protection operation at remote susbstation also need to be shared.
- SCADA data at 220kV Bhaba(HP) was freezed during the event. Availability and healthiness of SCADA data need to be ensured.
- DR/EL need to be shared for all the tripped elements for both ends.
- Remedial action taken report need to be shared.

b. HP representative and others informed the following:

➢ Analysis report of the event is yet to be received. Protection review at Kunihar was done and there are protection related issues which are to be attended.

NRLDC representative raised concerned over no submission of analysis of multiple elements tripping events at Kunihar, Baddi complex of HP control area. Details of fault, DR/EL of tripped elements also not received. In view of frequent grid events in Kunihar, Baddi complex of HP control area wherein load in range of 500-600MW gets affected, third-party protection audit need to be conducted and necessary corrective action need to be taken to minimise occurrence of such events.

2. Forum Recommendations:

➢ *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*

➢ *Healthiness of protection system need to be ensured to avoid delayed clearance of faults.*

➢ *HP shall expedite the conduct of third-party protection audit of 220kV Kunihar, Baddi S/s and submit the report to NRPC/NRLDC.* Necessary corrective action needs to be taken to minimise occurrence of such events.

C. Multiple elements tripping at 220 kV Badarpur (DTL) Station at 10th September 2023, 17:08 hrs

1. **Discussion during the meeting:**
   a. **NRLDC representative raised following points during the meeting:**
      - 220kV Badarpur (DTL) has double main single breaker bus scheme. It has source from 220 kV Tuglakabad-Badarpur (DTL) Ckt-1&2 and 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-1&2.
      - During antecedent condition, part load of 220kV Okhla and 220kV Sarita Vihar was fed from 220kV Badarpur (DTL) via 220kV Badarpur-Okhla ckt-1&2 and 220kV Badarpur-Sarita Vihar ckt-1&2 respectively.
      - As reported, at 17:08hrs, R-ph conductor near wavetrap of 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-2 at Badarpur end damaged and created R-N fault.
      - As per DR of Ballabhgarh(BB) end, R-N fault followed by Y-N & B-N fault with total fault clearance time of ~800msec is observed. Fault distance recorded at Ballabhgarh end was ~24.7km.
      - As reported, on this fault, 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-1&2 tripped from Ballabhgarh(BB) end only, 220 kV Tuglakabad-Badarpur (DTL) Ckt-1&2 tripped from Badarpur end in Z-4 and 220kV Badarpur-Okhla ckt-1&2 tripped on O/C E/F protection operation.
      - As per PMU at Ballabhgarh (PG), R-N fault which later converted into three phase fault with fault clearance time of ~1240msec is observed.
      - With the tripping of aforementioned lines, 220kV Badarpur S/s became dead and load feeding from Badarpur to 220kV Okhla and 220kV Sarita Vihar affected.
      - As reported by SLDC-Delhi, load loss of approx. 125MW is occurred in Delhi control area.
      - At 17:13 hrs, 220kV bus coupler breaker at Sarita Vihar S/s and Okhla S/s was closed and load was normalized.
      - Major observations:
        - Exact location and nature of fault?
        - Reason of delayed clearance of fault?
        - DR/EL of all the tripped elements need to be shared.

- Remedial action taken report to be shared.

b. DTL representative and others informed the following:

- Fault occurred on 220kV Badarpur-Ballabhgarh ckt-1, fault occurred between CT and wave trap.
- Initially, Badarpur end distance protection didn't sense the fault, during investigation it was found that fault resistance was around ~2ohm 9high resistance fault).
- Further, within next ~500msec, Ballabhgarh ckt-1&2 tripped from remote end and Okhla ckt-1&2 tripped from Badarpur end on O/C E/F protection operation.
- With the tripping of aforementioned elements, fault resistance reduced to ~0.5ohm and then distance protection relay of 220kV Badarpur-Ballabhgarh ckt-1 at Badarpur end sensed the fault in Z-4 and subsequently initiated tripping from Badarpur end.
- Resistive reach setting at Badarpur end has been increased.

2. Forum Recommendations:

- *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*
- *Healthiness of protection system need to be ensured to avoid delayed clearance of faults.*

D. Multiple elements tripping at 400/220 kV Azamgarh (UP) Station at 11th September 2022, 05:36 hrs

1. Discussion during the meeting:

a. NRLDC representative raised following points during the meeting:

- 220/132kV Azamgarh2(UP) S/s has double main transfer bus scheme at both 220 & 132 kV level.

- As reported, at 05:36 hrs, 220kV Bus-bar protection operated at Azamgarh2(UP) which resulted into tripping of all the elements connected to 220kV Bus-1 & 2 at Azamgarh2(UP). (Exact reason of busbar protection operation yet to be shared)
- Due to loss of supply at 132kV level of Azamgarh2(UP), both 132kV Bus-1 & 2 at Azamgarh2(UP) also became dead which resulted into total blackout of 220/132kV Azamgarh2(UP) S/s.
- As per PMU at Varanasi (PG), Y-N phase to earth fault with fault clearance time of 80ms is observed.
- As per SCADA, change in demand of approx. 465MW is observed in UP control area.
- Major observations:
  - Exact nature and location of fault?
  - Exact reason of busbar protection operation needs to be shared.
  - DR/EL of all the elements need to be shared for both the ends.
  - Remedial action taken report need to be shared.

b. UPPTCL representative and others informed the following:

- Y-ph bus fault occurred due to damage of Y-ph CT of bus coupler. As fault occurred on bus coupler, both zone-1 and zone-2 of bus bar protection operated.
- Time sync of the DR has been corrected.
- Damaged CT has been replaced.

2. PSC Recommendations:

- *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*
- *DR standardisation (time sync and nomenclature) need to be ensured.*

E. Multiple elements tripping at 400/220 kV Obra_B(UP) Station at 13th September 2023, 07:50 hrs

1. **Discussion during the meeting:**
   a. **NRLDC representative raised following points during the meeting:**
      - During antecedent condition, 200 MW Obra TPS - UNIT 12 was running through station transformer and generating approx. 124MW.
      - As reported, at 07:50 hrs, 400/220 KV 315 MVA ICT-1 at Obra-B(UP) tripped on R-ph differential protection operation due to blast of 220kV R phase bushing of transformer. Firefighting system installed to protect ICT from fire, operated automatically and protected the complete transformer from the spreading of fire and further damage to other equipment and ICT itself.
      - At the same time, 400/220 KV 315 MVA ICT-2 and 240 MVA ICT-3 at Obra-B(UP) also tripped on over-current earth-fault protection operation.
      - During the same time, “SPS related to overloading of remaining ICT after tripping of any ICT at Obra TPS” operated and 220kV Obra-A(UP)-Rewa Road (UP) Ckt-1 & 2 and 220kV Obra-A(UP)-Mirzapur (UP) Ckt tripped.
      - As per PMU at Allahabad (PG), R-N phase to earth fault with fault clearance time of 80ms is observed.
      - As per SCADA, change in demand of approx. 345MW is observed in UP control area.
      - As reported by SLDC-UP, load loss of approx. 308MW is observed in UP control area and generation loss of approx. 124MW is observed at Obra-B(UP).
      - Major observations:
        - As per SCADA, loading of ICTs before the incident were within permissible limit. Hence, it is suspected that loading of ICT-2 and 3 increased above 70% of rated current after tripping of ICT-1 and due to tripping of ICT-3 (as per SCADA SOE) SPS Case-3 operated. Exact sequence of the event needs to be shared.
        - Why did 400/220kV ICT-2&3 trip as fault was in ICT-1?
        - DR/EL of all the elements need to be shared for both the ends.
        - Remedial action taken report need to be shared.

b. UPPTCL representative and others informed the following:

- Fault occurred due to damage of R-ph bushing of 315MVA ICT-1. 20kV Amritsar-Verpal ckt-2 due to R-ph CT damaged at Verpal end. At the same
- At the same time, ICT-2 & 3 also tripped on O/C E/F protection operation.
- SPS case-3 is not implemented on site due to issue in logic implementation.
- Tripping of 220kV feeders occurred due to operation of SPS case-2, as current in ICTs reached to ~105% after tripping of ICT-1.

NRLDC representative raised concern over tripping of ICT-2&3 as fault cleared instantaneously. DR of ICT-3 also not received.

2. PSC Recommendations:

- *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*
- *Further review and detailed analysis of tripping event need to be done and detail report of the same need to be submitted to NRLDC & NRPC.*

F. Multiple elements tripping at 220kV Hissar_IA(Har) Station on 05th October 2023, 09:28 hrs

1. Discussion during the meeting:

a. NRLDC representative raised following points during the meeting:

- During antecedent condition, 220kV Hissar_IA(Har)-Masudpur Ckt 1 & 2 and 220/132kV 100MVA ICT-1 at Hissar_IA(Har) were already in open condition.
- As reported, at 09:28hrs, sparking was observed on the B-phase of 220 kV Bus Isolator of 220kV Hissar_IA(Har)-Hissar(PG) ckt-1 at Hissar_IA(Har) end.

- As per DR at Hissar_IA(Har), Bus Bar differential protection operated at 220kV level of Hissar_IA(Har) which led to tripping of all the elements connected to both the buses. (Exact reason of tripping of both the buses yet to be shared)
- Due to tripping of all the elements connected to both the buses, both 220kV Bus-1 & 2 at Hissar_IA(Har) and eventually the complete 220kV Hissar_IA(Har) S/s became dead.
- As per PMU at Hissar(PG), B-N phase to earth fault with fault clearing time of 80ms is observed.
- As per SCADA, change in demand of approx. 90MW is observed in Haryana control area. But as reported by SLDC-Haryana, change in demand of approx. 300MW is observed in Haryana control area.
- Major observations:
  - Exact reason of tripping of both the buses needs to be shared. Whether bus bar protection operated in both the buses? If yes, then why? Whether there is any issue with bus coupler opening?
  - DR of Hissar_IA(Har) are not time synced, time syncing of all the recording devices/software need to be ensured.
  - DR/EL of all the tripped elements along with tripping report of the event need to be shared from BBMB and PGCIL end.
  - Proper maintenance of protection equipment and their healthiness need to be ensured.
  - Remedial action taken report to be shared.

b. HVPNL & BBMB representative and others informed the following:

- 220kV Hissar_IA(Har) is having double main bus scheme.
- During antecedent condition, 220kV Bus-1 was under shutdown for maintenance activity. All the elements were connected at 220kv Bus-2.
- At 09:28 hrs, bus fault occurred on 220kV Bus-2, heavy sparking occurred on the old/obsolete 220 kV Bus isolator of 220kV Hissar_IA – Hissar_PG ckt-1.
- On this bus fault, bus bar protection of 220kV Bus-2 operated and all the elements connected at 220kV Bus-2 tripped.
- Issue of time sync of DR will be resolved on priority.

- BBMB representative informed that 220kV Hissar_IA- Hissar(BBMB) ckt-1&2 sensed fault in Z-1 at Hissar(BB) end due to overreach of distance protection at Hissar(BB) end due to short line.

NRLDC representative stated that in 47th PSC meeting PSC forum had recommended to implement line differential protection in 220kV Hissar_IA-Hissar(BBMB) ckt-1&2 to avoid unnecessary tripping of multiple lines in Hissar region due to overreach of distance protection in short lines. Haryana and BBMB agreed to implement the line differential protection however, implementation is still pending. It needs to be expedited.

2. PSC Recommendations:

- *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*
- *Time sync of DR at Hissar_IA end need to be done at the earliest.*
- *Haryana & BBMB shall expedite the Implementation of line differential protection in* 220kV Hissar_IA- Hissar(BBMB) ckt-1&2.

G. Multiple elements tripping at 765kV Koteshwar(PG) & 765kV Meerut(PG) stations on 12th October 2023, 15:36 hrs

1. Discussion during the meeting:

a. NRLDC representative raised following points during the meeting:

- 765/400kV Koteshwar(PG) has one and half breaker scheme at 765kV level and double main bus scheme at 400kV level. During antecedent condition, only 100MW Unit-1 at Koteshwar HEP was in running condition and was generating approx. 90MW and active power loading on 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 & 2 was approx. 45MW each.
- As reported, at 15:36hrs, “Protection operated in FSC” signal came at Meerut (PG) end which tripped group relays and sent DT to Koteshwar(PG). 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 & 2 tripped due to DT received at Koteshwar(PG) end.
- During the same time, 100MW Unit-1 at Koteshwar(TH) tripped on over-excitation due to loss of evacuation path.

- CBs from both the ends of 400kV Koteshwar(PG)-Tehri(TH) (PG) Ckt-1 & 2 and 400kV Koteshwar(PG)- Koteshwar (TH) (PG) Ckt-1 & 2 opened due to safety purpose.
- Due to this tripping, complete blackout occurred at 765/400kV Koteshwar(PG) & 400kV Koteshwar(TH).
- Although no generation was there at Tehri (TH) during the event time, but Tehri (TH) generation was affected from 16:00hrs to 17:14hrs.
- As per PMU Meerut (PG), no fault is observed in the system.
- As per SCADA, change in generation of approx. 90MW is observed at Koteshwar(TH).
- Major observations:
  - DR/EL of all the tripped elements, sequence of event along with tripping report of the event need to be shared.
  - Reason of DT sent from Koteshwar (THDC) end need to be shared.
  - Remedial action taken report to be shared.

b. POWERGRID representatives and others informed the following:

- Total generation of Koteshwar HEP and Tehri HEP is pooled at Koteshwar(PG) and evacuates through 765kV Koteshwar-Meerut D/C. Both the 765kV lines have FSC at Meerut end.
- Planned Shut down for AMP of bay no 705 availed on 12.10.2023 at 09.55 hrs. After isolation of Circuit Breaker (70552), isolators (70589A&B) and closing of Bay E/S (70589AE and BE1), it was observed that DC earth fault appeared in both sources simultaneously construing that both DC sources are mixed. However, DCEF in source-2 got reset but DCEF in Source 1 could not be reset due to persisting nature.
- As per information received from site, troubleshooting of DCEF was carried out and identified wiring in 70589 BE1 (Master MB) DC power cable looped to F1 MB box of 70589BE1. Cable termination was removed and found that DC1 Earth fault reset.
- At 15:36:01.821 Hrs DCEF in 220V source 1 appeared again. As DC supply is common for all the elements, CTs in all the bays went under CT SF6 lockout. There is no tripping logic for CT SF6 lockout in all the

bays. From SER it was observed that multiple events triggered from Main 1 relays & BCUs during event.

- In FSCs there is protection for DC earth fault in which tripping of line is initiated. At 15:36:01.852 Hrs, both the line tripped from Meerut end and Direct Trip signal sent from Meerut end to Koteshwar end in both circuits. As per DR analysis of main1 relay of both lines, it is observed that FSC operated Binary input became multiple times high and low (approx 6-9 ms pick up and 2-4 ms drop suggesting AC supply mixed up at the time of triggering) at Meerut end in both CKts. Meerut Koteshwar lines (DC) have FSCs installed at Meerut end.
- Relay internal logic is such that when FSC protection operates on permanent fault (viz. platform fault), line will get trip and DT will be sent to remote end. However, the FSC lockout/trip relays are removed from respective FSC protection panel due to outage of FSC platform since long time. Only Binary Inputs became high in Main1 Relays which lead to tripping.
- Due to tripping of 765kV Koteshwar-Meerut D/C evacuation path for Koteshwar HEP and Tehri HEP lost.
- IR test of suspected FSC cable from Main 1 trip relay to FSC CRP carried out and found in order. (>300 M Ohm)
- The troubleshooting carried out by further tracing of DC earth fault in Bay 705 BE1 earth switch. A mysterious loop wire (without ferrule) found in follower-1 MB between X1: 142 to X1: 400 leading mixing of 220V DC1 negative to 230 VAC phase wire. By removing of the loop wire, DC source 1 normalized in Earth Switch MB master and follower both.
- It is concluded that due to mixing of 230 AC supply with 220V DC1 during EF of DC1, multiple binary signals became high in BCUs and DC1 connected relays viz Main1 distance. CT SF6 lockout signals also appeared high but due to trip modification vide recent AM circular, tripping not occurred on CT SF6 lock out. Mixing of 230 AC supply with 220V DC1 occurred due to some maloperation by electrician during AMP work.

- Audit of DC system at Meerut and other stations was done. All the issues related to source mixing between DC supply and between DC & AC supply have been rectified. Now, DC supply is healthy.
- As Koteshwar(PG) GIS became dead, all the elements at Koteshwar(PG) were opened for further restoration of dead Koteshwar(PG) GIS.

2. *PSC Recommendations:*

- *Proper standard operating procedure need to be followed during any maintenance work to avoid occurrence of such event in future due to maloperation.*
- *Healthiness of DC system also need to be ensured.*

H. Multiple elements tripping at 400kV Uri-I & Uri-II (NHPC) on 14th October 2023, 04:23 hrs

1. <u>Discussion during the meeting:</u>

a. NRLDC representative raised following points during the meeting:

- During antecedent condition, 60 MW Unit-2 & 3 at Uri-2(NH) were running and generating approx. 36MW each and total MW generation of 72MW was evacuating through 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt and 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt.
- As reported, at 04:23hrs, 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt tripped on B-N phase to ground fault with fault current of approx. 1.89kA and fault distance of 11.87km from Wagoora(PG) end due to heavy wind and storm in the area.
- As per DR, 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt also tripped on B-N phase to ground fault at the same time with delayed fault clearance time of approx. 690ms and fault current of approx. 2.53kA from Uri-2(NH) end. Over-current protection operated at both Uri-1(NH) and Uri-2(NH) end as per DR.
- Due to tripping of both the lines, 60 MW Unit-2 & 3 at Uri-2(NH) tripped on over-excitation due to loss of evacuation path.
- On this, complete blackout occurred at 400kV Uri-2(NH).

- As per PMU at Wanpoh(PG), two consecutive B-N phase to ground fault is observed in the system with delayed fault clearance time of 720ms and 440ms respectively.
- As per SCADA, generation loss of approx. 72MW is observed at Uri-2(NH).
- Major observations:
  - According to Protection Philosophy of Northern region, no over-current protection should be applied on 400kV lines. Then why 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt tripped on over-current protection operation?
  - Reason of delayed clearance of fault need to be shared.
  - DR/EL of all the tripped elements along with tripping report of the event need to be shared for both the ends for proper analysis of the event.
  - Remedial action taken report to be shared.

b. NHPC representative and others informed the following:

- B-N fault occurred on 400kV Uri-II-Wagoora ckt at distance ~11km from Wagoora end, fault was in Z-1 from Wagoora end and in Z-2 from Uri-II end. Line length of 400kV Uri-II-Wagoora ckt is ~115km.
- On this fault, B-ph A/R started from Wagoora end and carried sent to Uri-II end. Line successfully autoreclosed from Wagoora end.
- At Uri-II end, Main-I&II relay initiated R-Ph A/R on Z-2 + carrier received however, R-ph pole didn't open and Z-2 also got reset. After further ~600msed Z-2 again started and relay initiated 3-ph tripping with A/R lockout. Hence, during 1st incidence of fault, Main-I&II relay at Uri-II end maloperated leading to delayed clearance of fault.
- As fault cleared with the delay from Uri-II end and Uri-I was also feeding the fault, during the same time, 400kV Uri-II-Uri-I ckt also tripped on over current protection operation with the delay of ~690msec.
- Over current protection in 400kV Uri-II-Uri-I ckt is kept to avoid overloading of 400kV Uri-II-Wagoora ckt in case of loss of evacuation path of Uri-I from Amargarh. Overcurrent protection was kept after approval in PSC meeting in past.

- Relay testing of Main-I&II relay at Uri-II end has been done and no discrepancy was found. Further review by superimposing same event will be done by availing shutdown in Feb24.
- POWERGRID & NHPC representatives agreed to review the over current protection in 400kV Uri-II-Uri-I ckt. As per NR protection philosophy, phase over current protection shouldn't be kept in 220kV & above line.

2. ***PSC Recommendations:***
   - *Proper monitoring and healthiness of protection system need to be ensured.*
   - *NHPC shall review the Main-I&II relay at Uri-II end in 400kV Uri-II-Wagoora ckt and ensure its proper operation in future.*
   - *POWERGRID and NHPC shall review the over current protection in 400kV Uri-II-Uri-I ckt. As per NR protection philosophy, phase over current protection shouldn't be kept in 220kV & above line.*

I. Multiple elements tripping at 220kV Agra2(UP) on 22nd October 2023, 06:00 hrs

1. <u>**Discussion during the meeting:**</u>
   a. **NRLDC representative raised following points during the meeting:**
   - 220/132kV Sikandra (Agra2) (UP) S/s has double main transfer bus scheme at 220kV level. However, during antecedent condition, all the elements were connected to 220kV Bus-1 only. 220kV Bus-2 and transfer were not in service condition.
   - As reported, at 06:00 hrs, 220 KV Auraiya(NT)-Agra2(UP) (PG) Ckt-1&2 tripped. At the same time, bus bar protection of 220kV Bus-1 at 220kV Agra2(UP) operated and as all eleemnts at Agra2(UP) were connected to 220kV Bus-1 only, all 220kV element at Agra2(UP) tripped. Details related to exact location and nature of fault yet to be received from UP.
   - As per PMU at Agra (PG), B-N phase to earth fault with unsuccessful A/R operation is observed. As per SCADA SOE at NRLDC, it seems that A/R operation occurred in 220kV Agra1(UP)-Agra2(UP) ckt-1. UP

has been communicated to share the DR/EL to ascertain the exact sequence of the event.

- Due to tripping of 220kV Bus-1, supply to 132kV side of Sikandra (Agra2) (UP) also lost which resulted into total blackout of 220/132kV Sikandra (Agra2) (UP) S/s.
- As per SCADA, change in demand of approx. 100MW is observed in UP control area.
- Major observations:
  - Exact location and nature of fault?
  - Why did bus bar protection operate at 220kV Agra2(UP)?
  - Why did 220kV Bus-2 and transfer bus at Agra-2(Sikandra) were not in service?
  - DR/EL of all the elements need to be shared for both the ends.
  - Exact sequence of the event needs to be shared.
  - Remedial action taken report need to be shared.

b. UP representative and others informed the following:

- During antecedent condition, all the elements were connected at 220kV Bus-1.
- B-N phase to earth fault occurred at ~2.7km from Agra_2(Sikandra) end in 220kV Agra_2-Agra_1 ckt. At the same time, fault occurred in core-2 of bus bar.
- Bus bar relay operated and as all the elements were connected to single bus, all the elements tripped.
- NRLDC representative raised concern over using only single bus at Agra2(Sikandra) even when there is double main transfer bus scheme.
- UP representative informed that practise of using single was there since past at Agra2. However, from November 2023, elements were equally divided on both the bus and both 220kV bus is in use.

2. PSC Recommendations:

- *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance*

Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.

J. Multiple elements tripping at 400kV Dadri (NTPC) and Dadri HVDC on 04th November 2023, 04:03 hrs

1. **Discussion during the meeting:**
   a. **NRLDC representative raised following points during the meeting:**
      - 400kV Dadri TPS(NTPC) has one and half breaker bus scheme. There are 04 buses at 400kV side. Bus-I, II and Bus III, IV are separated via interconnector. 490MW Units-5&6 are connected at Bus-III, IV side.
      - During antecedent condition, interconnectors were in opened condition. 490MW Unit-5 was not running and 490MW Unit-6 was generating approx. 455MW. HVDC Rihand-Dadri Bipole was carrying total ~600MW.
      - As reported, at 04:03:05:240 hrs, B-N phase to earth fault occurred on 400kV Dadri-Mandola ckt-1. Fault distance was approx. 100meter from Dadri TPS end. This fault was sensed by both the ends in Z-1. After ~160msec (08 cycles) of fault, B-ph pole of CB at both then ends opened and A/R started. Further after ~1sec (dead time), line successfully auto reclosed due to transient nature of fault. Delayed tripping initiation in Z-1 was due to Z-1 time delay setting which was kept as 100msec instead of instantaneous. As informed by NTPC Dadri, Z-1 time delay has been set as 0 sec (instantaneous).
      - As per PMU & DR of 400kV Dadri-Mandola ckt-1, B-N phase to earth fault with successful A/R operation is observed. Steady state fault current was approx. 35kA, and transient fault current magnitude was ~52kA.
      - On this fault, commutation failure at HVDC Rihand-Dadri occurred and power order dropped to zero (0).
      - Distance protection relay at Harshvihar end of 400kV Dadri-Harshvihar ckt-2 sensed the fault on 400kV Dadri-Mandola ckt in Z-1 and successful autoreclosed from Harshvihar end. Dadri end relay sensed fault in Z-4 as fault was in reverse direction however as informed by

Dadri, instant three phase tripping occurred on DT received from Harshvihar end. Reason of DT received at Dadri end is yet to be identified.

- During fault time, over voltage of the magnitude of approx. 723kV in 400kV Dadri-Mandola ckt-2 and Dadri end and approx. 560kV in 400kV Bus-2 at Dadri TPS is observed (as per PMU at Dadri TPS). Over voltage sustained for approx. 100msec
- On this over voltage, 400kV Dadri-Mandola ckt-2 tripped on over voltage stage-2 protection operation at Dadri end.
- At the same time, all three filter banks connected at Dadri HVDC tripped on over voltage protection operation. As reported by POWERGRID, over voltage protection of filter banks is 489.89kV with 20msec pickup time delay.
- Due to tripping of filter banks, HVDC Rihand-Dadri Bipole got blocked.
- From DR & PMU voltage plots, over voltage didn't occur in other 400kV elements at Dadri TPS.
- On overvoltage in Mandola ckt-2, Dadri TPS informed that neutral of CVT at Main 1 relay found opened at Dadri end which led to rise in voltage at secondary side. Reason of over voltage in 400kV Bus and Dadri HVDC bus is yet to be identified.
- Major observations:
  - Reason of over voltage in 400kV Bus need to be identified.
  - Mismatch is suspected in nomenclature of 400kV Bus at Dadri TPS in SCADA & PMU, it needs to be checked.
  - DRs at Dadri TPS end are not time synced. Time sync of DR with GPS need to be ensured.
  - Remedial action taken report to be shared.

b. NTPC & POWERGRID representative and others informed the following:

- Over voltage in Mandola ckt-2 observed due to issue in CVT secondary circuit. During inspection, multiple earthing was observed. Issue was rectified.

- To inspect the overvoltage in 400kV extended bus at HVDC Dadri, shutdown of bus-1 was taken, comprehensive inspection of secondary circuit was done. No discrepancy was found in secondary circuit.
- Discussion with OEM ABB was also done regarding increasing of time delay of tripping of HVDC filters on overvoltage. As per present settings, tripping initiated within 5-6msec on over voltage. OEM ABB recommended not to increase the time delay setting to ensure reliable and secure operation of HVDC system.
- NTPC representative informed that time syncing of DR is yet to be done at Dadri TPS.
- NTPC also agreed to review the nomenclature of bus name in PMU & SCADA in coordination with POWERGRID.

2. *PSC Recommendations:*

- *Proper monitoring, healthiness and maintenance of protection system need to be ensured.*
- *NTPC shall review the* nomenclature of bus name in PMU & SCADA in coordination with POWERGRID.
- *Reason of overvoltage reflected in one of the Dadri NTPC bus and in extended bus at Dadri HVDC is yet not clear. Necessary inspection/remedial action may be taken at Dadri NTPC and POWERGERID to avoid such incidents in future.*

K. Multiple elements tripping at 220kV Ropar GGSTP (Guru Gobind Singh TPS) on 30th November 2023, 06:51 hrs

1. <u>Discussion during the meeting:</u>

a. NRLDC representative raised following points during the meeting:

- 220/132kV Ropar GGSTP(PS) has main and transfer bus scheme at 220kV level.
- During antecedent condition, 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 4 (carrying ~164MW), UNIT 5 (carrying ~148MW) & UNIT 6 (carrying ~151MW) and 220kV feeders to Kharar, Mohali & Go-

bindgarh-2 were connected to 220kV main Bus section-III. Rest of the elements were connected to main Bus section-I & II.

- As reported, at 06:51 hrs, 220kV GGSTP-Kharar Ckt tripped on R-N phase to earth fault (zone-1 distance protection operated) with fault current of 4.071kA and fault distance of 33.91km from GGSTP end. Fault occurred due to heavy lightening.
- On this fault, all other elements connected to 220kV main Bus section-III tripped. (Exact reason yet to be shared)
- As reported by GGSTP Ropar, 220kV GGSTP-Bassi Pathana Ckt (connected to 220kV main Bus section-I) and 220kV GGSTP-Gobindgarh Ckt-1 (connected to 220kV main Bus section –II) also tripped during the same time. (Exact reason yet to be shared)
- As per SCADA SOE, 66kV Morinda-Kharar(PS) ckt also tripped at the same time. (Exact reason yet to be shared)
- As per PMU at Jalandhar (PG), R-N phase to earth fault is observed with delayed fault clearance time of 440ms.
- As per SCADA, generation loss of approx. 463MW occurred at Ropar GGSTP.
- As per SCADA load loss of approx. 60MW is observed in Punjab control area.
- Major observations:
  - Details of protection operated in all other elements connected to 220kV main Bus section-III need to be shared.
  - Exact reason of tripping of 220kV GGSTP-Bassi Pathana Ckt (connected to 220kV main Bus section-I) and 220kV GGSTP-Gobindgarh Ckt-1 (connected to 220kV main Bus section –II) need to be shared.
  - Reason of delayed clearance of fault need to be shared.
  - DR/EL of each tripped element along with tripping report of the event need to be shared from both the ends.
  - Remedial action taken report to be shared.

b. Punjab representative and others informed the following:

- R-N fault occurred on 220kV Ropar-Kharar line (connected at 220kV Bus-3 at Ropar), fault occurred at distance ~3km from Kharar end and ~33km from Ropar end.
- On this fault, line tripped from Kharar end after unsuccessful A/R operation on permanent fault. As A/R operation is kept disabled at Ropar end, 3-ph tripping initiated at Ropar end.
- Y & B phase pole opened at Ropar end however, R-ph pole didn't open which further led to operation of its LBB protection operation leading to tripping of all the elements connected at 220kV Bus-3.
- During inspection, it was found that, CB mechanism was in stuck condition and male & female contacts were in damaged condition. Thereafter, breaker was put under overhauling and have been restored back on 07th Dec'23.
- There was issue related to DR time sync found at Kharar end due to issue in GPS which have been attended and issue of DR time sync has been rectified.

2. ***PSC Recommendations:***
    - *Proper monitoring, healthiness and maintenance of protection system need to be ensured.*
    - *Timely submission of disturbance recorder (DR) and event logger (EL) files need to be ensured. As per IEGC clause 37.2 (c), Disturbance Recorder (DR), station Event Logger (EL), Data Acquisition System (DAS) shall be submitted within 24 hrs of the event.*
    - *Single phase autoreclsoing need to be enabled at Ropar end to avoid undesired tripping of line during transient fault.*

L. Multiple elements tripping at 800kV HVDC Kurukshetra (PG) on 09th January 2024, 14:00 hrs

1. **Discussion during the meeting:**
    a. **NRLDC representative raised following points during the meeting:**
    - During antecedent condition, 800kV HVDC Champa-Kurukshetra Bi-pole was carrying total 2500MW (625MW each pole).

- As reported at 14:00:20hrs, "commutation failure detected" and “Pole4 Instability Detected by SSAD” protection latched in Pole4 which initiated CATA2 sequence for blocking of Pole4 and isolated Pole4 from parallel Pole2.
- Further after ~800msec of initiation of CATA2 sequence by Pole4 on Instability protection, opening sequence to HVHS at both ends didn't initiate which led to failure of protective isolation of faulty Pole4 and generated CATB alarm leading to tripping of parallel Pole2 also.
- Further at 14:01:17 hrs, 17hrs, “Instability detected” protection latched in Pole1 also which initiated CATA2 sequence for protective isolation from Pole3.
- Further at 14:01:18hrs, like Pole4, CATA2 sequence in Pole1 also failed to initiate HVHS opening leading to protective sequence failure which generated CATB alarm that resulted in tripping of parallel Pole3.
- Due to tripping of all four (04) poles, power order reduced from 2500MW to 0MW.
- As per PMU, fluctuation in power order was observed.
- Major observations:
    - As reported, event occurred during attending LAN card failure related issue. Severe fluctuation in power order was observed during the event, prior intimation or emergency shutdown may be availed during any such LAN card replacement or any other emergency work.
    - Corrective actions taken/planned to be taken to minimise the frequent tripping of HVDC Champa-Kurukshetra Bipole and ensure its reliability?

b. POWERGRID representative and others informed the following:

- GE has recently upgraded the software version to version 6 in which all the control and protection logic has been revised. HVDC system is now little bit better and stable.
- POWERGRID representative stated that there is written procedure from GE to replace the LAN cards in online mode. There are two (02) LAN (1&2) to valve panel (it gives firing to thyristor for power order).

LAN 1&2 are redundant to each other. Event occurred while attending alarm in LAN-1.

- Tripping of Pole 2 & Pole 3 due to failure of Protective Isolation during CAT A2 sequence of parallel Pole is critical issue of new software version installed on 05.01.2024 and need to be addressed on priority to avoid further unwanted tripping of healthy Poles. The same has been intimated to GE for prompt action at their end.
- Further continuous follow ups and necessary actions are being taken in coordination with OEM GE to further strengthen the HVDC Kurukshetra system to minimise the event of outage of HVDC poles.

2. *PSC Recommendations:*

- *In view of frequent outage of multiple poles of HVDC Champa-Kurukshetra inter regional link, POWERGRID shall take necessary remedial and corrective actions to ensure the reliability of HVDC Champa-Kurukshetra.*

A.12.4 Tripping analysis details of all the tripping discussed during 49 PSC meeting is attached as **Annexure-XIII.**

A.13. Submission of protection performance indices to NRPC Secretariat on monthly basis (agenda by NRPC Secretariat)

A.13.1 AEE (P), NRPC apprised that *as per clause 15 (6) of IEGC 2023;*

- *Users shall submit the following protection performance indices of previous month to their respective RPC and RLDC on monthly basis for 220 kV and above (132 kV and above in NER) system, which shall be reviewed by the RPC:*

*a) The **Dependability Index** defined as* $D = Nc/Nc+Nf$

*b) The **Security Index** defined as* $S = Nc/Nc+Nu$

*c) The **Reliability Index** defined as* $R = Nc/Nc+Ni$

where,

Nc is the number of correct operations at internal power system faults, *Nf is the number of failures to operate at internal power system faults,*

Nu is the number of unwanted operations,

Ni is the number of incorrect operations and is the sum of Nf and Nu

- *Each user shall also submit the reasons for performance indices less than unity of individual element wise protection system to the respective RPC and action plan for corrective measures. The action plan will be followed up regularly in the respective RPC.*

A.13.2 The same agenda was discussed in the 48th PSC meeting and decided that each utility shall submit the Performance indices of previous month by 7th day of next month.

A.13.3 AEE(P), NRPC informed that few utilities (HVPN, HPPTCL, THDC-Koteshwar, LPGCL, DTPS- Anpara) have sent the same for January month as of now.

A.13.4 EE (P), NRPC highlighted that reasons and corrective actions are required to be submitted simultaneously for performance indices less than unity.

A.13.5 MS, NRPC stressed that all utilities must comply to the clause of IEGC, 2023 and update the status regularly.

Decision taken by Forum:

Forum requested utilities to submit above performance indices of previous month by 7th day of next month.

A.14. Standardized formats of Disturbance recorder (agenda by BBMB)

A.14.1 BBMB representative stated to have standardized formats of Disturbance recorder.

A.14.2 NRLDC representative mentioned that format has already been finalized in the meeting of Forum of load despatchers. The report of fold working group-3 on disturbance recorder (DR) parameter standardization (attached as **Annexure- XIV**) may be referred for the same.

Decision taken by Forum:

Forum requested members to refer the report of fold working group-3 on disturbance recorder (DR) parameter standardization.

Meeting ended with vote of thanks to the chair.

List of addressee

Members of Protection Sub-Committee*

S. No.	NRPC Member Organization	Designation	Email-ID
1	Member (GO&D), CEA	Director, NPC Division	skdotancea@nic.in
2	CTUIL	Sr.GM	schakraborty@powergrid.in
3	PGCIL	SrGM-AM	DevanandKushwaha@powergrid.in
4	NLDC*	Executive Director	scsaxena@grid-india.in
5	NRLDC*	Executive Director	nroy@grid-india.in
6	NTPC	GM(OS-NR)	dmandal@ntpc.co.in
7	BBMB	Director (P&C)	ddpntjmp@bbmb.nic.in
8	THDC*	ED (PSP&APP)	lpjoshi@thdc.co.in
9	SJVN	Additional General Manager	prakash_chand@sjvn.nic.in
10	NHPC	General Manager (O&M)	hod-om-co@nhpc.nic.in
11	NPCIL*	Director (Finance)	df@npcil.co.in
12	Delhi SLDC	General Manager	gmsldc@delhisldc.org
13	Haryana SLDC	Chief Engineer (SO&C)	cesocomml@hvpn.org.in
14	Rajasthan SLDC	Chief Engineer (LD)	ce.ld@rvpn.co.in
15	Uttar Pradesh SLDC	Chief Enginner attached to Dir (O)	director_op@upptcl.org
16	Uttarakhand SLDC	Chief Engineer	anupam_singh@ptcul.org
17	Punjab SLDC	Chief Engineer	ce-sldc@punjabsldc.org
18	Himachal Pradesh SLDC	Chief Engineer	cehpsldc@gmail.com
19	DTL	AGM-Protection	bharatgujardtl@gmail.com
20	HVPNL	Chief Engineer (TS)	cetspkl@hvpn.org.in
21	RRVPNL	CE (M&P)	ce.mps@rvpn.co.in
22	UPPTCL*	Managing Director	md@upptcl.org
23	PTCUL	SE(T&C)	setandchld@gmail.com
24	PSTCL	Chief Engineer (P&M)	ce-pm@pstcl.org
25	HPPTCL*	Managing Director	md.tcl@hpmail.in
26	IPGCL	GM-T	satyendrap@ipgcl-ppcl.nic.in
27	HPGCL	SE(Tech)	setech@hpgcl.org.in
28	RRVUNL*	CMD	cmd@rrvun.com
29	UPRVUNL	Chief Engineer, (L-2)	ce.ppmm@uprvunl.org
30	UJVNL*	Managing Director	mdujvnl@ujvnl.com
31	HPPCL*	Managing Director	md@hppcl.in
32	PSPCL*	CMD	cmd-pspcl@pspcl.in
33	DHBVN	CTO, DHBVN, Hisar	cto@dhbvn@org.in
34	Jaipur Vidyut Vitran Nigam Ltd.	Chief Engineer (M&P), Jaipur	acempit@jvvnl.org
35	Madhyanchal Vidyut Vitaran Nigam Ltd.*	Managing Director	mdmvvnl@gmail.com
36	UPCL*	Managing Director	md@upcl.org
37	HPSEB*	Managing Director	md@hpseb.in
38	Prayagraj Power Generation Co. Ltd.*	Head (Commercial & Regulatory)	sanjay.bhargava@tatapower.com
39	Aravali Power Company Pvt. Ltd*	CEO	SRBODANKI@NTPC.CO.IN
40	CLP Jhajjar Power Ltd.*	GM-Electrical	navin.chaturvedi@apraava.com
		DGM-Commercial	rajneesh.setia@apraava.com
41	Talwandi Sabo Power Ltd. *	COO	Vibhav.Agarwal@vedanta.co.in
42	Nabha Power Limited*	CEO	sk.narang@larsentoubro.com
43	Lanco Anpara Power Ltd*	President	sudheer.kothapalli@lancogroup.com
44	Rosa Power Supply Company Ltd	GM-ELECTRICAL	kesarinandan.pandey@relianceada.com
45	Lalitpur Power Generation Company Ltd	President	rnbedi.ltp@lpgcl.com
46	MEJA Urja Nigam Ltd.	DGM-EMD	rajeevpandey@ntpc.co.in
47	Adani Power Rajasthan Limited*	COO, Thermal, O&M	jayadeb.nanda@adani.com
48	JSW Energy Ltd. (KWHEP)*	Head Regulatory & Power Sales	jyotiprakash.panda@jsw.in
49	RENEW POWER*	CEO	sumant@renew.com
50	UT of J&K*	Chief Engineer, JKPTCL	sojpdd@gmail.com
51	UT of Ladakh*	Chief Engineer, LPDD	cepdladakh@gmail.com
52	UT of Chandigarh	Executive Engineer	elop2-chd@nic.in
53	BYPL	GM-SO	Som.Dutt@relianceada.com
54	Bikaner Khetri Transmission Limited	AGM- Protection and Metering	ashish.baviskar@adani.com
55	Adani Enterprises	Manager	mayursinhd.gohil@adani.com
*	*Organizations from where nominations are not received for PSC, memebers of NRPC have been mentioned. Nomination may be sent at the earliest.*		

Special Invitees		
S. No.	NRPC Member	E-mail
1	Greenko Group	pratul.g@greenkogroup.com
2	Sravanthi Energy Private Ltd	ktirumalrao@sravanthigroup.com
3	NTPC Renewable Energy wing	AMANNA@NTPC.CO.IN
4	RENEW POWER	sumant@renew.com
5	Adani Power Ltd	rajesh.gupta@adani.com
6	Avaada Energy	dhiren.bhatt@avaada.com
7	Mahindra Solar	KHEDKAR.RAMNATH@mahindra.com
8	ACME Heeragarh Powertech Pvt. Ltd.	planthead.badisidd.solar@acme.in
9	Tata Power Renewable Energy Ltd.	vineet.george@tatapower.com
10	Azure Power Pvt. Ltd.	prajesh.kumar@azurepower.com
11	Thar Surya Pvt. Ltd.	
12	Ayana Renewable Power Pvt. LTd.	arul@ayanapower.com
13	CSP(J)PL, Hero Future Energies	hfe_fns@herofutureenergies.com
14	ABC Renewable Energy(RJ-01) Pvt. Ltd.	shourabhr@brookfieldrenewable.in
15	Eden Renewable Cite Pvt. Ltd.	Jayant.Kumar@eden-re.com
16	ATIL	nihar.raj@adani.com
17	INDIGRID	Lokendra.Ranawat@indigrid.com
18	POWERLINK	sandeep.shukla@tatapower.com
19	ADHPL	sumitgarg@lnjbhilwara.com
20	Sekura Energy Limited	Krishnajith.MU@energy-sel.com

Annexure-P

49th Protection Sub-Committee Meeting on 25.01.2024 (10:30 AM)				
S.N.	**Name**	**Designation**	**Organization**	**E-mail**
1	T. P. Verma	Ch. Manager	CTU	tejprakash@powergrid.in
2	Sachin Singh	DGM (Comml.)	NTPC	sachinsingh@ntpc.co.in
3	Deepak Kumar	Asst. Manager	NRLDC	deepak.kr@grid-india.in
4	Jaganath Pani	Sr. Mgr	NHPC Ltd	jaganathpani@nhpc.nic.in
5	Ajay Kumar Arora	Sr. Maint-Engg.	NPCIL-RAPS	ajayarora@npcil.co.in
6	Rajat Sharma	Sr. Mgr (E)	HPPTCL	smprot1.tcl@hpmail.in
7	Ajay Chaudhary	Sr. Xen	HPSEBL	xen.dnt2020@gmail.com
8	Dharmendra Kumar	AE	HPSLDC	sehpsldc@gmail.com
9	Rajbir Singh Walia	A.S.E	PSTCL	rajbir_walia74@yahoo.com
10	Raman Jain	XEN	RVPNL	rajatsog@gmail.com
11	Prabhat Misra	Deputy Manager	JPL	prabhatkumar.mishra@apraava.com
12	Alok Kumar	Sr. GM	NRLDC, GRID INDIA	alok.kumar@grid-india.in
13	Md. Reza Ahmad	SE	UPPTCL	setnealbd@upptcl.org
14	H.S. Kaushal	Sr. GM	CTU	hsk@powergrid.in
15	Satendra Singh	CE	UPPTCL	satendra@gmail.com
16	Kavindra Singh	Administrator	UPPTCL	skavindra@yahoo.co.in
17	P.K. Mishra	SE	UPPTCL	setncmrt@upptcl.org
18	R.N. Bedi	President O & M	LPGCL	rnbedi.ltp@lpgcl.com
19	K. K. Thappa	SE	JKPTCL	secr1jkptcljmu@gmail.com
20	Arvind Bahuguna	AE	UJVNL	arvind.anvi222@gmail.com
21	Uma Shankar	EE	UJVNL (MB-II)	ujvnlofph@gmail.com
22	Vivek Karthikeyan	AGM	INDIGRID	vivek.karthikeyan7@indigrid.com
23	B.L. Gujar	AGM	DTL	bl.gujar@dtl.gov.in
24	Paritosh Joshi	Sr. Mgr (T)	DTL	paritosh.joshi@dtlgov.in
25	Sandeep Yadav	Chief Manager	POWERGRID	sandeepyadav@powergrid.in
26	Manoj Kumar Jha	Sr. GM	POWERGRID	mkjha@powergrid.in
27	Amit Maan	XEN	HVPNL	xenmpccggn@hvpn.org.in
28	Biresh Kumar Raghava	SE / M & P	HVPNL	sempccdelhi@hvpn.org.in
29	Ramneet Chanana	Dy. Manager (T) Protection	DTL	chanana.ramneet15@gmail.com
30	Lata Tewari	C & SO	SJVN	gmcsosjvn@gmail.com
31	Leena	C & SO Officer	SJVN	gmcsosjvn@gmail.com
32	Perumal S	Protection Engineer	WUPPTCL	perumal.wupptcl@gmail.com
33	Maaz	AE	UPPTCL	setncmrt@upptcl.org
34	Jay Prakash Singh Kushwaha	EE	UPPTCL	setncgxp@upptcl.org
35	Gaurav Singh	Dy. Manager	THDCIL	gauravsingh@thdc.co.in
36	Jeetendra Rajpoot	EE	UPPTCL	jsrajpoot91@gmail.com
37	Fahim Ahmad Dar	Asst. Manager	POWERGRID	fammy.123@powergrid.in
38	Arvind Giri	Sr. Manager	RPSCL Rosa Power	arvind.giri@relianieada.com
39	Aopmesh Nanna	DGM	NTPC Renewable	ananna@ntpc.co.in
40	Vishal Mohan Dahiya	Dy. DIR/P & T Chd	BBMB	ddpntpnp@bbmb.nic
41	Er. Ranbir Singh Sharma	AD/ P & T Cell Chd	BBMB	ranbir.bbmb@gmail.com
42	Asim Baig	EE	PTCUL	ee_tandc_ksp@ptcul.org
43	Manjesh Kumar	Sr. Mgr.	APCPL	manjeshkumar@ntpc.co.in
44	Praveen Rastogi	SE T & C LKO	UPPTCL	setnelko@upptcl.org
45	Ram Baran	SE T & C Asst.	UPPTCL	setneagra@upptcle.org
46	I.C. Mohante	EE (A) SE T & C Asst.	UPPTCL	m.iswarchandan@gmail.com

Draft of Revised Protection Philosophy/Protocol of Northern Region

S.N.	Protection Setting/Protocol	Mandated Setting
1	**Protection Scheme**	**220kV and above:** Independent Main-I and Main-II protection (of different make OR different type/different algorithm) of non-switched numerical type is to be provided with carrier aided scheme. **132kV and below:** One non-switched distance protection scheme and, directional over current and earth fault relays, should be provided as back up.
2	**Distance Protection Zone-1**	80% of the Protected line; Time Setting: Instantaneous.
3	**Distance Protection Zone-2**	0.35 second *(considering LBB time of 200mSec, CB open time of 60ms, resetting time of 30ms and safety margin of 60ms)* For a long line followed by a short line: 0.6 second
4	**Distance Protection Zone-3**	Zone-3 should overreach the remote terminal of the longest adjacent line by an acceptable margin (typically 20% of highest impedance seen) for all fault conditions. Time Setting: 800-1000 msec
5	**Distance Protection Zone- 4**	The Zone-4 reverse reach must adequately cover expected levels of apparent bus bar fault resistance. Time may be coordinated accordingly.

		Where Bus Bar protection is not available, time setting: 160 msec
6	**Lines with Series and other compensations in the vicinity of Substation**	• Zone-1: 80% of the protected line with 100ms-time delay. POR Communication scheme logic is modified such that relay trips instantaneously in Zone-1 on carrier receive. • Zone-2: 120 % of uncompensated line impedance for single circuit line. For Double circuit line, settings may be decided on basis of dynamic study in view of zero sequence mutual coupling. • Phase locked voltage memory is used to cope with the voltage inversion. Alternatively, an intentional time delay may be applied to overcome directionality problems related to voltage inversion. • over-voltage stage-I setting for series compensated double circuit lines may be kept higher at 113%.
7	**Power Swing Blocking**	Block tripping in all zones, all lines. Out of Step tripping to be applied on all inter regional tie lines. Deblock time delay = 2s
8	**Protection for broken conductor**	Negative Sequence current to Positive Sequence current ratio more than 0.2 (i.e. I2/I1 ≥ 0.2) Only for alarm: Time delay = 3-5 sec
9	**Switch on to fault (SOTF)**	Switch on to fault (SOTF) function to be provided in distance relay to take care of line energization on fault

10	**VT fuse fail detection function**	VT fuse fail detection function shall be correctly set to block the distance function operation on VT fuse failure.
11	**Carrier Protection**	To be applied on all 220kV and above lines with the only exception of radial feeders.
12	**Back up Protection**	On 220kV and above lines with 2 Main Protections: • Back up Earth Fault protections alone to be provided. • No Over current protection to be applied. At 132kV and below lines with only one Main protection: • Back up protection by IDMT O/C and E/F to be applied.
13	**Auto Re-closing with dead time.**	AR shall be enabled for 220 kV and above lines for single pole trip and re-closing. Dead time = 1.0s. Reclaim time = 25.0s Auto-recloser shall be blocked for following: • faults in cables. • Breaker Fail Relay • Line Reactor Protections • O/V Protection • Received Direct Transfer trip signals • Busbar Protection • Zone 2/3 of Distance Protection • Circuit Breaker Problems.
14	**Busbar protection**	To be applied on all 220kV and above sub stations with the only exception of 220kV radial fed bus bars.

15	**Local Breaker Backup (LBB)**	For 220 kV and above level substations as well as generating stations switchyards, LBB shall be provided for each circuit breaker. LBB Current sensor I > 20% In LBB time delay = 200ms
16	**Line Differential**	For cables and composite lines, line differential protection with built in distance back up shall be applied as Main-I protection and distance relay as Main-II protection. For very short line (less than 10 km), line differential protection with distance protection as backup (built-in Main relay or standalone) shall be provided mandatorily as Main-I and Main-II.
17	**Over Voltage Protection**	FOR 765kV LINES/CABLE: Low set stage (Stage-I): 106% - 109% (typically 108%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. 400kV LINES/CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. FOR 220 KV LINES: No over-voltage protection shall be used. FOR 220 KV CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds.

		High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. Drop-off to pick-up ratio of overvoltage relay: better than 97% Grading: Voltage as well as time grading may be done for multi circuit lines/cable.
18	**Resistive reach / blinder setting to prevent load point encroachment**	Following criteria may be considered for deciding load point encroachment: • Maximum load current (Imax) may be considered as 1.5 times the thermal rating of the line or 1.5 times the associated bay equipment current rating (the minimum of the bay equipment individual rating) whichever is lower. (Caution: The rating considered is approximately 15minutes rating of the transmission facility). • Minimum voltage (Vmin) to be considered as 0.85pu (85%).
19	**Direct Inter-trip**	To be sent on operation of following: Overvoltage Protection LBB Protection Busbar Protection Reactor Protection Manual Trip
20	**Permissive Inter-trip**	To be sent on operation of Distance Protection

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Annexure-II

उत्तर क्षेत्रीय विद्युत समिति

NORTHERN REGIONAL POWER COMMITTEE

Protection Philosophy/Protocol of Northern Region

(developed in compliance of IEGC 2023)

Version: 2.0

(approved in 71st NRPC meeting held on 29.01.2024)

January 2024

S.N.	Protection Setting/Protocol	Mandated Setting for transmission lines
1	**Protection Scheme**	**220kV and above:** Independent Main-I and Main-II protection (of different make OR different type/different algorithm) of non-switched numerical type is to be provided with carrier aided scheme. **132kV and below:** One non-switched distance protection scheme and, directional over current and earth fault relays, should be provided as back up.
2	**Distance Protection Zone-1**	Reach: 80% of the protected line; 110% of the protected line (In case of radial lines) Time Setting: Instantaneous.
3	**Distance Protection Zone-2**	Reach: Single Circuit Line: 120% of length of principle line section. Double circuit line: 150% coverage of line to take care of under reaching due to mutual coupling effect. Time setting: i. 0.35 second *(considering LBB time of 200mSec, CB open time of 60ms, resetting time of 30ms and safety margin of 60ms)* ii. 0.5-0.6 second *(For a long line followed by a short line)*

4	**Distance Protection Zone-3**	Reach: Zone-3 should overreach the remote terminal of the longest adjacent line by an acceptable margin (typically 20% of highest impedance seen) for all fault conditions. Time Setting: 800-1000 msec If zone-3 reach transcends to other voltage level, time may be taken upto 1.5 sec.
5	**Distance Protection Zone- 4**	The Zone-4 reverse reach must adequately cover expected levels of apparent bus bar fault resistance. Time may be coordinated accordingly. Where Bus Bar protection is not available, time setting: 160 msec.
6	**Lines with Series and other compensations in the vicinity of Substation**	• Zone-1: FSC end: 60% of the protected line. Time: Instantaneous; Remoted end: 60% of the protected line with 100ms-time delay. POR Communication scheme logic is modified such that relay trips instantaneously in Zone-1 on carrier receive. • Zone-2: 120 % of uncompensated line impedance for single circuit line. For Double circuit line, settings may be decided on basis of dynamic study in view of zero sequence mutual coupling. • Phase locked voltage memory is used to cope with the voltage inversion. Alternatively, an intentional time delay may be applied to overcome directionality problems related to voltage inversion.

		• over-voltage stage-I setting for series compensated double circuit lines may be kept higher at 113%.
7	**Power Swing Blocking**	Block tripping in all zones, all lines. Out of Step tripping to be applied on all inter-regional tie lines. Deblock time delay = 2s
8	**Protection for broken conductor**	Negative Sequence current to Positive Sequence current ratio more than 0.2 (i.e. $I2/I1 \geq 0.2$) Alarm Time delay: 3-20 sec. Tripping may be considered for radial lines to protect single phasing of transformers.
9	**Switch on to fault (SOTF)**	Switch on to fault (SOTF) function to be provided in distance relay to take care of line energization on fault.
10	**VT fuse fail detection function**	VT fuse fail detection function shall be correctly set to block the distance function operation on VT fuse failure.
11	**Carrier Protection**	To be applied on all 220kV and above lines with the only exception of radial feeders.
12	**Back up Protection**	1. On 220kV and above lines with 2 Main Protections: • Back up Earth Fault protections alone to be provided. • No Over current protection to be applied. 2. At 132kV and below lines with only one Main protection: • Back up protection by IDMT O/C and E/F to be applied.
13	**Auto Reclosing with dead**	AR shall be enabled for 220 kV and above lines for single pole trip and re-closing. Dead time = 1.0s. Reclaim time = 25.0s

	time.	Auto-recloser shall be blocked for following: i. faults in cables ii. Breaker Fail Relay iii. Line Reactor Protections iv. O/V Protection v. Received Direct Transfer trip signals vi. Busbar Protection vii. Zone 2/3 of Distance Protection viii. Circuit Breaker Problems. CB Pole discrepancy relay time:1.5 sec; for tie breaker: 2.5 sec
14	**Busbar protection**	To be applied on all 220kV and above sub stations with the only exception of 220kV radial fed bus bars.
15	**Local Breaker Backup (LBB)**	For 220 kV and above level substations as well as generating stations switchyards, LBB shall be provided for each circuit breaker. LBB Current sensor I > 20% In LBB time delay = 200ms In case of variation in CT ratio, setting may be done accordingly.
16	**Line Differential**	For cables and composite lines, line differential protection with built in distance back up shall be applied as Main-I protection and distance relay as Main-II protection. For very short line (less than 10 km), line differential protection with distance protection as backup (built-in Main relay or standalone) shall be provided mandatorily as Main-I and Main-II. Differential protection may be done using dark fiber

		(preferably), or using bandwidth.
17	**Over Voltage Protection**	FOR 765kV LINES/CABLE: Low set stage (Stage-I): 106% - 109% (typically 108%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. 400kV LINES/CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. FOR 220 KV LINES: No over-voltage protection shall be used. FOR 220 KV CABLE: Low set stage (Stage-I): 110% - 112% (typically 110%) with a time delay of 5 seconds. High set stage (Stage-II): 140% - 150% with a time delay of 100 milliseconds. Drop-off to pick-up ratio of overvoltage relay: better than 97% Grading: Voltage as well as time grading may be done for multi circuit lines/cable.
18	**Resistive reach setting to prevent load point encroachment**	Following criteria may be considered for deciding load point encroachment: • Maximum load current (Imax) may be considered as 1.5 times the thermal rating of the line or 1.5 times the associated bay equipment current

		rating (the minimum of the bay equipment individual rating) whichever is lower. (Caution: The rating considered is approximately 15minutes rating of the transmission facility). • Minimum voltage (Vmin) to be considered as 0.85pu (85%).
19	**Direct Inter-trip**	To be sent on operation of following: i. Overvoltage Protection ii. LBB Protection iii. Busbar Protection iv. Reactor Protection v. Manual Trip (400 kV and above) vi. Cable Fault (in composite lines)
20	**Permissive Inter-trip**	To be sent on operation of Distance Protection

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Annexure-III

Nodal Officers for Protection settings

Sr. NO.	Utility	Name	Designation	Mobile No.	E-mail id	Posting
1	Koteshwar HEP, THDC	Ashutosh Gairola	Sr. Mgr.	8126655557	ashutoshgairola@thdc.co.in	Koteshwar HEP
2	Tehri, HEP	Jaiveer Singh	Mgr. (O&M)	9412077467	jaiveersingh@thdc.co.in	Tehri HEP
3	DTL	Ms. Ramneet Chanana	Dy.Mgr.	9999533730	chanana.ramneet@gmail.com	220kV Substation Building PARKSTREET
4	APL-Kawai	Ashish Baviskar	General Manager	9099005321	ashish.baviskar@adani.com	
5	Adani Transmission Lim	Sunil Rawal	Head Protections	9687660504	sunil.raval@adani.com	
6	Nabha Power Limited	Chandresh Saxena	Joint General Manger	9755549270	chandresh.saxena@larsentoubro.com	HQ
7	NHPC	S K Das	GSM	9717786721	onm-protection@nhpc.nic.in	HQ
8		Jaganath Pani	SM	8800021271		HQ
9	LPGCL	Rudra Narayan Bedi	President& Head Maintenence	9151897307	rnbedi.ltp@lpgcl.com	Lalitpur
10	LPDD	Sh. Tundup Spalzang	Superintending Engineer	9596949606	sepddladakh@gmail.com	Leh
11	PSTCL	Er. Rajbir Singh Walia	ASE/P&OS	96461-18223		Ludhiana
12	UPPTCL (West, South west, south Central)	Pramod Kumar Mishra	SE (T&C), Meerut	9450909474	setncmrt@upptcl.org	Meerut
13	UPPTCL (Central, south east, North East)	Praveen Rastogi	SE (T&C), lucknow	9412749817	setnclko@upptcl.org	Lucknow
14	RPSCL	Kesarinandan Pandey	GM	9389484787	kesarinandan.pandey@relianceada.com	
15	RVUN	SH. Raman Jain	EE (KSTPS)	9413349559	raman_49559@rvun.in	KSTPS, Kota
16	PTCUL	Mr. Asim Baig	Executive Engineer	9413349559		
17	UJVNL	Er. Anup Deepak	Executive Engineer	9456590173	testdakpathar@gmail.com	Dakpathar, Dehradun
18		Er. Uma Shankar	Executive Engineer	9456590326	eetestdph@gmail.com	Chinayalisaur, Uttrakashi
19	KWHEP	Mr. Hunny Kalia	Manager	7018091548	hunny.kalia@ jsw.in	KWHEP
20		Mr. Amandeep Kumar	Deputy Manager	9417427904	amandeep.kumar@jsw.in	KWHEP
21	PPGCL	Mr. Dhanjay Singh	EMD Deptt.	8009900398	dhananjay.singh@ppgcl.co.in	PPGCL, Bara Plant
22	NPCIL RAPS	Sh. R.D.Yadav	STE(E&I)	9413354527	rdyadav@npcil.co.in	RAPS-3&4
23	BBMB	Er. Inderjit Singh Bajwa	Director/P&C	94639-98154	dirpc@bbmb.nic.in	
24	NTPC	Shri Ramesh kr singh	DGM(OS)			
25	HVPNL	Biresh Kumar Raghava	Superintending Engineer	9312599029	sempccdelhi@hvpn.org.in	M&P-cum-CC Circle, HVPNL, Delhi
26	HPPCL	Anjali Sharma	Sr. Mgr.	9418126921	anjali.sharma@hppcl.in	Corporate office O/o GM (Generation) HPPCL -Shimla

Protection Setting Data Submitted by Utilities of NR

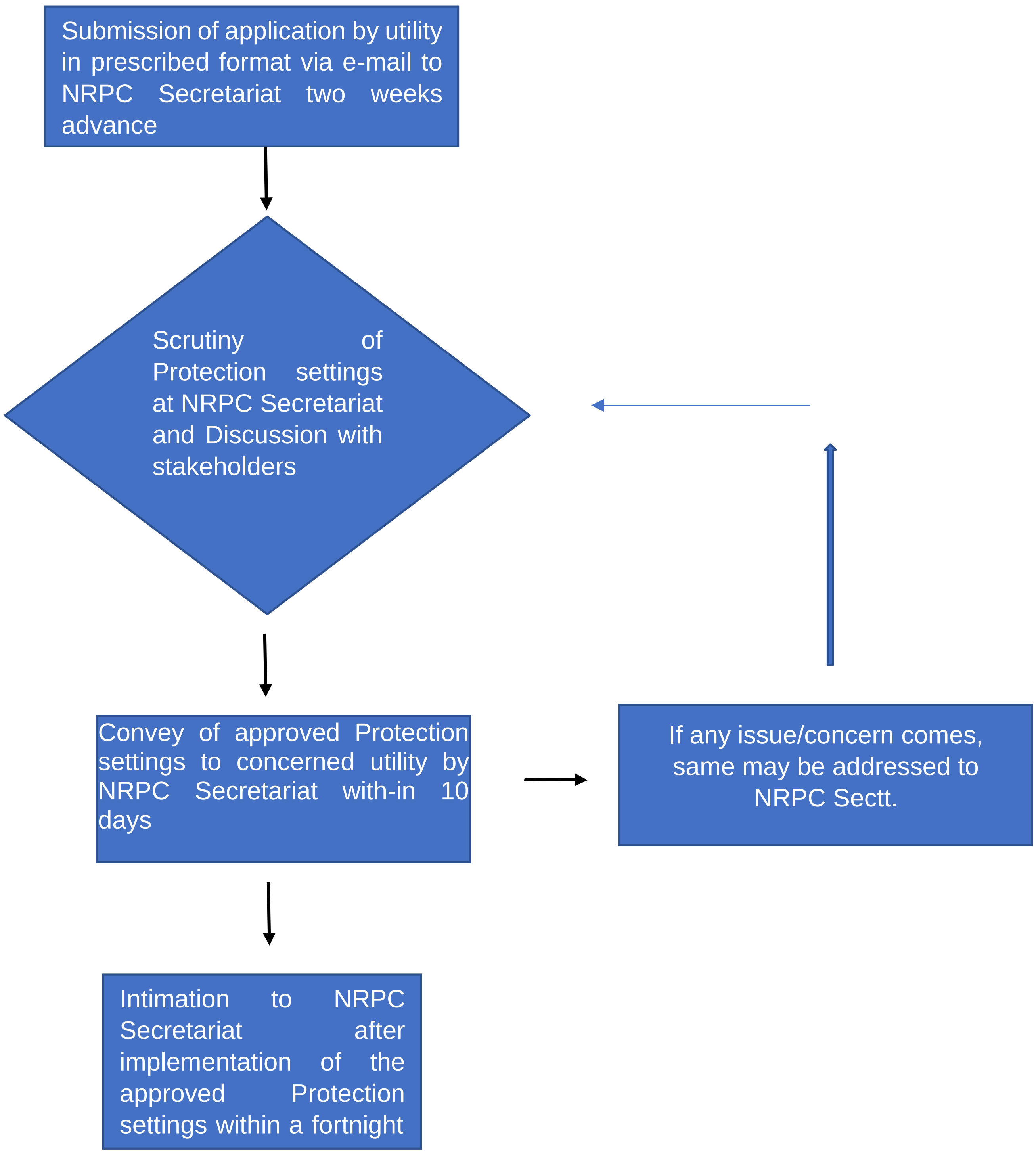
Sr. No.	Utility	400 kV and above Transmission lines	400 kV and above ICTs	400 kV and above Reactors
1	APCPL	Yes	Yes	Yes
2	BBMB	Yes	Yes	Yes
3	DTL	Yes	Yes	Yes
4	HVPNL (Panchkula TS)	Yes	Yes	Yes
	HVPNL (Hissar TS) (Except for 400 kV Nuhiyawali S/s	Yes	Yes	Yes
5	MEJA	Yes	Yes	Yes
6	NHPC	Yes	No	No
7	NPCIL			
	RAPP D	Yes	No	No
	NAPS	Yes	No	No
8	NTPC	No	No	No
	Only Dadri Coal	Yes	Yes	Yes
9	PPCL	Yes	No	No
10	PSTCL	Yes (Not in Format)	No	No
11	RVPNL	Yes	No	No
12	SJVN	Yes	NA	Yes
13	THDC	No	No	No
	Koteshwar HEP	Yes	NA	NA
14	South East UPPTCL	Yes	Yes	Yes
15	WUPPTCL	Yes	Yes	Yes
16	UPPTCL			
	Central Zone	Yes	Yes	Yes
	South Central Zone (Jhansi/ Banda and Orai)	Yes	Yes	Yes
	West Zone	Yes	Yes	Yes
	South West Zone (Fatehabad & Agra	Yes	Yes	Yes
	North West	Yes	Yes	Yes
	North East Zone	Yes	Yes	Yes
17	POWERGRID NR 1	Yes	Yes	Yes
18	POWERGRID NR 2	Yes	Yes	Yes
19	POWERGRID NR 3	Yes	Yes	Yes
20	HPPTCL (132 kV and above)	Yes	Yes	Yes
21	JKPTCL	Yes (for 220kV S/s) Jammu only	No	No
22	PTCUL (132 kV and above)	Yes	Yes	Yes
23	UPRVUNL			
	Obra TPS and Parichha TPS	Yes	Yes	Yes
	Anpara ATPS and Harduaganj	Yes	Yes	Yes
	Anpara DTPS	Yes	Yes	Yes
24	HPGCL	No	No	No
25	UPSLDC			
	Alaknanda	Yes	NA	NA
	PPGCL Bara	Yes	Yes	Yes
	Lanco Anpara	Yes	Yes	NA
	LPGCL	Yes	Yes	Yes
	Vishnuprayag	Yes	NA	NA
	Rosa TPS	Yes	Yes	NA
26	RRVUNL	Yes	Yes	Yes

Approval of Protection Settings by NRPC Secretariat

A. Steps:

1. Nominated nodal officer shall apply for revision or approval of new Protection settings via e-mail at seo-nrpc@nic.in in the prescribed formats in 2 weeks advance.
2. Further, NRPC will scrutinize and discuss with stakeholders, if required.
3. Subsequently, NRPC Secretariat will provide the approved Protection settings to the concerned stakeholder with-in 10 days after receiving request.
4. On approved settings, if any issue or concern arises, the same can be address to the NRPC Secretariat.
5. After the implementation of approved settings, stakeholder will intimate to NRPC Secretariat via e-mail at seo-nrpc@nic.in within a fortnight.

B. Flow Chart:


Submission of application by utility in prescribed format via e-mail to NRPC Secretariat two weeks advance
Scrutiny of Protection settings at NRPC Secretariat and Discussion with stakeholders
Convey of approved Protection settings to concerned utility by NRPC Secretariat with-in 10 days
If any issue/concern comes, same may be addressed to NRPC Sectt.
Intimation to NRPC Secretariat after implementation of the approved Protection settings within a fortnight

Annexure-VI

Status of Protection Audit Plan for FY 2024 -25

S. No.	NRPC Member	Category	Status
1	PGCIL	Central Government owned Transmission Company	Received
2	NTPC	Central Generating Company	
3	BBMB		Received
4	THDC		Received
5	SJVN		
6	NHPC		Received
7	NPCIL		
8	DTL	State Transmission Utility	Received
9	HVPNL		Received
10	RRVPNL		
11	UPPTCL		Received for Agra, Jhansi, Lucknow, Meerut zone
12	PTCUL		
13	PSTCL		
14	HPPTCL		
15	IPGCL	State Generating Company	
16	HPGCL		
17	RRVUNL		
18	UPRVUNL		
19	UJVNL		
20	HPPCL		
21	PSPCL	State Generating Company & State owned Distribution Company	
22	HPSEBL	Distribution company having Transmission connectivity ownership	
23	Prayagraj Power Generation Co. Ltd.	IPP having more than 1000 MW installed capacity	Received
24	Aravali Power Company Pvt. Ltd		
25	Apraava Energy Private Limited		Received
26	Talwandi Sabo Power Ltd.		
27	Nabha Power Limited		
28	Lanco Anpara Power Ltd		
29	Rosa Power Supply Company Ltd		
30	Lalitpur Power Generation Company Ltd		Received
31	MEJA Urja Nigam Ltd.		
32	Adani Power Rajasthan Limited		
33	JSW Energy Ltd. (KWHEP)		
34	Greenko Group	Other IPP	
35	Sravanthi Energy Private Ltd		
36	NTPC Renewable Energy wing		
37	RENEW POWER		
38	Adani Power Ltd		
39	Avaada Energy		
40	Mahindra Solar		
41	ACME Heeragarh Powertech Pvt. Ltd.		
42	Tata Power Renewable Energy Ltd.		
43	Azure Power Pvt. Ltd.		
44	Thar Surya Pvt. Ltd.		
45	Ayana Renewable Power Pvt. LTd.		

46	CSP(J)PL, Hero Future Energies		
47	ABC Renewable Energy(RJ-01) Pvt. Ltd.		
48	Eden Renewable Cite Pvt. Ltd.		
49	UT of J&K	UT of Northern Region	
50	UT of Ladakh		
51	UT of Chandigarh		
52	ATIL	Other transmission licensee in NR	
53	INDIGRID		
54	POWERLINK		
55	ADHPL		Received
56	Sekura Energy Limited		
57	WUPPTCl	Other transmission licensee in UP	
58	SEUPPTCL	Other transmission licensee in UP	
59	Vishnuprayag Hydro Electric Plant (J.P.)	Other Generating Units in UP	
60	Alaknanda Hydro Electric Plant (GVK)	Other Generating Units in UP	

Scope of work for
Centralized Database containing details of relay settings for grid elements connected to 220 kV and above

Scope of software shall be broadly as below for all elements in Northern Region connected to 220 kV and above voltage level:

- **A. Protection Settings Database Management System.**
- **B. Protection Setting Calculation and Study Tool.**
- **C. Repository of DR/EL and analysis.**
- **D. Application of protection settings by utilities and its approval by NRPC.**
- **E. Reporting of performance indices by utilities.**
- **F. Repository of protection audit reports.**

A. Protection Settings Database Management System

1. To create facility to store all types of relay settings of all power system elements (connected to 220 kV and above in Northern Region such as lines, cable, ICT, Reactor/Capacitor, generator, GT, STATCOM/SVC, FSC/TCSC, HVDC) in one system irrespective of the manufacturer and relay type and controlled access to users.
2. Complete modeling of elements with relevant system parameters **based on data received from utilities** for transmission lines, generators, transformers, reactors, substation layouts, and associated protective relays in the substations. The model should include CT, PT, Isolator, Breaker and other bay equipment's ratings along with rating of the BUS and the type of conductor used for the BUS. The modeling should be done as per bus-breaker philosophy instead of node-oriented model.
3. Creation of necessary relay templates of all make and model existing in grid. **Template for electro-mechanical relay shall also be required to be created. Users shall have option to provide settings of electro-mechanical relay.**
4. Option to users to upload relay setting files (downloaded from relay) directly.
5. To capture the life cycle of protection settings and template.
6. To create an interface with Protection Setting Calculation and Study Tool.

7. To provide Role based access control.
8. Building the entire Northern region network data for load flow and fault calculation, Protection database and substation SLD preparation.
9. Hardware setup and software package capable of meeting the above objectives. Associated servers for installation and Deployment of application and database software along with standard Operating System –With Main and Back up.
10. Work flow Management.
11. Availability of historical fault data for predicting nature of fault.
12. The tool should be capable of analyzing, storing, and handling all fault records (Disturbance record, Event Logger, COMTRADE files, etc.) for a minimum period of prescribed years; and the updated database to be used for fault analysis should be permanently available.
13. Reports:
    a. Feature to generate reports as per user requirement.
    b. User can generate report in standard format like .xls, .pdf.
14. History log: All user activities such as user operations, data management, template management, configuration management and workflow shall be logged to track the user activities.
15. Import and Export: There shall be an option to import template and data from any third party application in standard formats like .xml and .xls
16. Relay characteristics curve can be drawn from the setting data.
17. Provision to attach documents to relay template and relay data can be made available. Option to accept setting data as per the audit and verify/compare the field setting with protection database setting and generate error report.
18. Provision to store and retrieve audit reports.
    c. Provision to store and retrieve relay tripping incidence report.
    d. Facility to store and retrieve setting guidelines as per various committees.
    e. Automatic Reconciliation Tool should be available which will generate automatic reconciliation requests for relay settings in the database.
    f. Up-to-date application guides and user manuals of all relays is a part of the relay library.
19. A user-friendly interface with features such as
    a) Web based System.

b) Role based access control
c) Flexible customization of user roles, grants, actions from Master control panel
d) User Access Monitor
e) Relay Template Management
f) Create\Edit\Delete relay templates
g) Viewing relay template
h) Locking and Unlocking templates
i) Copy & Edit templates from the existing template
j) Import and Export templates
k) Relay Data management
l) Create\Edit\Delete relay data
m) Viewing relay data
n) Locking and Unlocking relay data
o) Copy & Edit relay data from the existing data
p) Import and Export relay data

20. Built with standard relays library data for different manufacturers, including but not restricted to the following protection features:

i. **Transmission Line & cable (including compensated):**
Distance, over current, earth fault, over voltage, Line Differential protection.

ii. **Power Transformer:**
Differential Protection, Under Impedance protection, Over fluxing Protection, Thermal Overload Protection, Low Impedance Restricted Earth Fault Protection, High Impedance Restricted Earth Fault Protection, back-up over current (Directional/ Non-Directional) and earth fault protection (Directional/ Non-Directional).

iii. **Shunt Reactors:**
Differential protection, Restricted Earth Fault, Back Up Protection (Impedance / overcurrent)

iv. **Generator:**
Differential Protection, Stator Earth Fault Protection (Both 95% and 100% protection), Inter – Turn Differential Protection, Backup impedance, Voltage Controlled O/C, Negative Sequence, Field Failure,

Reverse Power/Low forward Power, Pole Slipping, Overload, Over voltage, Under Frequency, Dead Machine, Rotor Earth Fault, Over Fluxing.

v. Generator Transformer/ Unit Auxiliary Transformer:

Differential Protection, Back up Earth Fault Protection, Back up over current, Restricted Earth Fault.

vi. HVDC:

- Converter Protection: Valve Short Circuit Protection, DC Differential Protection, DC Harmonic Protection, DC Under voltage Protection, DC Overvoltage Protection, AC Over voltage Protection, AC Under voltage Protection, AC Voltage Stress Protection of Converter, Group Differential Protection, Bridge Differential Protection, Overcurrent Protection, Sub-Synchronous Resonance Protection, AC Valve Winding Ground Fault Supervision,
- DC Filter Protection: Capacitor Differential Over current Protection, Capacitor Unbalance Supervision, Inverse Overcurrent Time Protection, DC Filter Differential Protection,
- DC Line Protection: Travelling Wave Front Protection, Under voltage Sensing Protection, Under voltage Operation Protection, DC Line Differential Protection, AC-DC Conductor Contact Protection.
- Electrode Line Protection: Electrode Bus Differential Protection, Electrode Current Balance Protection, Electrode Over Current Protection, Electrode line open circuit Over voltage Protection, Station Ground Overcurrent Protection, Open Conductor Electrode Line Protection
- DC Busbar Protection: HV Side DC Bus bar Differential Protection, Neutral Side DC Busbar Differential Protection, DC Differential Backup Protection, Valve Protection
- Converter Transformer Protection: differential protection, high impedance, restricted earth fault protection, ground earth fault overcurrent protection, thermal overload protection, over-fluxing protection, directional definite time / inverse-time overcurrent protection and directional earth fault overcurrent protection.

- AC Filter Sub-bank Protection (Shunt/Capacitor/Resistor): Differential, overcurrent, overload, unbalance supervision, Zero Sequence Overcurrent.

vii. **STATCOM:**

- Transformer Protection: Differential protection, REF protection, Directional Overcurrent protection, Ground Overcurrent, over flux protection, Transformer mechanical trips.
- STATCOM (MV) Bus protection: Bus Differential protection, Ground over current protection, used with neutral Grounding Transformer, Under/ Over Voltage protection, Over voltage (Open Delta) protection.
- STATCOM Branch Protection: Differential protection and/or O/C protection, Ground over current protection , Valve Overcurrent protection (in Controls), DC overvoltage protection (in Controls)
- MSR/TCR Branch Protection: Differential protection, Ground over current protection, Reactor branch unbalance protection, Thermal Overload protection.
- MSC/TSC Branch Protection: Differential protection, Ground over current protection, Capacitor Overvoltage (Using current signal) protection, Capacitor unbalance protection, over current protection.
- Harmonic Filter Protection: Ground over current protection, Capacitor Overload (Using current signal) protection, over current protection, Neutral Voltage shift.
- Auxiliary Transformer Protection: Over current, open delta voltage protection.

viii. **SVC:**

- Coupling Transformer (HV & MV) Protection: Differential protection, REF protection, Directional Overcurrent protection, Ground Overcurrent, over flux protection, Transformer mechanical trips.
- SVC Bus Bar protection: Bus Differential protection, Ground over current protection, used with neutral Grounding Transformer, Under/ Over Voltage protection, Over voltage (Open Delta) protection.

- TCR Protection: Differential protection, Ground over current protection, Reactor branch unbalance protection, Thermal Overload protection.
- TSC Protection: Differential protection, Ground over current protection, Capacitor Overvoltage (Using current signal) protection, Capacitor unbalance protection, over current protection.
- Harmonic Filter Protection: Differential protection, Ground over current protection, Capacitor Overvoltage (Using current signal) protection, Capacitor unbalance protection, over current protection, Neutral Voltage shift.
- Auxiliary Transformer Protection: Over current, open delta voltage protection.

ix. **FSC & TCSC:** Capacitor unbalance, Capacitor overload, Line current supervision, MOV overload, MOV short term energy protection, MOV high current protection, MOV high temperature protection, MOV failure protection, Flashover to platform protection, Spark Gap protection, Trigger circuit supervision, Sub-harmonic protection, Pole disagreement protection, Bypass switch failure protection,

x. **BUSBAR & LBB**: Differential protection, Beaker Failure Protection

21. Protection Settings Database Management System shall be suitable for integration with other portals, software of protection. It shall be able to integrate any third party application to share data between protection database management software and calculation engine/tool and vice versa.
22. Training of utilities.
23. AMC.

B. Protection Setting Calculation and Study Tool.

This module shall be capable of giving recommendation of Protection Setting for protections of elements as mentioned under point no. 20 of para A. Calculation Tool should be capable of performing the following:

1. Relay co-ordination for power system elements. Co-ordination check shall be conducted for relays of all make.
2. Primary/back-up relay pairs generation.
3. Fault calculation will be a part of relay co-ordination program.

4. Transparent Fault calculation results.
5. Simulation engines for protection co-ordination, power flow analysis, fault calculation, transient stability studies, electromagnetic transient analysis, and protection relay operation post-mortem analysis. There should be features to study low frequency oscillations, 3rd zone tripping, PSS tuning support and Voltage collapse prediction feature.
6. The protection calculation tool should be capable of interacting with the relay data in the database.
7. Tool for simulating the performance/ behavior of the protection system under all possible normal and abnormal operating conditions of the power system, including effect of changing one or more parameter setting of the relays.
8. Diagnostics Tool for verifying proper coordination among various protective relays.
9. Computation of critical clearing time.
10. Plotting Log-Log grid and graphs.
11. Option to check existing relay settings with respect to field or vice versa.
12. Computation of Out of Step Tripping Protection Settings.
13. Display of sequence operation of relays with respect to tripping time.
14. Switching status for all relays elements from the screen.
15. Association of relays to power system elements.
16. Disturbance analysis can be done on mapping of disturbances files with corresponding relay.
17. It shall have standard power system components and relay symbols.
18. Automatic computation of zone setting for distance protection.
19. Feature for viewing existing and newly computed relay settings.
20. Pre-loaded standard relay curves.
21. Directional and non-directional feature for relays.
22. Overload factor, unbalance factor and discrimination time (user defined/selectable) for each relay.
23. Inbuilt discrimination time calculator for grading of relays.
24. Facility to model the back-up protection settings of generating units / GTs.

C. Repository of DR/EL and analysis.

a) Platform for upload of DR/EL by utilities and access to all.

b) Tracking of non-compliance in uploading.
c) Tool for analysis of DR/EL.
d) Tool shall be integrated with outage portal of NRLDC so that it can capture details of outages of elements automatically from NRLDC portal so that users can upload DR, EL, FIR, tripping report, analysis report.

D. Application of protection settings by utilities and its approval by NRPC.

a) Platform for application of protection setting by utilities.
b) Hierarchical role for scrutiny and approval of setting by NRPC.
c) Intimation of approval of settings by NRPC.
d) Intimation of implementation of settings by utilities.

E. Reporting of performance indices by utilities.

a) Platform for reporting of performance indices by utilities.
b) Feature for scrutiny and intimation of errors to utilities by NRPC.
c) Recording of justification note for non-compliance.

F. Repository of protection audit reports.

a) Platform for reporting of internal and external audit report of all utilities.
b) Tracking non-compliance and next due date.
c) Web-based Checklist for protection audit should be made available for Constituents to self-auditing.

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Annexure-VIII

S. No.	NRPC Member	Category	No. of License Key Required	Remarks
	License holder for Centralized Database Portal of Northern region			
1	NRPC	Secretariat	2	
2	PGCIL	Central Government owned Transmission Company	3	NR-1,2,3
3	NLDC	National Load Despatch Centre	1	
4	NRLDC	Northern Regional Load Despatch Centre	2	
5	NTPC	Central Generating Company	1	
6	BBMB		2	
7	THDC		1	
8	SJVN		1	
9	NHPC		1	
10	NPCIL		1	
11	Delhi SLDC	State Load Despatch Centre	1	
12	Haryana SLDC		1	
13	Rajasthan SLDC		1	
14	Uttar Pradesh SLDC		1	
15	Uttarakhand SLDC		1	
16	Punjab SLDC		1	
17	Himachal Pradesh SLDC		1	
18	DTL	State Transmission Utility	2	Gen. & Trans.
19	HVPNL		1	
20	RRVPNL		1	
21	UPPTCL		6	6 zones
22	PTCUL		1	
23	PSTCL		1	
24	HPPTCL		2	
25	IPGCL	State Generating Company	1	
26	HPGCL		1	
27	RRVUNL		1	
28	UPRVUNL		1	
29	UJVNL		1	
30	HPPCL		1	
31	PSPCL	State Generating Company & State owned Distribution Company	1	
32	HPSEBL	Distribution company having Transmission connectivity ownership	4	
33	Prayagraj Power Generation Co. Ltd.	IPP having more than 1000 MW installed capacity	1	
34	Aravali Power Company Pvt. Ltd		1	
35	Apraava Energy Private Limited		1	
36	Talwandi Sabo Power Ltd.		1	
37	Nabha Power Limited		1	
38	Lanco Anpara Power Ltd		1	
39	Rosa Power Supply Company Ltd		1	
40	Lalitpur Power Generation Company Ltd		1	
41	MEJA Urja Nigam Ltd.		1	
42	Adani Power Rajasthan Limited		1	
43	JSW Energy Ltd. (KWHEP)		1	
44	Greenko Group	Other IPP	1	
45	Sravanthi Energy Private Ltd		1	
46	NTPC Renewable Energy wing		1	
47	RENEW POWER		1	
48	Adani Power Ltd		1	
49	Avaada Energy		1	
50	Mahindra Solar		1	
51	ACME Heeragarh Powertech Pvt. Ltd.		1	
52	Tata Power Renewable Energy Ltd.		1	
53	Azure Power Pvt. Ltd.		1	
54	Thar Surya Pvt. Ltd.		1	
55	Ayana Renewable Power Pvt. LTd.		1	
56	CSP(J)PL, Hero Future Energies		1	
57	ABC Renewable Energy(RJ-01) Pvt. Ltd.		1	
58	Eden Renewable Cite Pvt. Ltd.		1	
59	UT of J&K	UT of Northern Region	3	(1, 1, 1 transco, SLDC jammu, Sub SLDC Kashmir)
60	UT of Ladakh		1	
61	UT of Chandigarh		1	
62	ATIL	Other transmission licensee in NR	1	
63	INDIGRID		1	
64	POWERLINK		1	
65	ADHPL		1	
66	Sekura Energy Limited		1	
67	WUPPTCI	Other transmission licensee in UP	1	
68	SEUPPTCL	Other transmission licensee in UP	1	
69	Vishnuprayag Hydro Electric Plant (J.P.)		1	
70	Alaknanda Hydro Electric Plant (GVK)		1	
	Total		87	

Annex-I

Annexure-IX

Status of Bus bar protection				
Constituent Name	**Name of Station**	**Status of Bus bar protection(as reported)**	**Expected date of revival(as reported)**	**Present Status**
Uttarakhand	220 KV Substation, Ramnagar, Roorkee	Blocked due to more elements added at 220 KV Voltage level.		
	220 KV Sub Station, SIDCUL, Haridwar			
	220kV Jhajhra, Dehradun	Not commissioned yet		
	400KV Kashipur (220kV side)	Available but Non operational	31-Mar-24	Work is under process.
	220kv Haldwani	Not Available	31 December 2024	Budget for FY 2023-24.
	220kv Pantnagar	Available but Non operational	31-Mar-24	Work is under process.
	220kV Rishikesh	Available but Non operational	31 December 2024	It has been Taken in Budget for FY 2023-24.
	220kV Chamba	Not commissioned yet	31 December 2024	It has been Taken in Budget for FY 2023-24.
Haryana	**220kV S/Stn Badshahpur**	**Installed and Operational**		**Commissioned on 20.02.2023**
	220kV S/Stn Sec-52A, Gurgaon	Not Installed	31.03.2024	Panel has been installed. Commissioning pending due to non- availability of shutdown.
	220kV S/Stn Sec-1 Manesar	**Installed and Operational**		**Commissioned on 26.02.2023**
	220kV S/Stn Panchgaon	**Installed and Operational**		**Commissioned on 05.01.2024**
	220kV S/Stn Rewari	Not Installed	31.03.2024	Material is not allocated so far. Installation will be carried out after allocation of material.
	220kV S/Stn Narnaul	Not Installed	31.03.2024	Panel has been installed. Work in progress on turnkey basis. Isolators of 220 kV TFs have to be replaced thereafter the work shall be completed.
	220kV S/Stn Mohinder Garh	**Installed and Operational**		**Commissioned on 28.10.2023**
	220 KV S/Stn Palwal	Not Installed	30.06.2024	Panel has been installed. Commissioning is pending.
	220 KV S/Stn Rangala Rajpur	**Installed and Operational**		**Commissioned on 22.06.2023**
	220 kV Unispur	Installed but Non-Operational	31.03.2024	5 Nos. Peripheral relay of bus bar protection are defective. The same shall be made operational by 31.03.2024.
	220 kV Nissing	Installed but Non-Operational	31.03.2024	Existing Bus bar panel is of old and obsolete design. New Bus Bar protection scheme panel has been drawn from the store & Commissioning& installation are pending. The same shall be made operational by 31.03.2024.
	220KV Pehowa	Installed but Non-Operational	31.03.2024	Old & Obsolete, Allocation of New BBP and allied material awaited.
	220kV Kaithal	Not Installed	31.03.2024	Control Cable for Bus-Bar Protection Scheme has been drawn from DD Stores, 220kV Bus-Bar Protection panel is awaited.
	220 KV Sonepat	Not Installed	31.05.2024	220 KV Bus Bar Protection Scheme will be installed / commissioned within 45 days after the availability of the necessary material i.e 220kV Duplex, Directional, Bus Bar Cum B Coupler C and R Panel, Auxiliary Voltage 220V DC (without SAS) required for commissioning. It has been gathered from the P&M wing that the material is likely to be available in DD stores by April 2024.
	220 KV REGC, Sonepat	Not Installed	15.03.2024	The 220KV C&R Panel for Bus Bar Protection has been drawn from DD Store on dated 20.04.2023 and the work for installation of Bus Bar protection scheme is under progress. Erection work & wiring work completed with all respect. Testing of relays is pending at the end of Firm M/s Shifang and Bus Bar protection scheme will be commissioned dt 15.03.2024.
	220KV Jind	**Installed and Operational**		**Commissioned on dated 27.06.23.**
	220 KV Fatehabad	**Installed and Operational**		**Commissioned on dated 22.07.23**
	220 KV Hukmawali	Installed but Non-Operational	30.10.2023	Bus-coupler CB defective & new panel withdrawn from DD store. Errection work under progress & the same will be completed 31.08.23.
	220 KV Bhuna	Installed but Non-Operational	31.12.2024	The Siemens make Bus Bar protection Scheme installed at the time of commissioning of the substation went out of order. The higher authority decided to replace with new one. M/s Schneider make new Scheme was then allocated and drawn from DDS Ballabgarh and installed at site, but while testing of same, three out of four relays of the Bus Bar Panel found faulty for which matter is under pursuance with firm.
	220 KV Sirsa	Not Installed		Not required being single source of supply
	220 KV Rania	Not Installed	31.03.2024	Estimate for Bus Bar Protection is sanctioned but C&R panel is not available in store.
	220 KV Bhiwani	Not Installed	31.03.2024	Bus Bar Protection scheme has been proposed in integrated planning meeting and requirement of material have been generated in PR.
	220kV Madanpur	Not Installed	31.03.2024	Material is not allocated so far. Installation will be carried out after allocation of material.
	220kV Tepla	Installed but Non-Operational	31.03.2024	material allocation is awaited.
	220kV Rajokheri	Installed but Non-Operational	31.03.2024	The S/Stn. Is being constructed on turnkey, BBP has been installed. Commissioning is yet to be completed by the firm. Matter is taken up with bus-bar protection firm engineer for commissioning.
BBMB	**220kV Charkhi Dadri**	**Installed and Operational**		**commissioned on 31.01.2023**
	220kV Samaypur	**Installed and Operational**		**made operational on 23.12.2023**
	220kV Dhulkote	Not Installed		Not feasible
	220kV Jagadhari	Not Installed		
	220kV Barnala	Not Installed		
UP	220kV Parichha	Installed but Non-Operational	30.06.2023	
	220kV Partapur	Installed but Non-Operational	Jan-23	
	220kV Bareilly (400/220kV Bareilly)	Installed but Non-Operational	Dec-23	Old panel capacity exhausted. New relay panel supplied & need to be
	220kV Pilibhit	Not Installed	Dec-23	New Relay panel supplied & need to be commissioned by Service Engineer
	220kV Amariya	**Installed and Operational**		**commissioned on 15th July 2023**
	220kV Sultanpur	Installed but Non-Operational		Isolator contact status are not received due to damage of contacts on every
	220kV New Tanda	Not Installed		Busbar protection panel available on 03.03.2023 but not commissioned
	220kV Shahjhanpur	Installed but Non-Operational		NC/No switch status of bus isolator were improper & require control cable for
	220kV Ajijpur	Installed but Non-Operational		1. HV side 220kV CT of 160MVA T/F-I & II has bot proper ratio for bus bar
	220kV Nirpura	Installed but Non-Operational	Jan-23	
	220kV IITGNL	Installed but Non-Operational	Mar-23	
	220kV Rampur	Installed but Non-Operational	31.03.2024	
	220kV Barahua	Installed but Non-Operational		As Per Ex-En Transmission Approvel is Pending at HQ Level As Per Ex-En
	220kV Bansi	**Installed and Operational**		**commissioned on 10th August 2023**
	220 KV S/S Azamgarh-2(Bargahan)	Installed but Non-Operational		
	220kV Chandausi	**Installed and Operational**		**made operational on 13.10.2023**
	220kV Rampur	Installed but Non-Operational	30.04.2024	Main relay of bus bar protection is not working. Firm engineer visit is awaited
	220kV Sec. - 148, Noida	Installed but Non-Operational	31.01.2024	Work has been completed. Testing is due.
	220kV sec. 38A, Botanicla Garden	Not Installed	31.03.2024	Bus Bar protection panel not alloted
	220kV sec.-62, Noida	**Installed and Operational**		**made operational on 12.10.2023**
	220kV Dadri	Installed but Non-Operational	28.02.2024	Wiring work is in process.
	400kV S/S Agra	**Installed and Operational**		**commissioned on 13th September 2023**
	220kV S/S Bah	Not Installed		
	220kV Sirsaganj	Not Installed		
	220kV S/S Farrukhabad (New)	**Installed and Operational**		**commissioned on 25th August 2023**
	220kV Boner	Not Installed	31.03.2024	Tender under process
	220kV Kasganj (Soron)	**Installed and Operational**		
	220kV Khair	Installed but Non-Operational	31.03.2024	Tender under process; (New ICT-3 is not configured in bus bar relay)

	220kV Kidwainagar	Installed but Non-Operational		
	220kV Chhata	Installed but Non-Operational	31.03.2024	Tender under process; (New ICT-3 is not configured in bus bar relay)
	220kV Harduaganj	Installed but Non-Operational	31.12.2023	
	220kV Lalitpur	Not Installed	23-Apr	INSTALLATION IS NOT DONE DUE TO UNAVAILABLE OF CABLES. CABLE REQUEST HAS BEEN SENT TO LUCKONW HQ.
	220kV Sarnath	Installed but Non-Operational	Nov-23	
	220kV Sirathu, Kaushambi	Not Installed	Mar-23	
	220kV substation Fatehpur	Installed but Non-Operational	Mar-23	
	220kV S/S Bhelupur	Not Installed	Mar-23	
	220kV Hardoi Road, Lucknow	**Installed and Operational**		**commissioned on 08th October 2023**
	220kV CG City, Lucknow	Installed but Non-Operational	31.08.2023	Configurational error
	220kV Barabanki	Installed but Non-Operational	30.09.2023	Relay configuration is required for addtitional 220kV Jehta 1 &2 bays
	220kV Kursi Road, Lucknow	Installed but Non-Operational	30.09.2023	1- 87BB Auxilliary busbar relay at 160MVA T/F not available
	220kV BKT, Lucknow	Installed but Non-Operational	31.08.2023	Mian bus bar relay defective
	220kV Gomti Nagar, Lucknow	Installed but Non-Operational		Mal opoerating
	400 KV Substation Sarnath	**Installed and Operational**		**Now operational**
	220kV S/S Raja Talab	Installed but Non-Operational	15.11.2023	RELAY DEFECTIVE
	20kV S/S Harahua	Installed but Non-Operational	31.11.2023	NOT COMMISSIONED
	220kV S/S Sahupuri	Installed but Non-Operational	Requirement for panel has been raised,not received from	Defective
	220kV S/S Mirzapur	Not Installed	3 Month	-
HP	220kV Chamba	**Installed and Operational**		**commissioned in Jan-2024**
	220kV MattaSidh	Installed but Non-Operational	31.03.2024	Work in under progress
	220kV kangoo	Installed but Non-Operational		
	220kV Nangal	Installed but Non-Operational		
	220kV Katha Baddi	Installed but Non-Operational		
Punjab	220 KV S/S Kotlisurat Malhi	Not Installed	31.03.2024	There is delay due to availability of OEM engineer
	220 KV S/S Maur	Not Installed		
	220 KV S/S Science city	Not Installed		
	220 KV S/S Banga	Not Installed		
	220 KV S/S Hoshiarpur	Not Installed		
	220 KV S/S Goraya	Not Installed		
	220 KV S/S Badhni kalan	Not Installed		
	220 KV S/S Bhari	Not Installed		
	220 KV S/S Bhawanigarh	Not Installed		
Rajasthan	765 KV GSS Phagi	Installed but non operational	Dec-23	CU of Alstom make Bus-Bar is defective. Purchas case will be taken up
	220 kV GSS Vatika	Not installed		As M/s ER did not finished the project, so it was awarded to M/s Kaycee infra on risk-cost basis , however the bus bar scheme has not been commissioned yet. Matter has been taken up with firm
	220 kV GSS Niwana	Not installed		To be commissioned shortly
	220 kV GSS Alwar	Not installed		CU defective in existing ABB make Bus bar Scheme. Matter has been taken up with firm
	220 kV GSS Bansur	Not installed		To be commissioned shortly
	220 kV GSS Behror	Not installed		To be commissioned shortly
	220KV GSS Hindaun	Not installed		To be commissioned shortly
	220KV GSS Dooni	Not installed		To be commissioned shortly
	220KV GSS Bhawanimandi	Not installed		**commissioned**
	220 KV GSS Sakatpura, Kota	Not installed	Dec-23	Work is pending on the part of M/s GE and S.E. (T&C), RVPN, Kota due to defective Central Control Unit. CU will be send to firm for repair
	400 KV GSS Ajmer (220 KV BUS)	Installed but non operational		Isolator status of in 87BB of respective 220 KV bay No. 213,214, 215 & 216 was not avaliable due to this 220 KV Main Bus-bar-II is out of ckt. work under progress
	220 kV GSS, Beawar	Not installed		New Bus Bar protection commissioning work is ongoing of M/S Danish. Case has been taken up with firm
	220 KV GSS Jethana	Not installed		New Bus Bar protection commissioning work is ongoing of M/S Danish. To be commissioned shortly
	220 KV GSS Kuchaman City	Installed but non operational		due to problem in Central Unit Relay (87CU) Since 28.01.2022 , CU has been removed due to defective & replacement / repair under process at GSS Part. Case has been taken up with firm
	220 KV GSS Bherunda	Not installed		New Bus Bar protection commissioning work is ongoing of M/S Danish. To be commissioned shortly
	220 KV GSS Kuchera	Not installed		New Bus Bar protection commissioning work is ongoing of M/S Danish. To be commissioned shortly
	220 KV GSS Reengus	Installed but non operational		New Bus Bar Scheme has been proposed and approved for replacement from defective Bus-Bar Scheme. The Replacement work will be carried out by firm shortly
	220 KV GSS Laxmangarh	Not installed		**Commissioned**
	220KV GSS Khetri Nagar	Installed but non operational	Dec-23	The newly Bus bar protection scheme has been proposed and approved for replacement of deffective bus bar scheme. hence the work of replacement will be carried out by the firm shortly
	400 KV GSS, Babai	Installed but non operational		PU of 315 MVA ICT-III is defective with error code 0X83720007. Matter has been taken up with firm
	220 KV GSS Chittorgarh	Installed but non operational		All bay units of the BUS BAR scheme are defective. Matter has been taken up with firm
	400 KV GSS BHILWARA(220 KV BUS)	Installed but non operational		BAY UNIT OF 220 KV TBC DEFECTIVE. Matter has been taken up with firm
	220 KV GSS MANDALGARH	Not installed		**commissioned**
	220KV GSS Debari	Not installed	Dec-23	Going to be install / commission new bus bar protection scheme supply by Danish.
	220KV GSS Amberi	Not installed		Going to be install / commission new bus bar protection scheme supply by Danish.
	220KV GSS Madri	Not installed		Going to be install / commission new bus bar protection scheme supply by Danish.
	400 KV GSS Surpura (Jodhpur) 220 KV	Installed but non operational		Allotted & Panel Received
	400 KV GSS Akal (Jaisalmer) 220 KV	Installed but non operational		One PU defective. Case has been taken up with firm
	220 KV GSS Jodhpur	Installed but non operational		A&FS and TS issued. Case has been send for approval
	220 KV GSS NPH Jodhpur	Not installed		To be commissioned shortly
	220 KV GSS Badisid	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Bhadla	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Pali	Installed but non operational		New bays to be incorporated and GPS defective. work under progress
	220 KV GSS Ramgarh	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Balotra	Installed but non operational		Isolator status issue. work under progress
	220 KV GSS Sayla	Not installed		Allotted & Panel Received. To be commissioned shortly
	400 KV GSS Bikaner 400 KV BUS	Installed but non operational		Not operational (Areva Make) Communication fiber error. Matter has been
	220 KV GSS Ratangarh	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Sujangarh	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Halasar	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Tehandesar	Not installed		Allotted & Panel Received. To be commissioned shortly
	220 KV GSS Rawatsar	Not installed		Allotted & Panel Received. To be commissioned shortly

Annexure-X

Status of protection relay type				
Constituent Name	**Name of Station**	**Element Name**	**Present Status**	**Remark**
Uttarakhand	220kV Rishikesh	SIDCUL line	Main-II is not installed	
		Chamba line		
		Dharasu line-2		
	220kV Chamba	Rishikesh line		
HP	220kV MattaSidh	220kV transformer bank-1 & 2	Static relay	
Rajasthan	220 kV GSS Sanganer	220 kV HEERAPURA	Static	
	220 kV GSS Phulera	220 KV HEERAPURA	Static	
		220 kV Makrana	Static	
	220 KV GSS CHOMU	220 kV Heerapura	Static	
		220 kV Reengus Line	Static	
	220 kV GSS Kukas	220 kV Manoharpur Line	Static	
		220 kV Alwar Line	Static	
	220kV GSS Dausa	220 kV SawaiMadhopur Line	Static	
		220 kV Bassi-I Line	Static	
		220 kV Bassi-II Line	Static	
		220 kV Alwar Line	Static	
		220 kV Mandawar Line	Static	
	220KV BHARATPUR GSS	220 KV DHOLPUR	Static	
	220 KV GSS SAKATPURA	220 kV ANTA(NTPC)	Static	
	220 KV DAHRA	220 kV BARAN	Static	
		220 kV SAKATPURA	Static	
	220KV GSS MODAK	220 kV RANPUR	Static	
		220 kV Jhalawar	Static	
	220 KV GSS JHALAWAR	220 kV Modak	Static	
	220KV GSS HINDAUN	220KV Sikrai Line	Static	relay defective
	220KV GSS DHOLPUR	220 kV DCPP	Static	
	220 KV GSS Reengus	220 KV Laxmangarh	Static	
	220 KV GSS Nagour	220KV NOKHA	Static	
		220KV KUCHERA	Static	
	220KV GSS Kankroli	220 KV PGCIL-I	Static	
	220 KV GSS SIROHI	220 KV (400) KV PGCIL Bhinmal	Static	
	220 KV GSS SIROHI	220 KV Jalore	Static	
	220 KV GSS BHINMAL	220 KV (400) KV PGCIL Bhinmal-I	Static	
	220 KV GSS BALI	220kV Sirohi	Static	
	220 KV GSS Suratgarh	220 KV STPS-I	Static	
		220 KV STPS-II	Static	
		220 KV Hanumangarh Line	Static	
	220 KV GSS Sri Ganganagar	220 KV Hanumangarh Line	Static	
	220 KV GSS Hanumangarh	220 KV Suratgarh	Static	
	220KV GSS Ratangarh	220KV Rawatsar	Static	
	220KV GSS Ratangarh	220KV Halasar	Static	
	220KV GSS Ratangarh	220KV InterConnector-I	Static	
	220KV GSS Ratangarh	220KV InterConnector-II	Static	
	220KV GSS Sujangarh	220KV Ratangarh	Static	
	220 KV GSS Bikaner	220 KV Badnu Line	Static	
	220 KV GSS Bikaner	220 KV Interconnector-I Line	Static	
	220 KV GSS Bikaner	220 KV Spare Line	Static	
	220kV Madanpur	220/66kV 100 MVA PTF T-1	Electromechanical	Working properly, need to be replace with numerical relay
		220/66kV 100 MVA PTF T-1 A	Electromechanical	Working properly, need to be replace with numerical relay
		220kV Bus-Coupler	Backup relay -Numerical all other relays are Electromechanical	Working properly, need to be replace with numerical relay
		220/66kV 100 MVA PTF T-1 A	Electromechanical Execept Differential relay (Numerical)	Working properly, need to be replace with numerical relay
	220 KV S/Stn Shahbad	100 MVA 220/66 KV T/F T-1	Electrostatic	Working properly, need to be replace with numerical relay
		220 KV Bus Coupler	Electrostatic	Working properly, need to be replace with numerical relay
		Incomer of 220/66 KV T/F T-1	Electrostatic	Working properly, need to be replace with numerical relay
		Incomer of 220/66 KV T/F T-2	Electrostatic	Working properly, need to be replace with numerical relay
	220 KV S/STnTepla	220KV Bus Coupler	Electromechanical	Working properly, need to be replace with numerical relay
	220KV S/Stn Jorian	220KV Jorian -DCRTPP Ckt-1	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220KV Jorian -DCRTPP Ckt-2	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220KV Jorian -Shahbad Ckt-1	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220KV Jorian -Shahbad Ckt-2	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220KV Jorian -Abdullapur Ckt-1	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay

Haryana		220KV Jorian -Abdullapur Ckt-2	Main-1 & Main-2 = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220/66, 160MVA T/F T-1	Defferntial Relay = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
		220/66, 100MVA T/F T-2	All Electromechanical	Working properly, need to be replace with numerical relay
		220/66, 100MVA T/F T-3	Defferntial & REF Relay = Numerical all other Electromechanical	Working properly, need to be replace with numerical relay
	220 kv Salempur	220 KV BAKANA–SALEMPUR CKT-I	All electromechanical type,except DPR relays	Working properly, need to be replace with numerical relay
		220 KV BAKANA–SALEMPUR CKT-II	All electromechanical type,except DPR relays	Working properly, need to be replace with numerical relay
		220 KV SALEMPUR-NISSING CKT-I	All electromechanical type,except DPR relays	Working properly, need to be replace with numerical relay
		220 KV SALEMPUR-NISSING CKT-II	All electromechanical type,except DPR relays	Working properly, need to be replace with numerical relay
		220 KV BUS-COUPLER	All electromechanical type	Working properly, need to be replace with numerical relay
		220/66 KV 100MVA T/F T-I	All electromechanical type,except Differential relays	Working properly, need to be replace with numerical relay
		220/66 KV 100MVA T/F T-2	All electromechanical type,except Differential relays	Working properly, need to be replace with numerical relay
	TS Division Karnal	220kV Nissing-PTPS Ckt-I	All electromechanical type,except DPR relays	
		100 MVA 220/132kV T-8	All electromechanical type,except Differential relay	Differential relay replcaed with Numerical type
		220 kV Bus-coupler	All electromechanical type	C&R panel will be replaced soon
		220 KV DCRTPP–UNISPUR CKT-I	All electromechanical type,except DPR relays	
		220 KV DCRTPP–UNISPUR CKT-II	All electromechanical type,except DPR relays	
		220 KV KARNAL–UNISPUR LINE	All electromechanical type,except DPR relays	
		220/132 KV 100 MVA T/F T-1	All electromechanical type,except R.E.F & Differential relay	
		220/132 KV 100 MVA T/F T-2	All electromechanical type,except R.E.F & Differential relay	
		220/132 KV 160 MVA T/F T-4	All electromechanical type,except R.E.F & Differential relay	
	220kV S/Stn Palla	100MVA 220/66kV T-1	REF & backup Electromechnical	
		100MVA 220/66kV T-2	REF & backup Electromechnical	
		100MVA 220/66kV T-7	Diff & Backup lectromechnical and REF static	
		220kV Palla - Sector 78	backup Electromechnical	
		220kV Palla - FGPP ckt-II	backup Electromechnical	
	220 kV S/Stn. Pali	100 MVA 220/66 kV T-1	REF & backup Electromechnical	
		100 MVA 220/66 kV T-3	REF & backup Electromechnical	
		220 kV Pali-BBMB Samaypur Ckt 1	backup Electromechnical	
		220 kV Pali-BBMB Samaypur Ckt 2	backup Electromechnical	
		220 kV Pali-Sector 46 Ckt 1	backup Electromechnical	
		220 kV Pali-Sector 46 Ckt 2	backup Electromechnical	
		220 kV Pali-Sector 65 Ckt 1	backup Electromechnical	
		220 kV Pali-Badshahpur Ckt 2	backup Electromechnical	
		220 kV Pali-Sector 56 Ckt 1	backup Electromechnical	
		220 kV Pali-Sector 56 Ckt 2	backup Electromechnical	
	220kV S/Stn Palwal	220/66kV 160MVA T-1 T/F	REF & backup Electromechnical	
		220/66kV 100MVA T-2 T/F	Diff, REF & Backup Electromechnical	
		220kV Prithala Palwal Ckt I	backup Electromechnical	
		220kV Prithala Palwal Ckt II	backup Electromechnical	
	220kv S/Stn. Sector 52A GGM	Sec 56-Sec 52A ckt 1	NUMERICAL RELAY qty 02 and electromechanical qty 01 (backup)	LINE IS PROVIDED WITH 2 MAIN NUMERICAL DPR AND 01 ELECTROMECHANICAL FOR BACKUP
		Sec 56-Sec 52A ckt 2	NUMERICAL RELAY qty 02 and electromechanical qty 01 (backup)	LINE IS PROVIDED WITH 2 MAIN NUMERICAL DPR AND 01 ELECTROMECHANICAL FOR BACKUP
		Sec 72-Sec 52A	NUMERICAL RELAY qty 02 and electromechanical qty 01 (backup)	LINE IS PROVIDED WITH 2 MAIN NUMERICAL DPR AND 01 ELECTROMECHANICAL FOR BACKUP
		Sec 57-Sec 52A	NUMERICAL RELAY qty 02 and electromechanical qty 01 (backup)	LINE IS PROVIDED WITH 2 MAIN NUMERICAL DPR AND 01 ELECTROMECHANICAL FOR BACKUP
	220KV S/Stn. Sonepat		(Diff.-3 , REF-3, O/C/E/F-4 , Electromechnical Relays	The electromechanical differential and DPR are not available in the store. However, the same shall be replaced after availability in the store.
	220kV Rohtak		(REF-2, O/C/E/F-12) Electromechnical Relays	
	400 KV S/S Moradabad	400 KV MORADABAD - RAMPUR LINE	LBB- ABB(RAICA) / STATIC	UNDER PGCIL
		400 KV MORADABAD - KASHIPUR LINE	LBB- English Electric(CTIG) / Electromechnical	Will be replaced by July24
		400 KV, TRANSFER BUS	LBB- English Electric(CTIG) / Electromechnical	
		400 KV, BUS COUPLER	LBB- English Electric(CTIG) / Electromechnical	
	220kV S/S BARAUT	220/132kV 200MVA TRANSFORMER-1	REF Protection - Electromechanical	
	220kV S/S BAGHPAT	220/132kV 160MVA TRANSORMER-1	Backup (L.V. Side) - Electromechanical	
	220 kV KHURJA	220/132Kv 200MVA Transformer-I	REF-Static	
	220 kV DEBAI	220/132Kv 100MVA Transformer-I	Numerical	
	220 kV Jahangirabad	220/132Kv 160MVA Transformer-I	REF-Static	
	400KV S/S MURAD NAGAR	220KV LONI LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		220KV FARID NAGAR LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		220KV INTER CONNECTOR-I MURAD NAGAR LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		220KV INTER CONNECTOR-II MURAD NAGAR LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		220KV SAHIBABAD LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	

UP		220KV PRATAP VIHAR LINE	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		220KV TBC	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		400KV TBC	O/C & E/F RELAY IS ELECTROMECHANICAL.	
		400KV ALIGARH LINE	LBB RELAY IS ELECTROMECHANICAL.	
		400KV ATOUR LINE	LBB RELAY IS ELECTROMECHANICAL.	
	220KV S/S MURAD NAGAR	220KV BUS COUPLER	O/C RELAY IS ELECTROMECHANICAL	
	400KV S/S Gorakhpur	400KV TBC	Electromechanical	
		220KV TBC	Electromechanical	
	220KV S/S Barahua	220KV PGCIL	Back up relay electromechenical	
	220KV S/S Basti	220 KV Basti Tanda line	67N(2TJM12)(Electromechanical)	
		63MVA Transformer-II	HV Side directional o/c&e/f(Electromechanical)	
	400 KV SS Kasara,Mau	200MVA, 400/132KV ICT-1st	REF & Over flux relay Electromechanical	
		200MVA, 400/132KV ICT-2nd	REF & Over flux relay Electromechanical	
	220 KV SS Substation Hafizpur Azamgarh	160 MVA ICT -1	Electromechanical(EE Make)	Replaced with Siemens make numerical relay on 16.10.2023
	220kV Khara		Electromechanical	process of replacing electrochemical relay with numerical relay has been started, it will be completed within 2-3 months.
	220kV Gokul	160MVA ICT-1	Electromechanical (Diff and O/C)	New panels are available at S/s and replacement work is under process
	220kV Meetai	200MVA ICT-1	Electromechanical (E/F and O/C), Diff:Static	
		200MVA ICT-2	Electromechanical (E/F and O/C), Diff:Static	
	220kV Atrauli	160MVA ICT-1	Electromechanical + Numerical	Tender process is complete.
		160MVA ICT-2	Electromechanical + Numerical	
	220kV Mainpuri	160MVA ICT-1	Electromechanical(REF) + Numerical	New panels are available at S/s and replacement work is under process
		160MVA ICT-2	Electromechanical(REF) + Numerical	
	220kV Panki	220kV Bus coupler	Electromechanical	Under process
	400kV S/S Sultanpur	240 MVA ICT-II	Non Numerical	
		50 MVAR Obra Line Reactor	Non Numerical	
	220kV S/S Sultanpur	220kV B/C	Non Numerical	
		160 MVA T/F-I	Non Numerical	
NPCIL	220kV RAPPC	220KV Anta line	Backup relay: Static relay(RAPDK3)	Procurement of Numerical relay is in progress for replacement of Static relay (Backup protection).
	220kV NAPP	NAPP-SAMBHAL		Main-2 distance protection is under procurement. ECD- June2024
		NAPP-SIBHOLI		Main-2 distance protection is under procurement. ECD- June2024
		NAPP-DIBAI		Main-2 distance protection is under procurement. ECD- June2024
		NAPP-KHURJA		Main-2 distance protection is under procurement. ECD- June2024
		NAPP-ATRAULI		

Annexure-XI

RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LTD

[Corporate Identity Number CIN: U40109RJ2000SGC016485]
(AN ISO 9001:2015 CERTIFIED COMPANY)
Regd. Office: VidyutBhawan, Janpath ,Jyoti Nagar, Jaipur 302005

OFFICE OF THE SUPERINTENDING ENGINEER (Automation, N/M &SP)
Rom No.323, VidyutBhawan, Janpath ,Jyoti Nagar, Jaipur (Tel.No. 2740752 / Fax No. 2740794)
Email: se.pp@rvpn.co.in, website: www.http://emergy.rajasthan.gov.in/rvpnl

No. RVPN/ SE(AUTOMATION)/ XEN(PP&D)/ AE-2(P&P)/ D.116 Jaipur Date 21.12.2023

The General Manager (NRLDC)
Grid Controller of India Limited,
18-A, ShaheedJeet Singh SansanwalMarg, KatwariaSarai
New Delhi-110016.

Sub:-Proposed SPS for 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station.

On the above captioned subject, please find attached the proposed SPS for 2x315 MVA, 400/220 KV ICTs at Suratgarh Thermal Power Station with request to please include in the next meeting of OCC for discussion and necessary approval of the OCC forum. This SPS has been finalized after detailed deliberations with the officers of RVPN, RVUN and Rajasthan SLDC in a meeting held on dated 12.12.2023.

Encl: As above

Yours sincerely,

(S.C. Meena)
Chief Engineer (PP & D)

Copy to the following for information and necessary action please-

1. The Member Sceratry (NRPC), 18-A, ShaheedJeet Singh Marg, KatwariaSarai, New Delhi-110016
2. The Chief Engineer (LD/T&C/MPT&S/O&M), RVPN, Jaipur/Jodhpur/Jodhpur/RVUN-STPS-Suratgarh.
3. The Chief Engineer, Power System Planning & Appraisal-I Division, CEA, Sewa Bhawan, RK Puram-I, New Delhi-110066
4. The Superintending Engineer (Operation), NRPC, 18-A, ShaheedJeet Singh Marg, Katwaria Sarai, New Delhi-110016.
5. The System Operator-2, NRLDC, 18-A, ShaheedJeet Singh Marg, Katwaria Sarai, New Delhi-110016

Encl: As above

Chief Engineer (PP & D)

Signature valid
Digitally signed by Suresh Chand Meena
Designation : Chief Engineer
Date: 2023.12.20 16:10:35 IST
Reason: Approved

Proposed SPS for 2x315 MVA, 400/220 kV ICTs at SURATGARH THERMAL POWER STATION

1. Generation Details at STPS

- There is generation on the 220 kV voltage level and 400 kV voltage level at Suratgarh Thermal Power Station (STPS).
- There are 6 generating units at STPS. Each unit is rated at 250MW. Two generators are connected on the 220 kV bus and four generators are connected on the 400 kV bus. Details of the generating units at STPS are included in Table 1.

Table 1: Generation Capacity at STPS

S. No.	Name of Generating Unit	Rated MW Capacity	Ex-bus Generation	Rated Generation Voltage (kV)	Voltage of Bus to which Generating unit is connected
1	Unit-1	250 MW	225MW	16.5kV	220 kV
2	Unit-2	250 MW	225MW	16.5kV	220 kV
3	Unit-3	250 MW	225MW	16.5kV	400 kV
4	Unit-4	250 MW	225MW	16.5kV	400 kV
5	Unit-5	250 MW	225MW	16.5kV	400 kV
6	Unit-6	250 MW	225MW	16.5kV	400 kV

2. Details of Installed ICTs and Transmission Lines

- There are 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station (STPS).
- These ICTs are used to step down the power from 400kV voltage level to 220 kV voltage level to meet load demand in Halasar, Bhadra, Rawatsar, Suratgarh, Hanumangarh, Padmapur and Sriganganagar region.
- Loading on these ICTs is maximum during off-RE hours.
- Load sharing on both the ICTs is almost equal.
- 220 kV GSS at Halasar, Bhadra, Rawatsar and Udyogvihar are connected to STPS through 220 kV S/C lines. These GSS are further connected in ring system.
- 220 kV GSS Suratgarh is connected to STPS through 220 kV D/C line.
- 220 kV GSS Suratgarh, 220 kV GSS Padampur, 220 kV GSS Hanumangarh and 220 kV GSS Udyogvihar are connected in ring system.
- Power map of transmission system in Suratgarh and nearby region is shown in Figure 1.

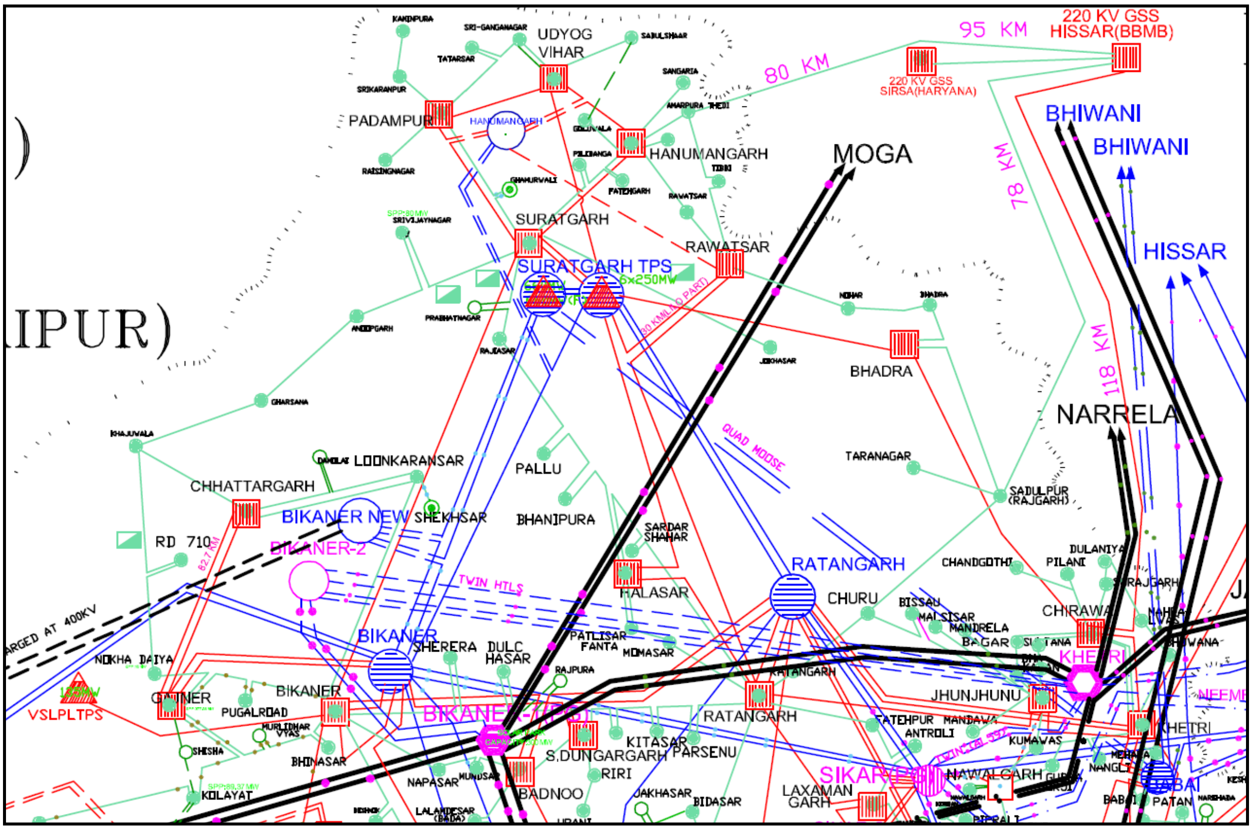


Fig. 1 Power map of Suratgarh region

3. Load Details on ICTs and Transmission Lines Associated with STPS

- The 2x315MVA, 400/220 kV ICTs at STPS are used to cater load demand in the Halasar, Bhadra, Rawatsar, Suratgarh, Hanumangarh, Padmapur and Sriganganagar region.
- Peak Loads recorded on the 400/220 kV ICTs, 400 kV lines and 220 kV lines associated with STPS are detailed below in Table 2.
- Peak loads and average loads recorded on the 220/132 kV Transformers on the 220 kV GSS in the region is also mentioned in the Table 1.

Table 1: Load Details on ICTs and Transmission Lines Associated with STPS and GSS fed from STPS

S. No.	Name of Element	Recorded Peak Load (MW)	Average Load (MW)
1	315MVA, 400/220 kV ILT-I at STPS	297MW	260 MW
2	315MVA, 400/220 kV ILT-II at STPS	297MW	260 MW
3	400 kV STPS-Ratangarh Line-I	640MW	
4	400 kV STPS-Ratangarh Line-II	640MW	
5	400 kV STPS-Bikaner Line	225MW (Bidirectional Power flow)	
6	400 kV STPS-SCSTPS Line-I	550MW (Import)	
7	400 kV STPS-SCSTPS Line-II	550MW (Import)	
8	220 kV S/C STPS-Halasar line	196 MW	106 MW
9	220 kV S/C STPS-Rawatsar line	174MW	120MW
10	220 kV S/C STPS-Bhadra line	209.6MW	174.8MW

11	220 kV S/C STPS-Udyogvihar (Sriganganagar) line	206MW	144MW
12	220 kV STPS-Suratgarh line Ckt-I	246MW	201MW
13	220 kV STPS-Suratgarh line Ckt-II	246MW	200MW
14	220 kV S/C Halasar-Ratangarh line	196 MW	106 MW
15	220 kV S/C Rawatsar-Ratangarh line	134MW	90MW
16	220 kV Suratgarh-Hanumangarh line	246MW	138MW
17	220 kV Suratgarh-Padampur line	191MW	113MW
18	220 kV Suratgarh-Bikaner line	119MW	65MW
19	220 kV Padampur-Udyogvihar line	136MW	70MW
20	220 kV Udyogvihar-Hanumangarh line	145MW	92.75MW
21	100MVA, 220/132 kV transformer-I at Bhadra	87.21MW	74.48MW
22	100MVA, 220/132 kV transformer-II at Bhadra	87MW	64.3MW
23	160MVA, 220/132 kV transformer at Rawatsar	143MW	100MW
24	160MVA, 220/132 kV transformer-I at Halasar	160MW	124MW
25	100MVA, 220/132 kV transformer-II at Halasar	100MW	58MW
26	100MVA, 220/132 kV transformer-I at Suratgarh	105MW	87MW
27	100MVA, 220/132 kV transformer-II at Suratgarh	98MW	78MW
28	50MVA, 220/132 kV transformer-III at Suratgarh	53MW	47MW
29	100MVA, 220/132 kV transformer-I at Hanumangarh	91.10MW	71.37MW
30	160MVA, 220/132 kV transformer-II at Hanumangarh	154MW	122.20MW
31	160MVA, 220/132 kV transformer at Udyog Vihar	148MW	103MW
32	100MVA, 220/132 kV transformer-I at Padampur	60MW	42MW
33	160MVA, 220/132 kV transformer-II at Padampur	82MW	63MW

4. Proposed SPS for ILTs at Suratgarh Thermal Power Station

- Communication channels are available on the following transmission lines which can be used to communicate the trip command from STPS to the transformers installed on the respective 220 kV GSS:-
  - 220 kV S/C STPS-Rawatsar line line
  - 220 kV S/C STPS-Bhadra line
  - 220 kV S/C STPS-Udyogvihar (Sriganganagar) line
- 220 kV GSS Rawatsar is fed from STPS sometimes and sometimes it is also fed from ratangarh depending on the load and grid conditions. Hence, 220 kV GSS Rawatsar cannot be included in the SPS for ICTs at STPS. 220 kV GSS Halasar can be considered for SPS after shifting of a PLCC panel from 220 kV GSS Ratangarh to STPS.
- After detailed analysis of loading conditions, power injection, available communication channels & grid interconnection issues, following universal logic is proposed for the 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station (STPS) which will work for all the operating scenarios:-

  SPS Logic: **Overloading of the ILTs due to tripping of generating units on the 220 kV Bus or increased load in the region or tripping of one 315 MVA, 400/220 kV ICT. These overload settings with time delays will be implemented for both the ICTs.**

Trip command for the Transformers at 220 kV GSS will be generated from both the ILTs at 100% loading.

- Trip 2x100MVA, 220/132 kV Transformer at 220 kV GSS Bhadra with time delay of 1.0s (**Load curtailment: 138.78MW**)
- Trip 1x160MVA, 220/132 kV Transformer and 1x100MVA, 220/132 kV Transformer at 220 kV GSS Halasar with time delay of 1.2s (**Load curtailment: 182 MW**)
- Trip 1x160MVA, 220/132 kV Transformer at 220 kV GSS Udyogvihar and 132 kV S/C Udyogvihar-Sriganganar line with time delay of 1.4s (**Load curtailment: 103MW**)

- Tripping commands for the transformers installed at the identified 220 kV GSS will be generated from the overload/Over current relays of both the 315MVA, 400/220 kV ILTs at STPS during the condition of overloading of ILTs at STPS. The overloading may be observed due to tripping of generators connected on 220 kV Bus, increased load in the region or tripping of any one of 315MVA, 400/220 kV ICT at STPS. Schematic diagram for implementation of proposed SPS Logic-1 is elaborated in Figure 2.

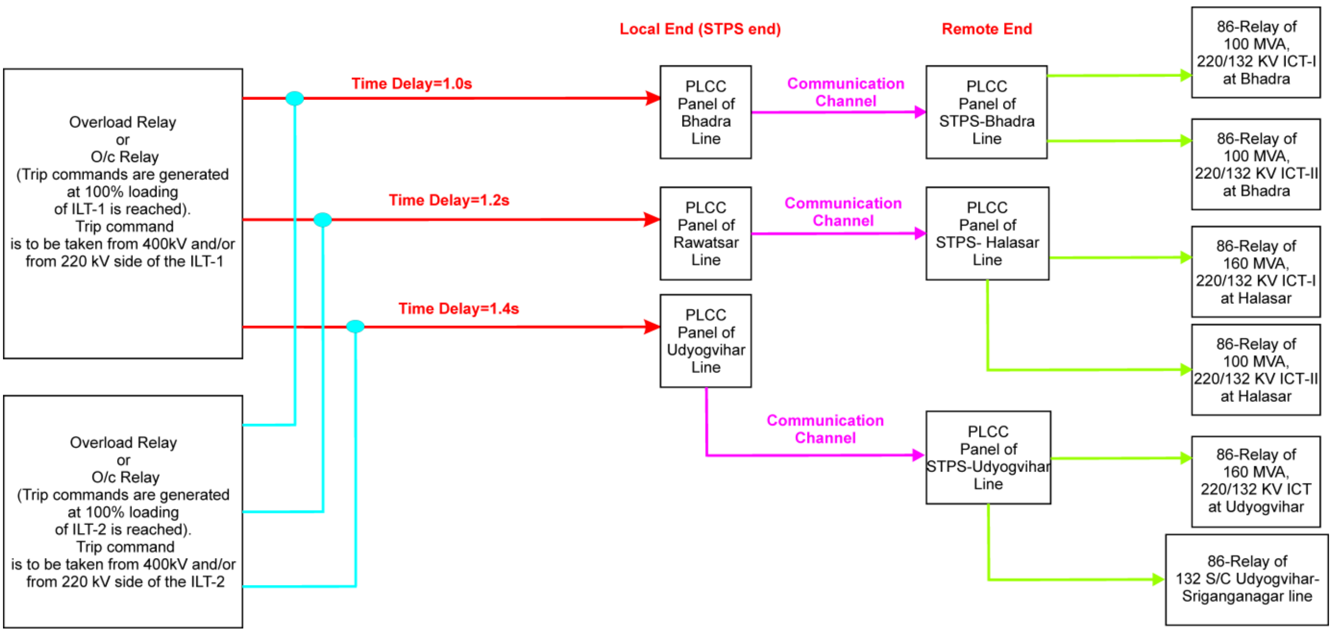


Fig. 2 Schematic diagram for implementation of proposed SPS Logic

- To maintain supply of critical loads connected to all the GSS in the region, tripped 220/132 kV Transformers at the identified 220 kV GSS may be re-connected after applying load shedding on all the GSS in the region in such a quantum to maintain loadings on the 2x315MVA, 400/220 kV ILTs at STPS within permissible limits. Same procedure will be adopted in the event of tripping of any one of the 315MVA, 400/220 kV ILT at STPS to maintain loadings on the healthy ILT at STPS within permissible limits.

Annexure-XII

RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LTD

[Corporate Identity Number CIN: U40109RJ2000SGC016485]
(AN ISO 9001:2015 CERTIFIED COMPANY)
Regd. Office: VidyutBhawan, Janpath ,Jyoti Nagar, Jaipur 302005

OFFICE OF THE SUPERINTENDING ENGINEER (Automation, N/M &SP)
Rom No.323, VidyutBhawan, Janpath ,Jyoti Nagar, Jaipur (Tel.No. 2740752 / Fax No. 2740794)
Email: se.pp@rvpn.co.in, website: www.http://emergy.rajasthan.gov.in/rvpnl

No. RVPN/ SE(AUTOMATION)/ XEN(PP&D)/ AE-2(P&P)/ D. 131 Jaipur Date 10.01.2024

The General Manager (NRLDC)
Grid Controller of India Limited,
18-A, ShaheedJeet Singh SansanwalMarg, KatwariaSarai
New Delhi-110016.

Sub:-Proposed SPS for 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station.

On the above captioned subject, please find attached the revised proposed SPS for 2x315 MVA, 400/220 KV ICTs at Suratgarh Thermal Power Station after incorporating the comments of Grid-India with request to please consider for discussion and necessary approval of the OCC forum.

Encl: As above

(S.C. Meena)
Chief Engineer (PP&D)
RVPNL, Jaipur.

Copy to the following for information and necessary action please-

1. The Member Sceratry (NRPC), 18-A, ShaheedJeet Singh Marg, KatwariaSarai, New Delhi-110016
2. The Chief Engineer (LD/T&C/MPT&S/O&M), RVPN, Jaipur/Jodhpur/Jodhpur/RVUN-STPS-Suratgarh.
3. The Chief Engineer, Power System Planning & Appraisal-I Division, CEA, SewaBhawan, RK Puram-I, New Delhi-110066
4. The Superintending Engineer (Operation), NRPC, 18-A, ShaheedJeet Singh Marg, KatwariaSarai, New Delhi-110016.
5. The System Operator-2, NRLDC, 18-A, ShaheedJeet Singh Marg, KatwariaSarai, New Delhi-110016

Encl: As above

Chief Engineer (PP&D)
RVPNL, Jaipur

RajKaj Ref
5320207

Signature valid
Digitally signed by S[illegible]sh Chand Meena
Designation :[illegible] Engineer
Date: 2024.01.[illegible]8:00:35 IST
Reason: Approved

Proposed SPS for 2x315 MVA, 400/220 kV ICTs at SURATGARH THERMAL POWER STATION

1. Generation Details at STPS

- There is generation on the 220 kV voltage level and 400 kV voltage level at Suratgarh Thermal Power Station (STPS).
- There are 6 generating units at STPS. Each unit is rated at 250MW. Two generators are connected on the 220 kV bus and four generators are connected on the 400 kV bus. Details of the generating units at STPS are included in Table 1.

Table 1: Generation Capacity at STPS

S. No.	Name of Generating Unit	Rated MW Capacity	Ex-bus Generation	Rated Generation Voltage (kV)	Voltage of Bus to which Generating unit is connected
1	Unit-1	250 MW	225MW	16.5kV	220 kV
2	Unit-2	250 MW	225MW	16.5kV	220 kV
3	Unit-3	250 MW	225MW	16.5kV	400 kV
4	Unit-4	250 MW	225MW	16.5kV	400 kV
5	Unit-5	250 MW	225MW	16.5kV	400 kV
6	Unit-6	250 MW	225MW	16.5kV	400 kV

2. Details of Installed ICTs and Transmission Lines

- There are 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station (STPS).
- These ICTs are used to step down the power from 400kV voltage level to 220 kV voltage level to meet load demand in Halasar, Bhadra, Rawatsar, Suratgarh, Hanumangarh, Padmapur and Sriganganagar region.
- Loading on these ICTs is maximum during off-RE hours.
- Load sharing on both the ICTs is almost equal.
- 220 kV GSS at Halasar, Bhadra, Rawatsar and Udyogvihar are connected to STPS through 220 kV S/C lines. These GSS are further connected in ring system.
- 220 kV GSS Suratgarh is connected to STPS through 220 kV D/C line.
- 220 kV GSS Suratgarh, 220 kV GSS Padampur, 220 kV GSS Hanumangarh and 220 kV GSS Udyogvihar are connected in ring system.
- Power map of transmission system in Suratgarh and nearby region is shown in Figure 1.

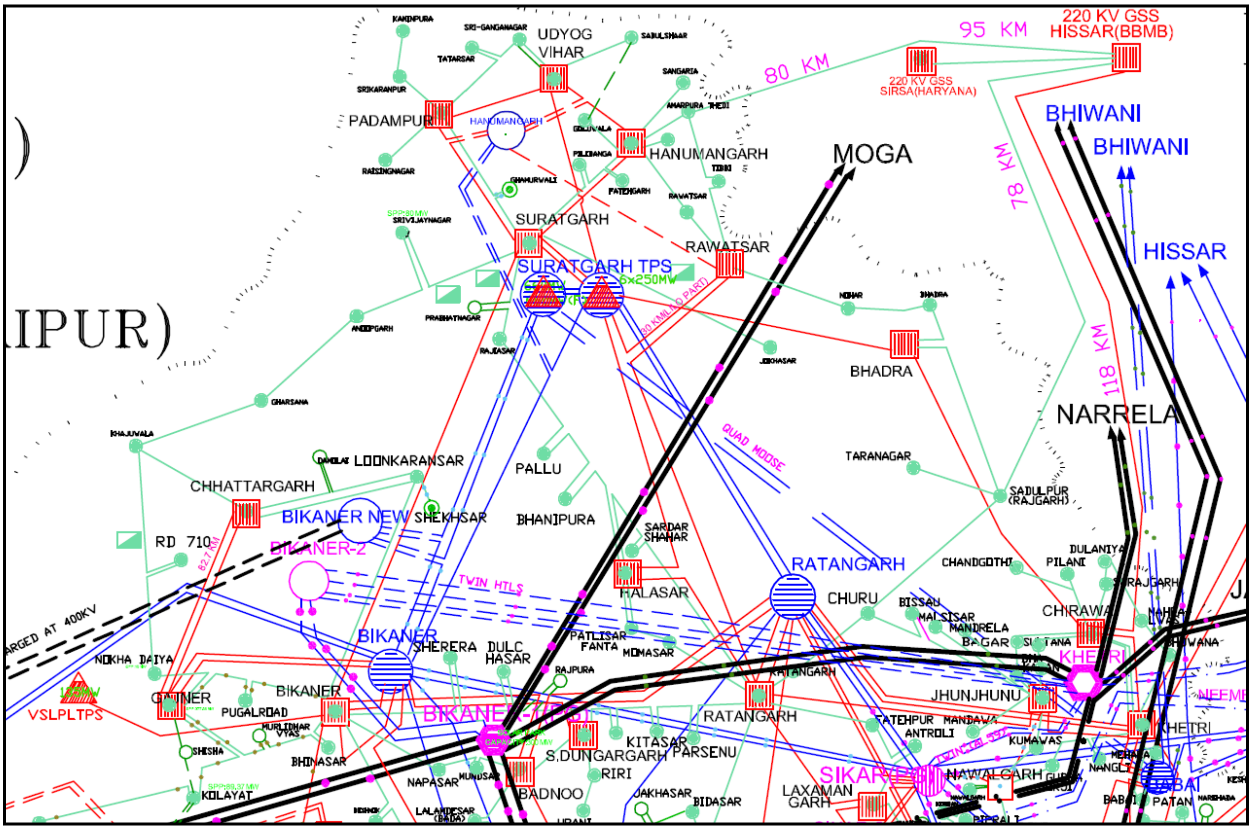


Fig. 1 Power map of Suratgarh region

3. Load Details on ICTs and Transmission Lines Associated with STPS

- The 2x315MVA, 400/220 kV ICTs at STPS are used to cater load demand in the Halasar, Bhadra, Rawatsar, Suratgarh, Hanumangarh, Padmapur and Sriganganagar region.
- Peak Loads recorded on the 400/220 kV ICTs, 400 kV lines and 220 kV lines associated with STPS are detailed below in Table 2.
- Peak loads and average loads recorded on the 220/132 kV Transformers on the 220 kV GSS in the region is also mentioned in the Table 1.

Table 1: Load Details on ICTs and Transmission Lines Associated with STPS and GSS fed from STPS

S. No.	Name of Element	Recorded Peak Load (MW)	Average Load (MW)
1	315MVA, 400/220 kV ILT-I at STPS	297MW	260 MW
2	315MVA, 400/220 kV ILT-II at STPS	297MW	260 MW
3	400 kV STPS-Ratangarh Line-I	640MW	
4	400 kV STPS-Ratangarh Line-II	640MW	
5	400 kV STPS-Bikaner Line	225MW (Bidirectional Power flow)	
6	400 kV STPS-SCSTPS Line-I	550MW (Import)	
7	400 kV STPS-SCSTPS Line-II	550MW (Import)	
8	220 kV S/C STPS-Halasar line	196 MW	106 MW
9	220 kV S/C STPS-Rawatsar line	174MW	120MW
10	220 kV S/C STPS-Bhadra line	209.6MW	174.8MW

11	220 kV S/C STPS-Udyogvihar (Sriganganagar) line	206MW	144MW
12	220 kV STPS-Suratgarh line Ckt-I	246MW	201MW
13	220 kV STPS-Suratgarh line Ckt-II	246MW	200MW
14	220 kV S/C Halasar-Ratangarh line	196 MW	106 MW
15	220 kV S/C Rawatsar-Ratangarh line	134MW	90MW
16	220 kV Suratgarh-Hanumangarh line	246MW	138MW
17	220 kV Suratgarh-Padampur line	191MW	113MW
18	220 kV Suratgarh-Bikaner line	119MW	65MW
19	220 kV Padampur-Udyogvihar line	136MW	70MW
20	220 kV Udyogvihar-Hanumangarh line	145MW	92.75MW
21	100MVA, 220/132 kV transformer-I at Bhadra	87.21MW	74.48MW
22	100MVA, 220/132 kV transformer-II at Bhadra	87MW	64.3MW
23	160MVA, 220/132 kV transformer at Rawatsar	143MW	100MW
24	160MVA, 220/132 kV transformer-I at Halasar	160MW	124MW
25	100MVA, 220/132 kV transformer-II at Halasar	100MW	58MW
26	100MVA, 220/132 kV transformer-I at Suratgarh	105MW	87MW
27	100MVA, 220/132 kV transformer-II at Suratgarh	98MW	78MW
28	50MVA, 220/132 kV transformer-III at Suratgarh	53MW	47MW
29	100MVA, 220/132 kV transformer-I at Hanumangarh	91.10MW	71.37MW
30	160MVA, 220/132 kV transformer-II at Hanumangarh	154MW	122.20MW
31	160MVA, 220/132 kV transformer at Udyog Vihar	148MW	103MW
32	100MVA, 220/132 kV transformer-I at Padampur	60MW	42MW
33	160MVA, 220/132 kV transformer-II at Padampur	82MW	63MW

4. Proposed SPS for ILTs at Suratgarh Thermal Power Station

- Communication channels are available on the following transmission lines which can be used to communicate the trip command from STPS to the transformers installed on the respective 220 kV GSS:-
  - 220 kV S/C STPS-Rawatsar line line
  - 220 kV S/C STPS-Bhadra line
  - 220 kV S/C STPS-Udyogvihar (Sriganganagar) line
- 220 kV GSS Rawatsar is fed from STPS sometimes and sometimes it is also fed from ratangarh depending on the load and grid conditions. Hence, 220 kV GSS Rawatsar cannot be included in the SPS for ICTs at STPS. 220 kV GSS Halasar can be considered for SPS after shifting of a PLCC panel from 220 kV GSS Ratangarh to STPS.
- After detailed analysis of loading conditions, power injection, available communication channels & grid interconnection issues, following universal logic is proposed for the 2x315MVA, 400/220 kV ICTs at Suratgarh Thermal Power Station (STPS) which will work for all the operating scenarios:-

  SPS Logic: **Overloading of the ILTs due to tripping of generating units on the 220 kV Bus or increased load in the region or tripping of one 315 MVA, 400/220 kV ICT. These overload settings with time delays will be implemented for both the ICTs.**

Trip command for the Transformers at 220 kV GSS will be generated from both the ILTs at 100% loading.

- Trip 2x100MVA, 220/132 kV Transformer at 220 kV GSS Bhadra and 220kV S/C Bhadra-Chirawa line with time delay of 1.0s (**Load curtailment: 138.78MW**)
- Trip 1x160MVA, 220/132 kV Transformer and 1x100MVA, 220/132 kV Transformer at 220 kV GSS Halasar and 220kV S/C Halasar-Ratangarh line with time delay of 1.2s (**Load curtailment: 182 MW**)
- Trip 1x160MVA, 220/132 kV Transformer at 220 kV GSS Udyogvihar and 132 kV S/C Udyogvihar-Sriganganar line with time delay of 1.4s (**Load curtailment: 103MW**)

- Tripping commands for the transformers installed at the identified 220 kV GSS will be generated from the overload/Over current relays of both the 315MVA, 400/220 kV ILTs at STPS during the condition of overloading of ILTs at STPS. The overloading may be observed due to tripping of generators connected on 220 kV Bus, increased load in the region or tripping of any one of 315MVA, 400/220 kV ICT at STPS. Schematic diagram for implementation of proposed SPS Logic-1 is elaborated in Figure 2.

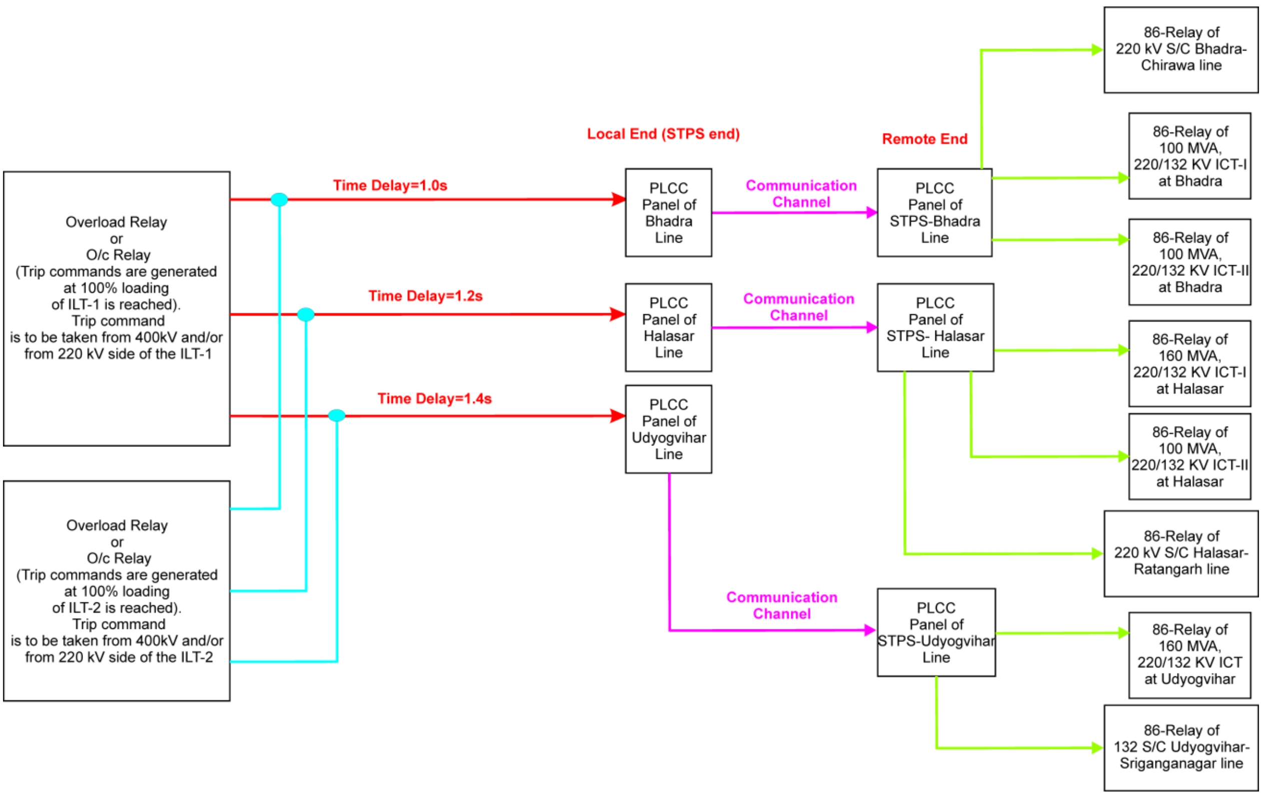


Fig. 2 Schematic diagram for implementation of proposed SPS Logic

- To maintain supply of critical loads connected to all the GSS in the region, tripped 220/132 kV Transformers at the identified 220 kV GSS may be re-connected after applying load shedding on all the GSS in the region in such a quantum to maintain loadings on the 2x315MVA, 400/220 kV ILTs at STPS within permissible limits. Same procedure will be adopted in the event of tripping of any one of the 315MVA, 400/220 kV ILT at STPS to maintain loadings on the healthy ILT at STPS within permissible limits.

Annexure-XIII

Multiple elements tripping at 400kV Rosa TPS(UP)

07th September 2023

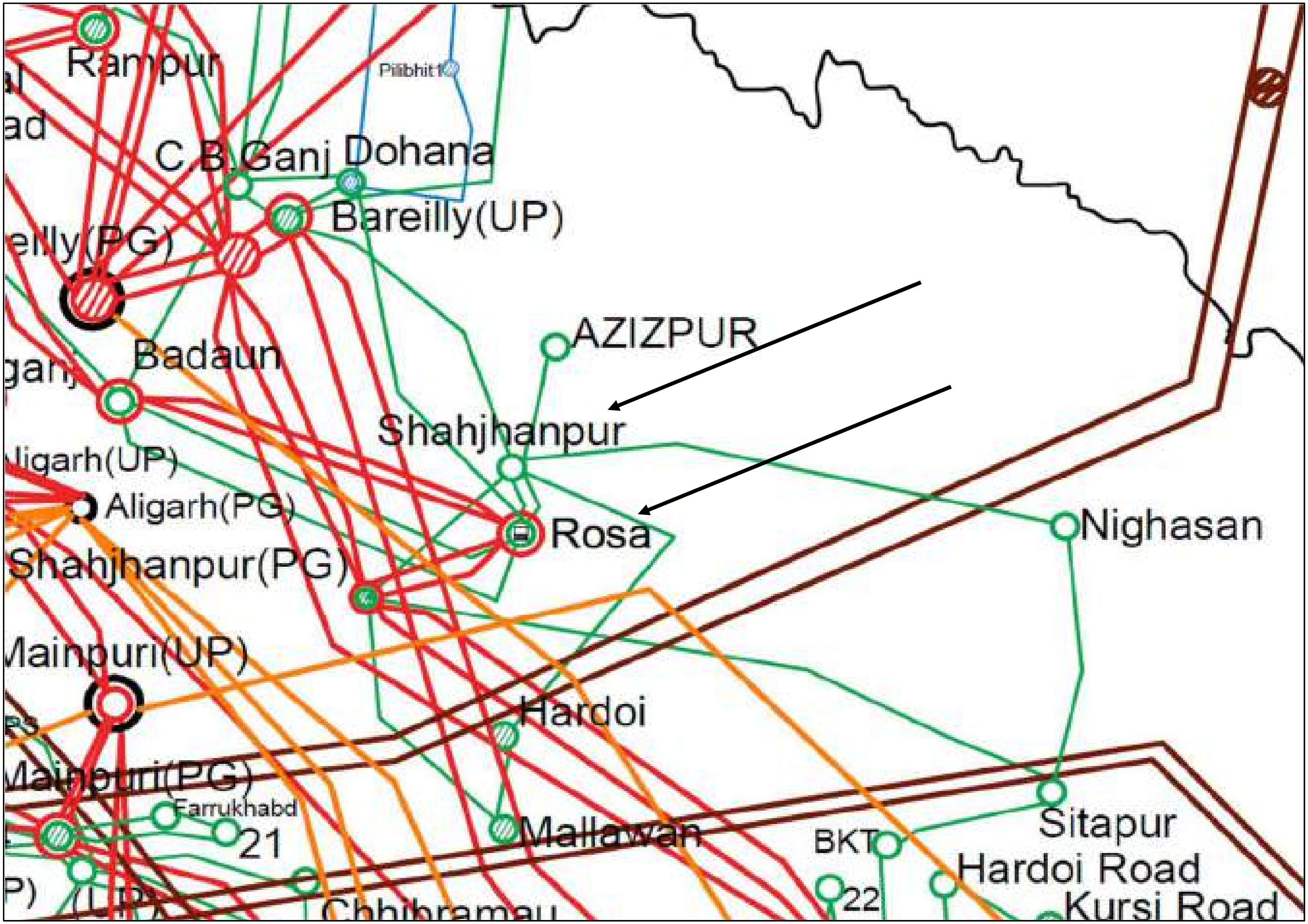
Brief of event:

- 400/220kV Rosa(UP) S/s has double main transfer bus scheme as 400 & 220kV level.
- As reported, at 12:37 hrs, **R-Y fault occurred on 220kV Rosa-Badaun(UP) Ckt-2,** Rosa end distance protection sensed fault in Z-2 (93km). **Line CB at Rosa end didn't open and LBB also failed to operate.** R-ph conductor of 220kV Rosa-Badaun(UP) Ckt-2 was found broken.
- Further, adjacent 220kV feeders at Rosa and tripped from remote end and 400/220kV 200MVA ICTs at Rosa tripped on O/C E/F protection operation.
- At the same time, 300 MW Rosa TPS - UNIT 2 tripped on standby earth fault protection operation and 220kV Shahjahanpur(PG)-Shahjhanpur(UP) Ckt also tripped from Shahjhanpur(PG) end only. (as per SOE).

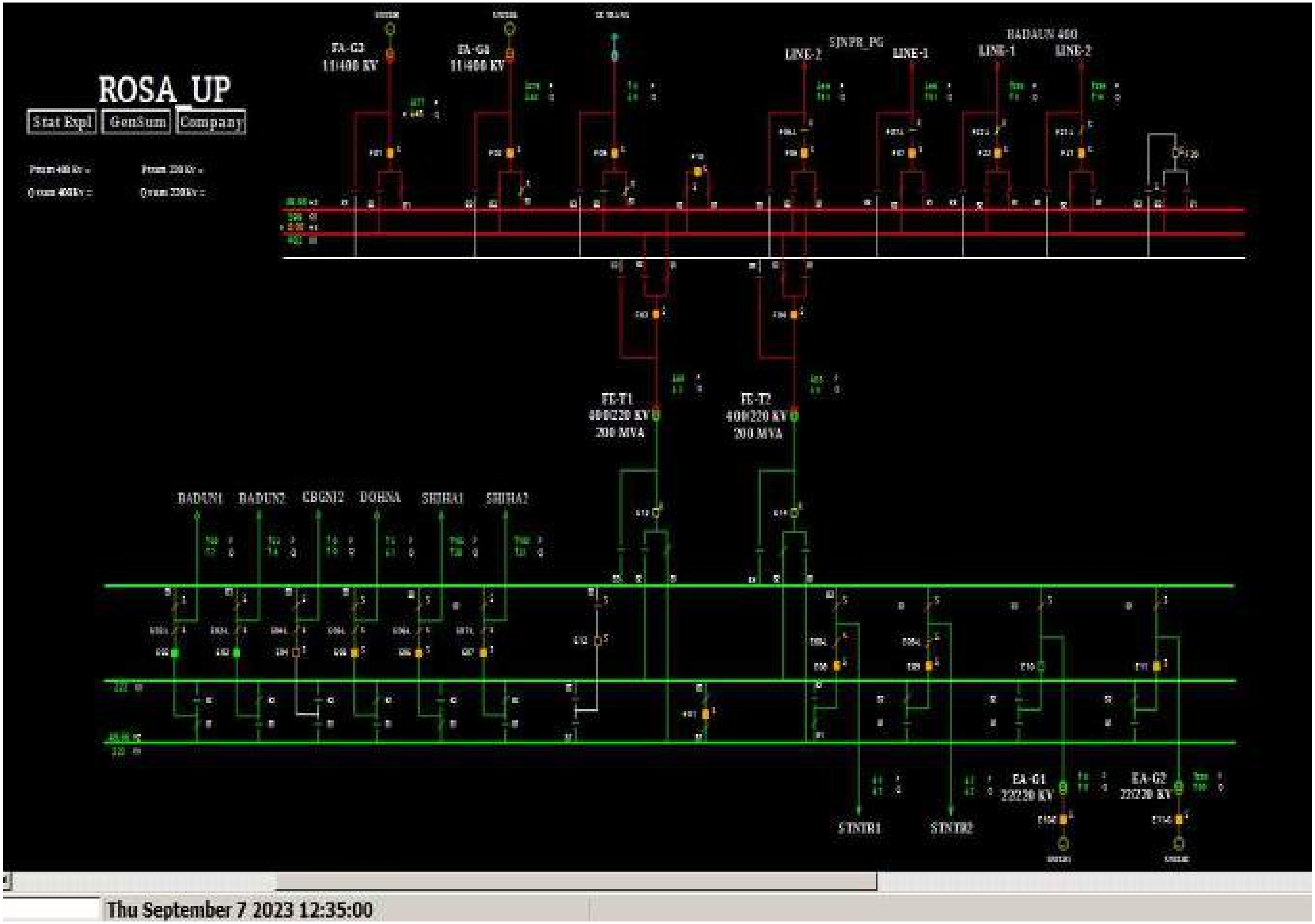
Elements tripped:

i. 400/220kV 200MVA ICT-1 at Rosa(UP)
ii. 400/220kV 200MVA ICT-2 at Rosa(UP)
iii. 300 MW Rosa TPS - UNIT 2
iv. 220kV Shahjahanpur(UP)-Rosa TPS(UP) Ckt-1
v. 220kV Shahjahanpur(UP)-Rosa TPS(UP) Ckt-2
vi. 220kV Rosa-Badaun(UP) Ckt-1
vii. 220kV Rosa-Badaun(UP) Ckt-2
viii. 220kV Rosa-Dohna(UP) Ckt-1
ix. 220kV Shahjahanpur(PG)-Shahjhanpur(UP) Ckt

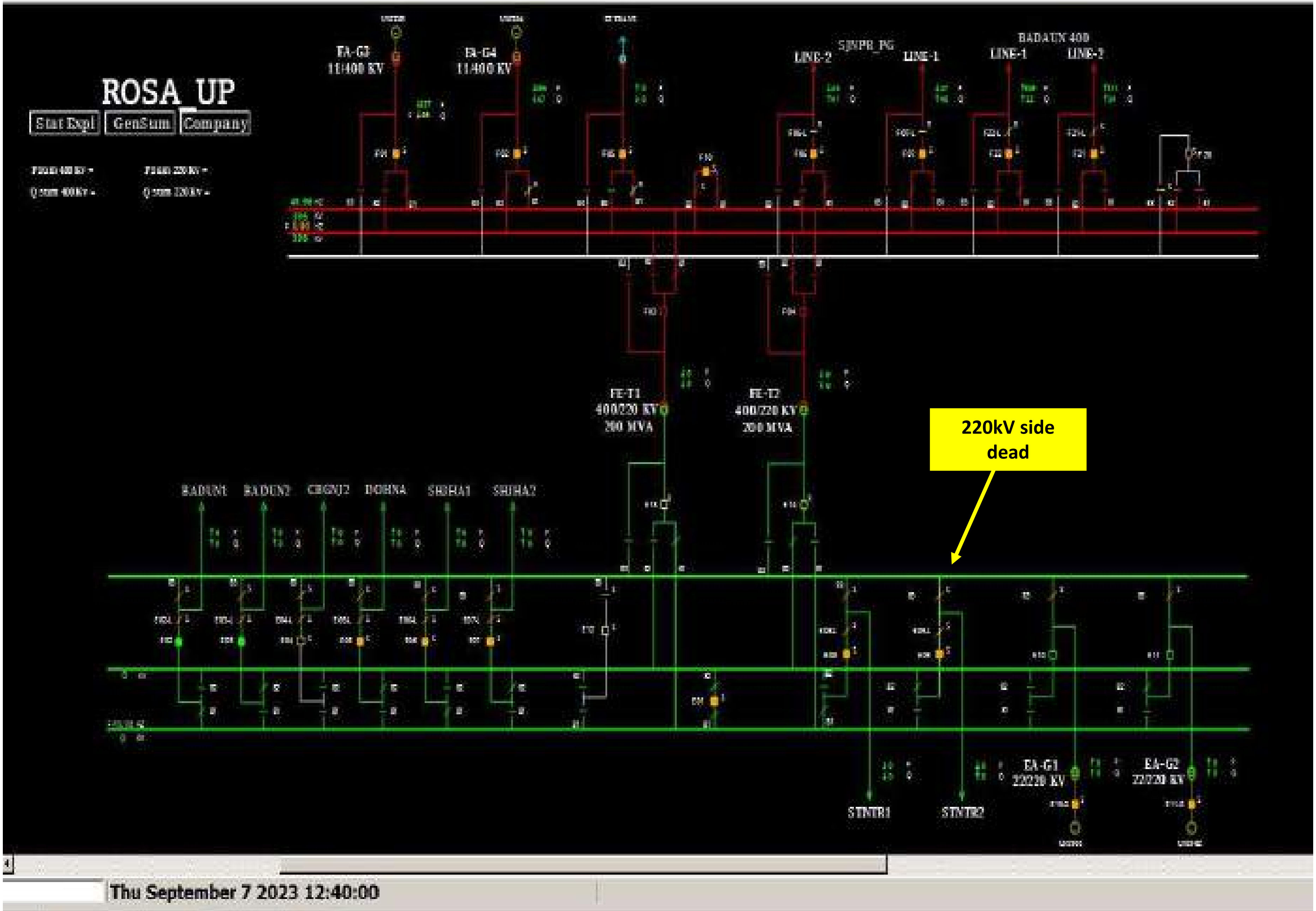
Network Diagram



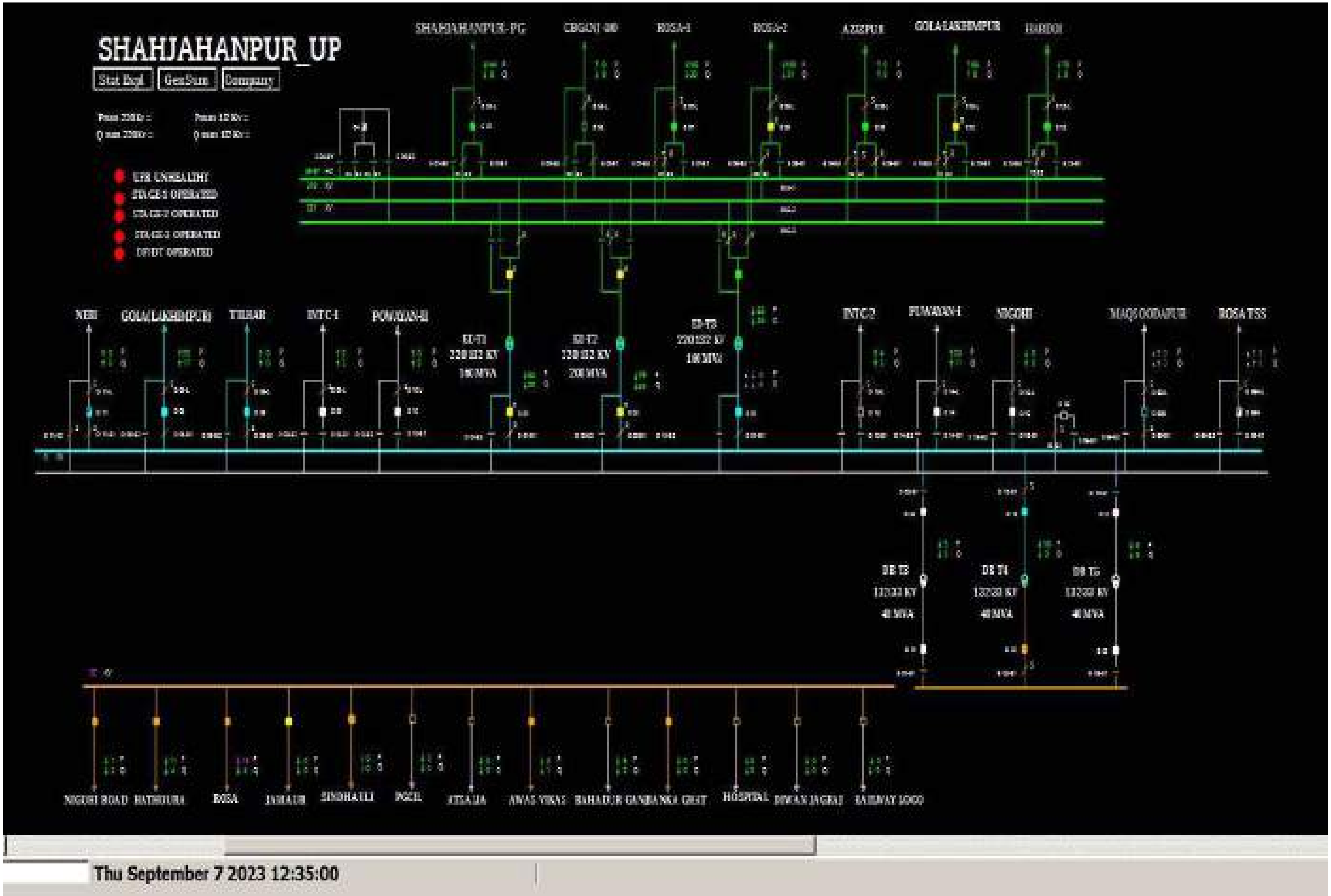
SLD of 400/220kV Rosa TPS(UP) before the event



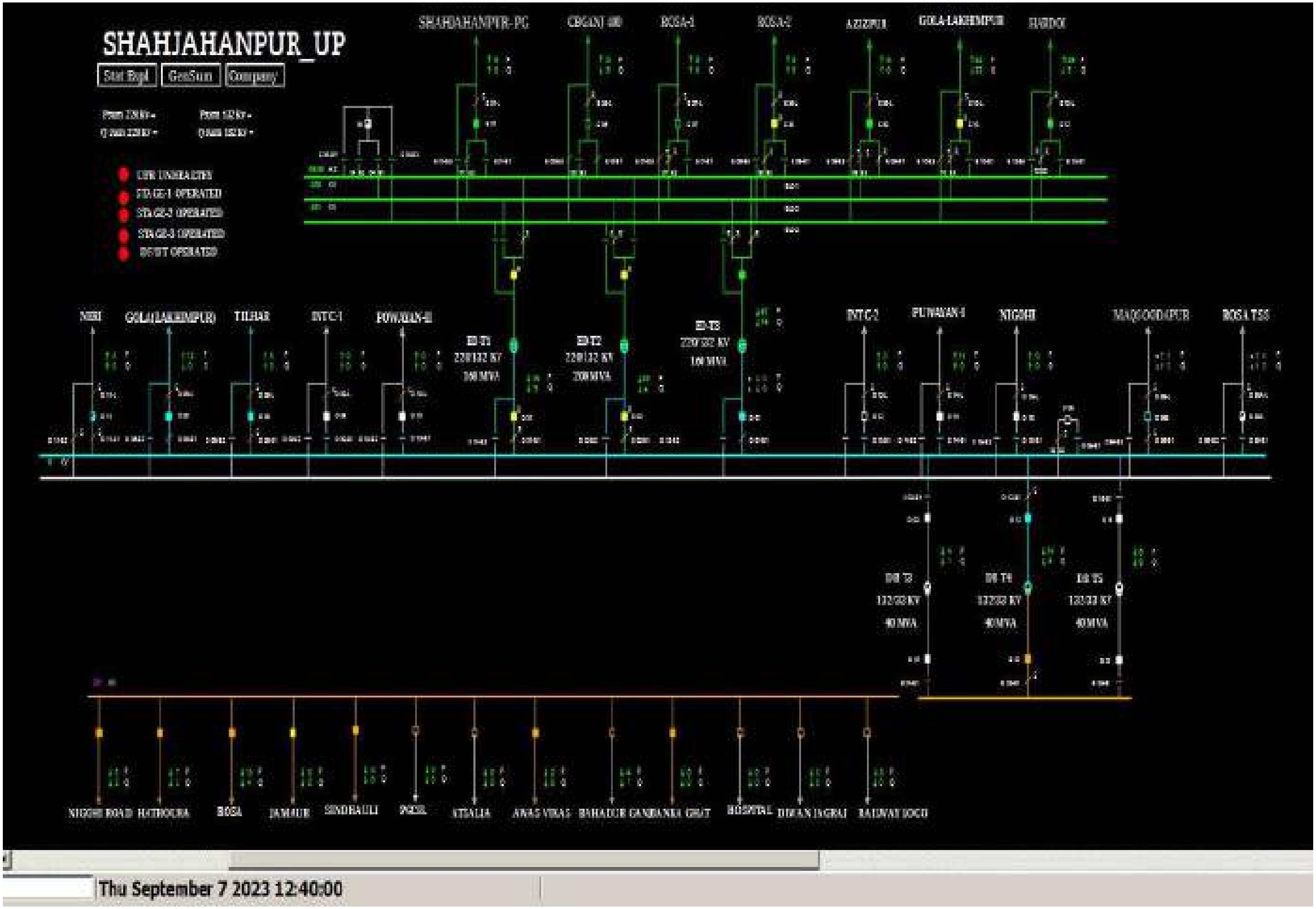
SLD of 400/220kV Rosa TPS(UP) after the event



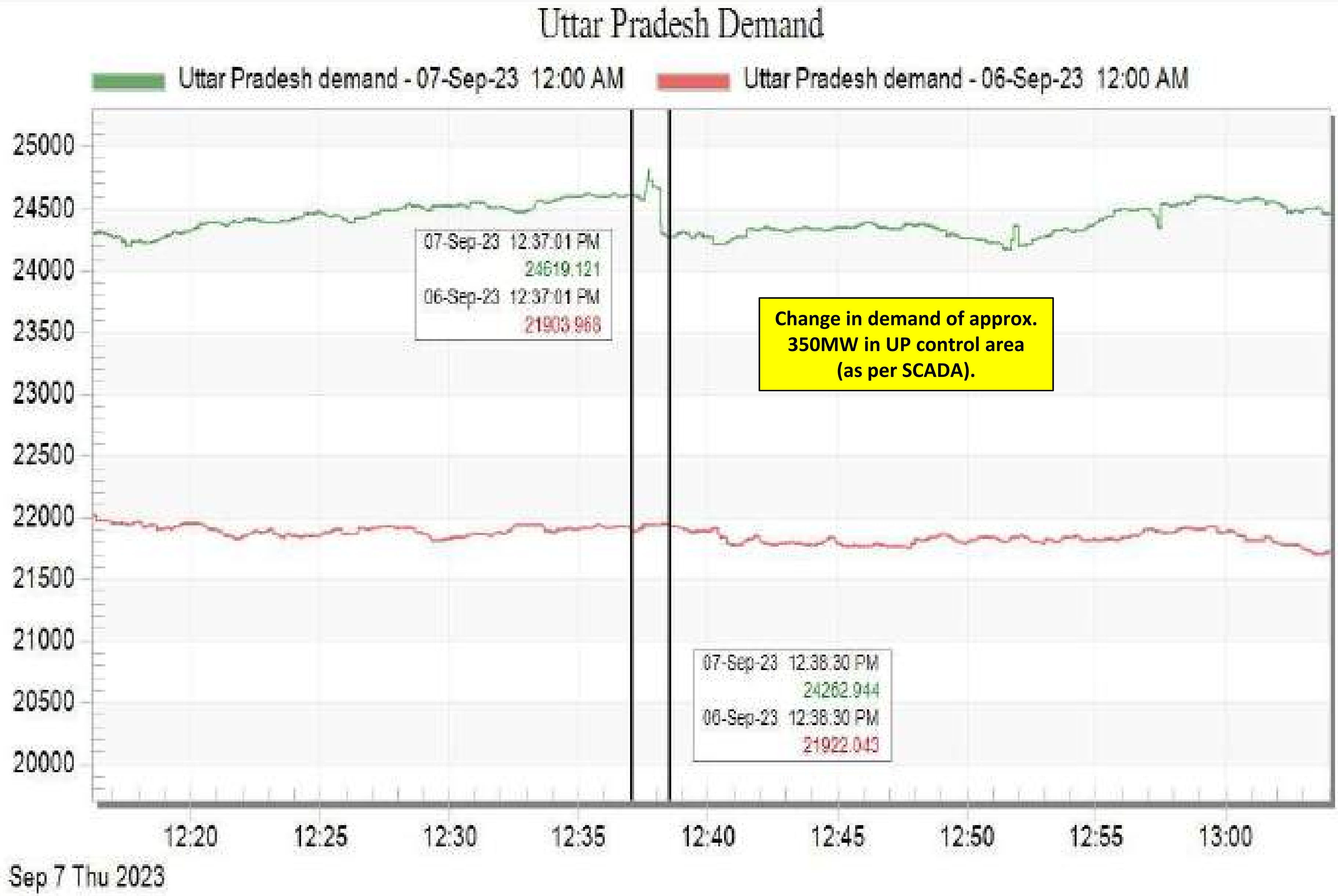
SLD of 220/132/33kV Shahjahanpur(UP) before the event



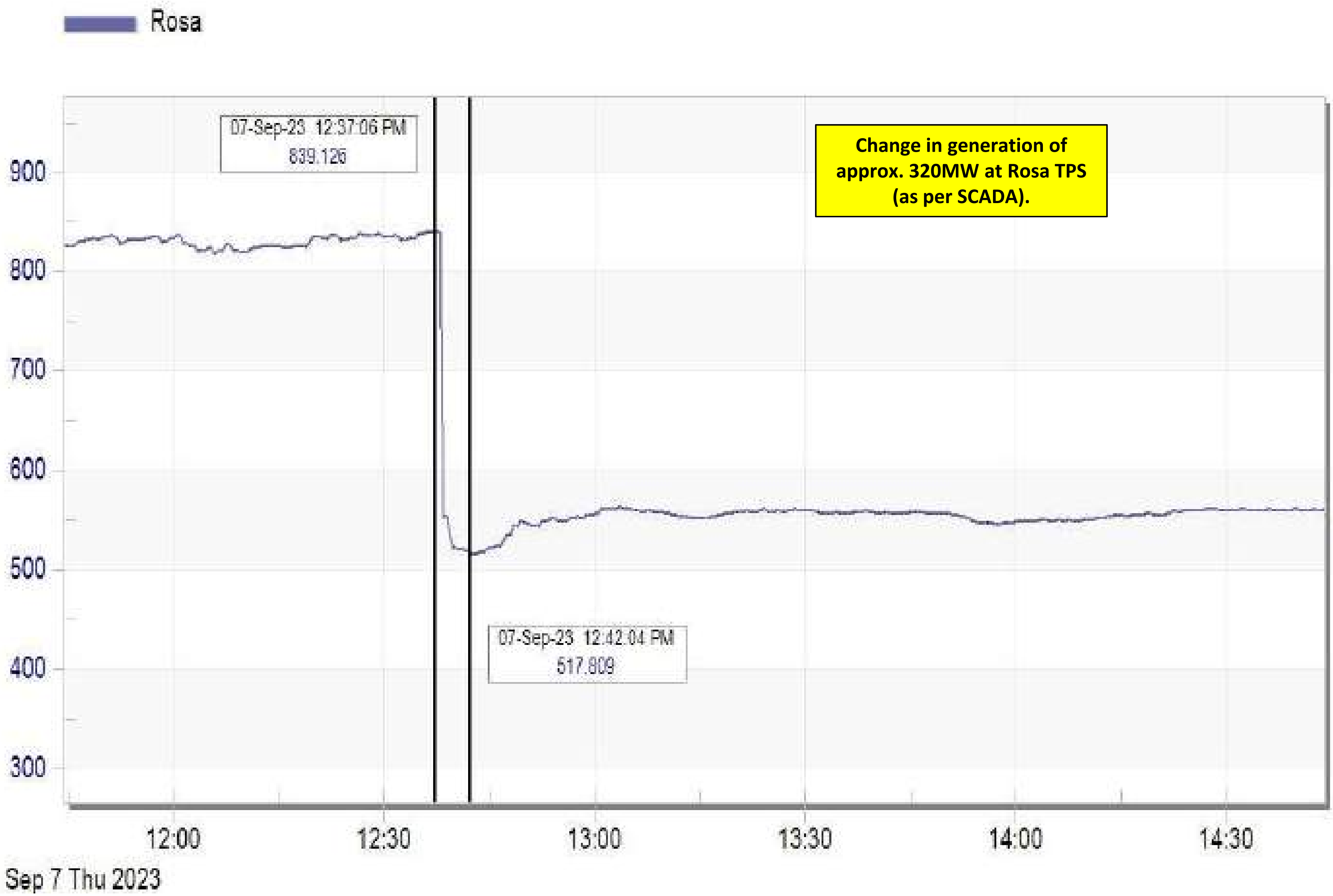
SLD of 220/132/33kV Shahjahanpur(UP) after the event



Uttar Pradesh demand vs generation during the event

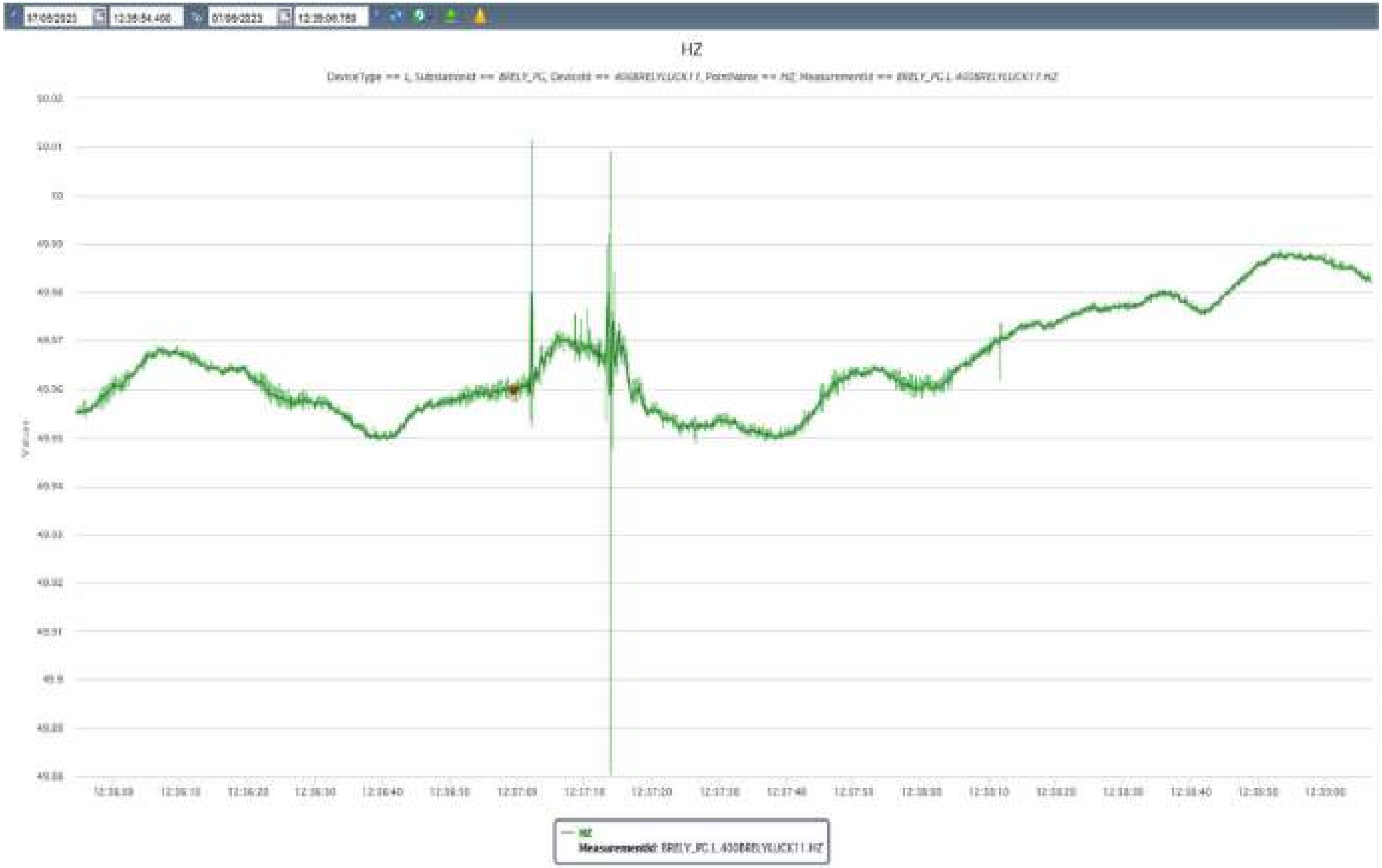


Rosa TPS generation during the event



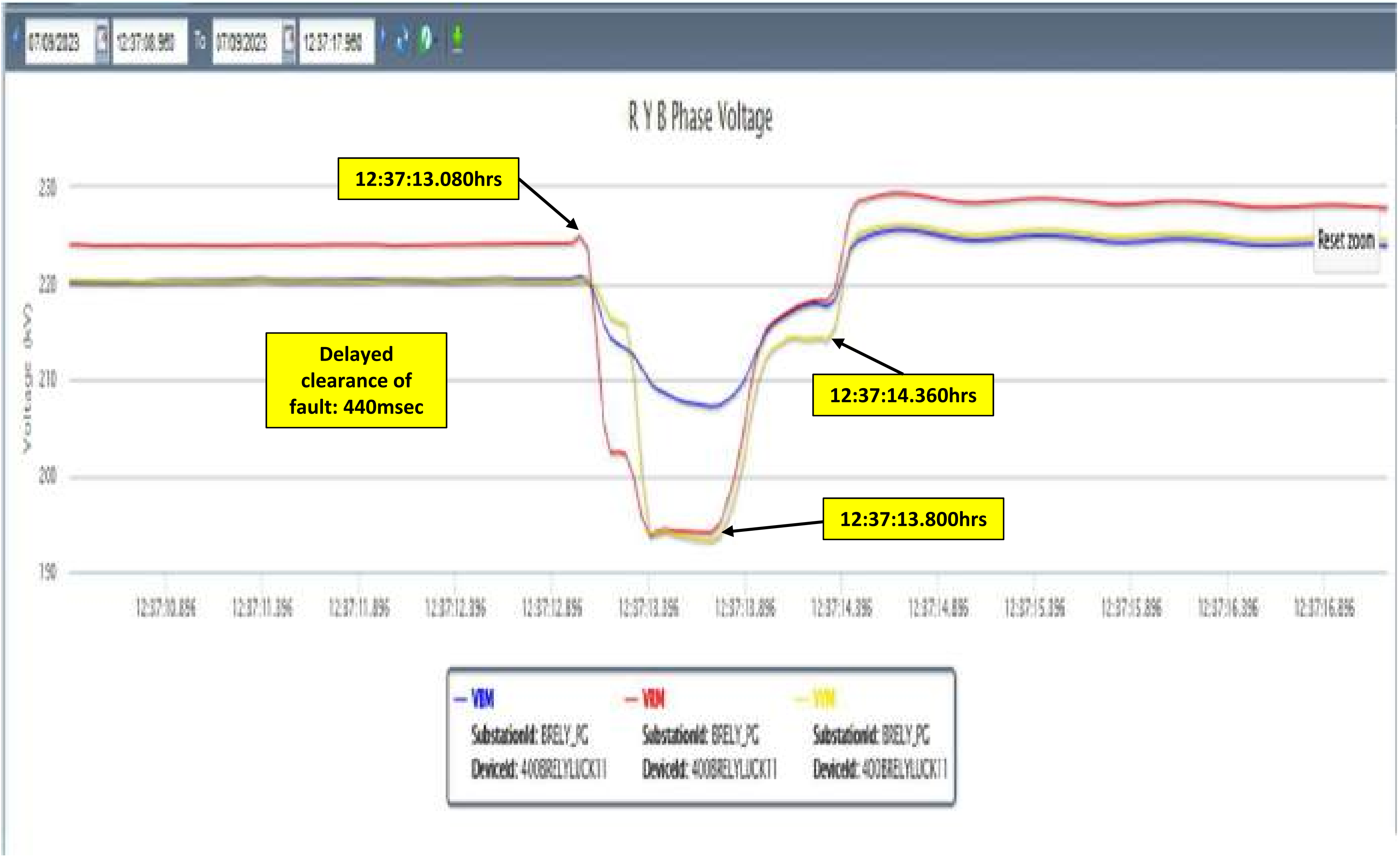
PMU Plot of frequency at Bareilly(PG)

12:37 hrs/07-Sept-23



PMU Plot of phase voltage magnitude at Bareilly(PG)

12:37 hrs/07-Sept-23



SCADA SOE

Time	Station Name	Voltage	Element Name	Element Type	Element Status	Remark
12:37:13,418	BADUN_UP	220kV	07ROSA1	Circuit Breaker	Open	Line CB at Baduan end of 220kV Rosa-Baduan ckt opened
12:37:13,785	ROSA_UP	400kV	03T1	Circuit Breaker	Open	CB at 400kV end of 400/220kV 200MVA ICT-1 at Rosa(UP) opened
12:37:13,876	SHJHA_UP	220kV	07ROSA1	Circuit Breaker	Open	Line CB at Shahjhanpur end of 220kV Shahjhanpur-Rosa ckt-1 opened
12:37:13,924	DOHNA_UP	220kV	06ROSA	Circuit Breaker	Open	Line CB at Dohna end of 220kV Rosa-Dohna ckt opened
12:37:13,985	SHAJAHANPUR	220kV	07SJN_UP	Circuit Breaker	Open	Line CB at Shahjhanpur(PG)) end of 220kV Shahjhanpur(PG)-Shajhanpur(UP) ckt opened
12:37:14,392	ROSA_UP	400kV	04T2	Circuit Breaker	Open	CB at 400kV end of 400/220kV 200MVA ICT-2 at Rosa(UP) opened
12:37:14,618	ROSA_UP	220kV	11G2	Circuit Breaker	Open	CB of 300MW Rosa TPS Unit-2 opened

Point of discussion

i. Why did breaker of the 220kV Rosa-Badaun(UP) Ckt-2 not open from Rosa end? Mechanical healthiness of CB need to be ensured.
ii. Why did LBB of 220kV Rosa-Badaun(UP) Ckt-2 not operate? Necessary corrective actions need to be taken to avoid such events in future.
iii. On which protection 220kV Shahjahanpur(PG)-Shahjhanpur(UP) Ckt tripped from Shahjhanpur(PG) end?
iv. DR/EL of all the elements need to be shared for both the ends.
v. Final tripping report also not received.
vi. Remedial action taken report need to be shared.

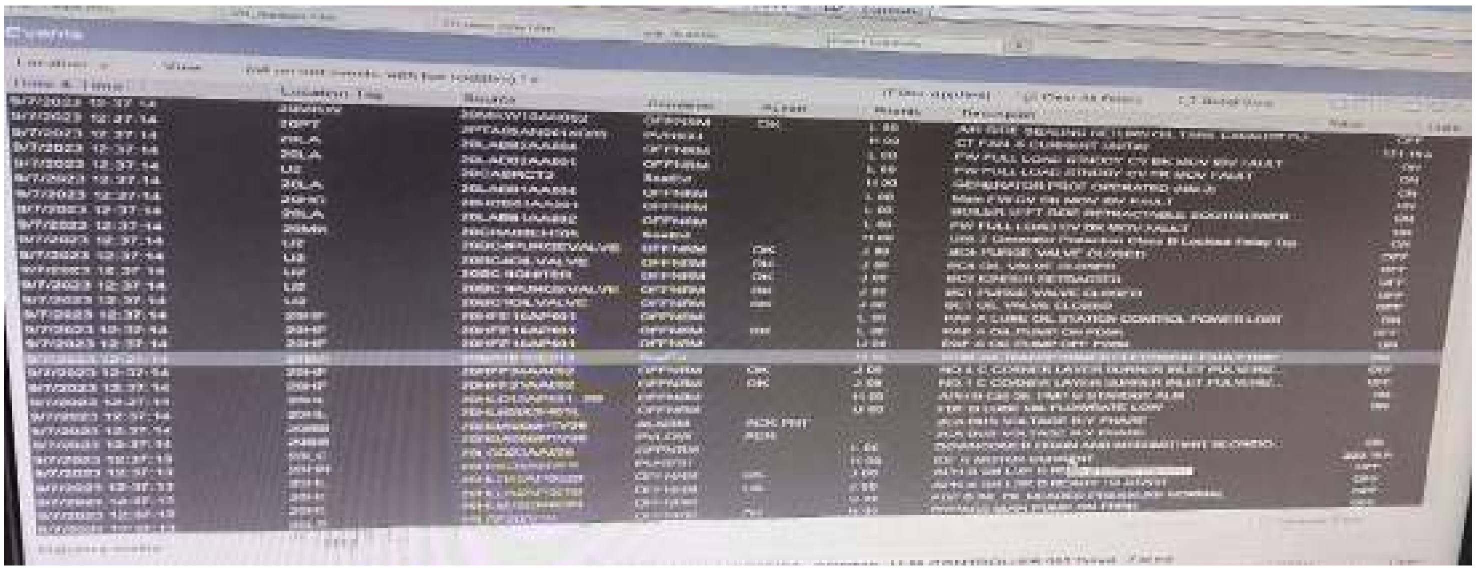
Rosa Tripping details by UP

Unit 2 was running on 295 MW. At 12:37:19 hrs Unit-2 tripped due to grid disturbance.

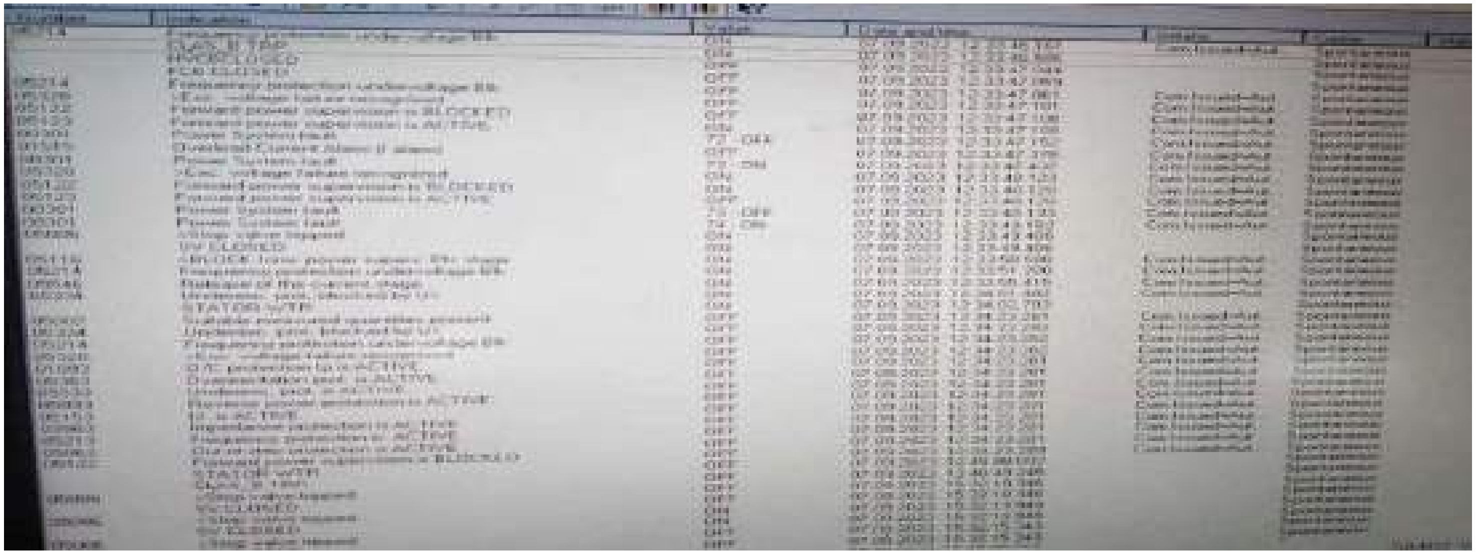
Unit-2:

Disturbances in GT relay panel Unit-2: Standby earth fault protection was observed in Unit-2 GT relay panel (Micom P634).

In DCS signal, “U2 generator protection Class-B lockout relay operated trip” was operated as a first trip signal.



Unit-2 DCS SOE

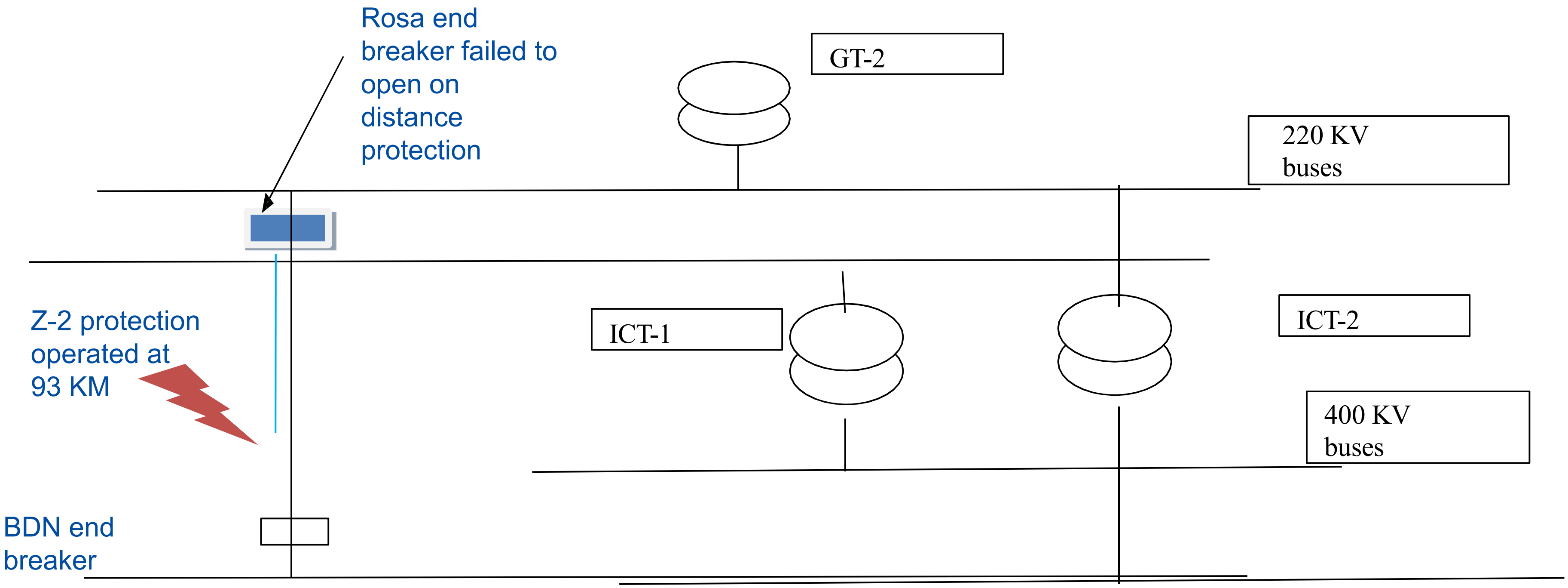


Unit-2 Generator Relay SOE (7UM62)-Class-B Trip

U2 GT Relay current graph in faulty (R Phase) (Recorded in Micom 632)

Summary: GT-2 tripped on Standby earth fault due to R-phase fault in 220 KV grid.

FAULT LOCATION:

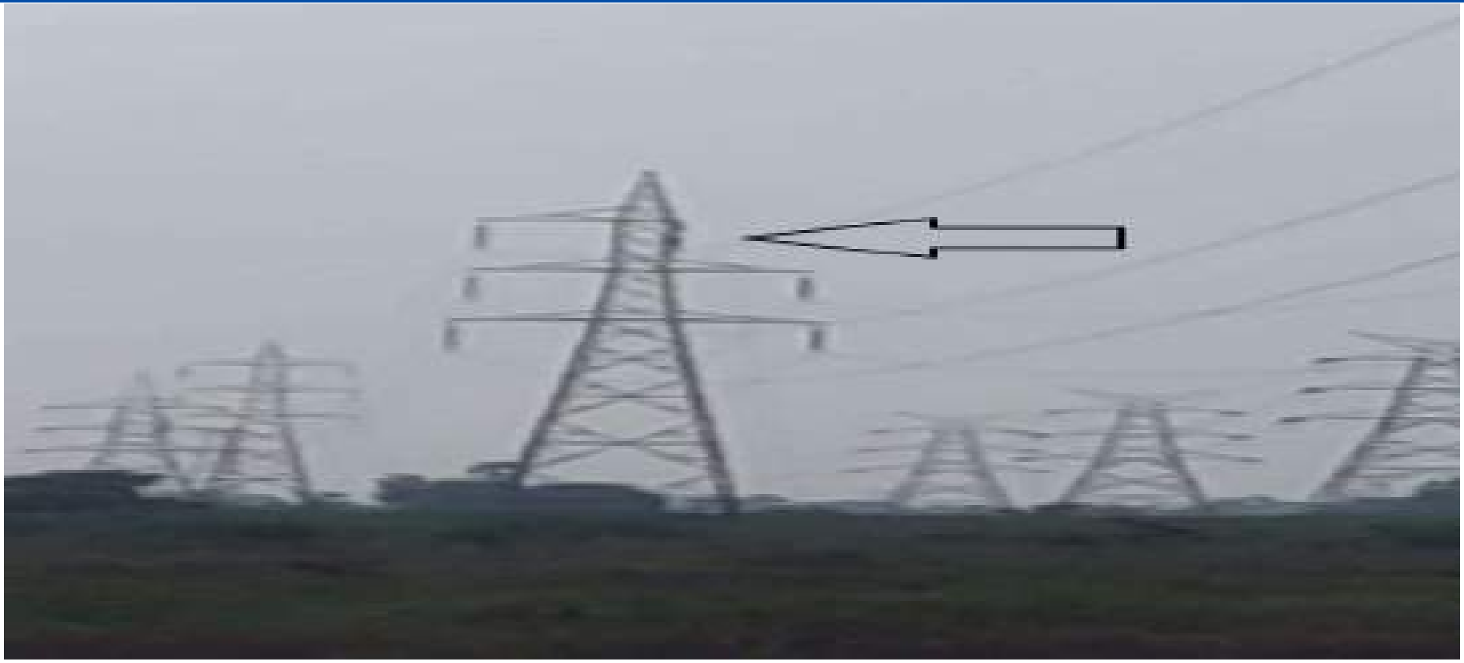


Fault Single line diagram

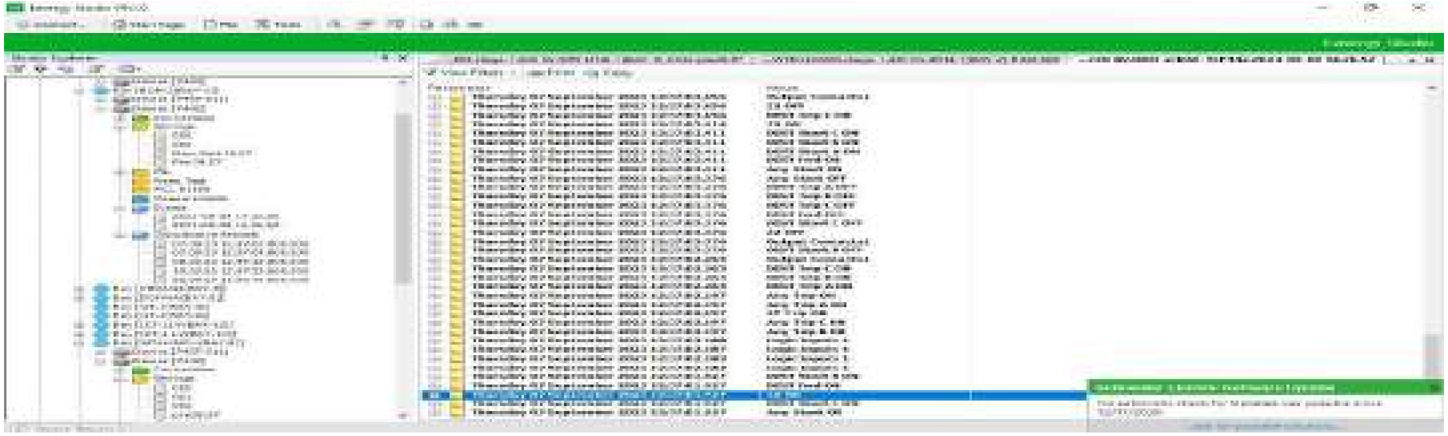
On dated 07.09.2023, 220 KV BDN CKT-2 were tripped around 12:37 Hrs. On preliminary inspection it was found that feeder got tripped on zone-2 DEAD fault

Started phase-ABC
Tripped phase-ABC
Distance Zone -2
system frequency-50.01 hz
fault location-93.12 km
1A-214.3 A
1B-2220 A
IC-2006 A
VAN-124 KV
VBN-101.8 KV
VCN-102 KV

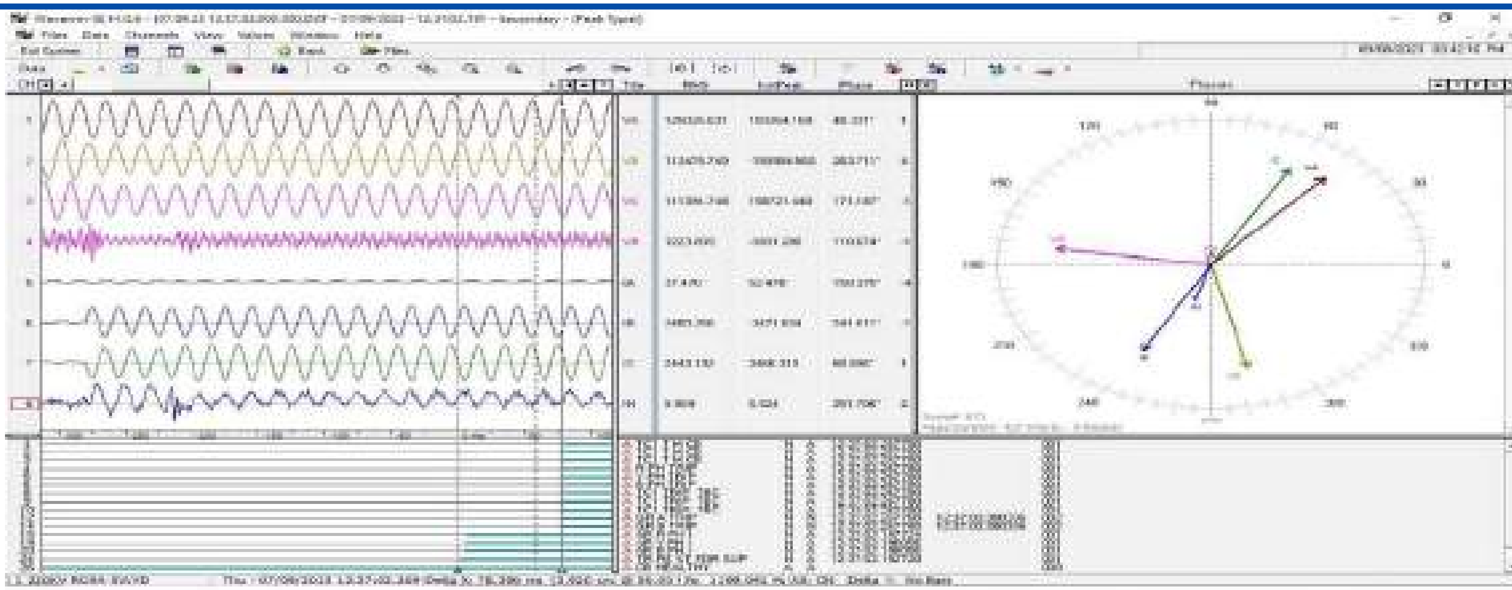
During line patrolling by M/s UPPTCL it was found that jumpers, ground wire and cross arms of the tower were damaged and opened at multiple locations. 220 KV Rosa Badaun end breaker failed to clear the fault as both the trip coils along with DC supply fuses of the breaker found blown due to suspected mechanical jamming at the R pole mechanism. Heavy jerk and sparking also observed at breaker poles. Fault kept on fed from U-2 generator which subsequently results in operation of SEF.As the fault was in reverse direction for other intact breakers of 220KV bus, all other breakers remained intact at Rosa end(Z-4 protection taken at 50 % shortest line at local bus). Other end breakers of remote substation were tripped in either Zone-3/2 protection .
LBB protection found in error locked CZ mode ,which was checked and later on taken in service.



Damaged cross arm



Event in micom 442(Z-2 enabled)



DR and fault summary

Breaker fail initiated at PU-P743

PU error lock alarm and CU-P741 out of service

Observation-

1. 220 KV Rosa BDN CKT-2 ground wire, R phase conductor and cross arm found snagged at multiple locations.
2. 220 KV Rosa BDN Ckt-2 R phase breaker pad found heated
3. R phase dropdown jumper connecting to CVT found damaged from top
4. Breaker TC coils and DC fuse found blown at the breaker panel
5. Conductor strands near dead end joint found damaged

Damaged trip coils and breaker pad

Damaged conductors at dead end and CVT jumper

DC circuit blown fuse

Action taken-

220 KV BDN-2 Breaker pad repairing and connection

Breaker Poles	CB close timings(In millisec)	CB trip timing(In millisec)
R phase pole	66.5	19.5
Y phase pole	66	20
B phase pole	66	19.5

Breaker testing results

R pole(in micro –ohm)	Y pole(in micro-ohm)	B pole(in micro-ohm)
22	22	13

Static contact resistance measurement at 200 Amps

Remarks-

1.220 KV Rosa Badaun Ckt-2 M-1 and M-2 Relay testing done by third party, whose detailed test report already submitted to UPSLDC on dated 17.10.2023

2.The same line tripped on 28th Dec-23 under Z-1 protection .No protection abnormality observed

---- End of Report ----

Multiple elements tripping at 220kV Kunihar(HP)

06th September 2023

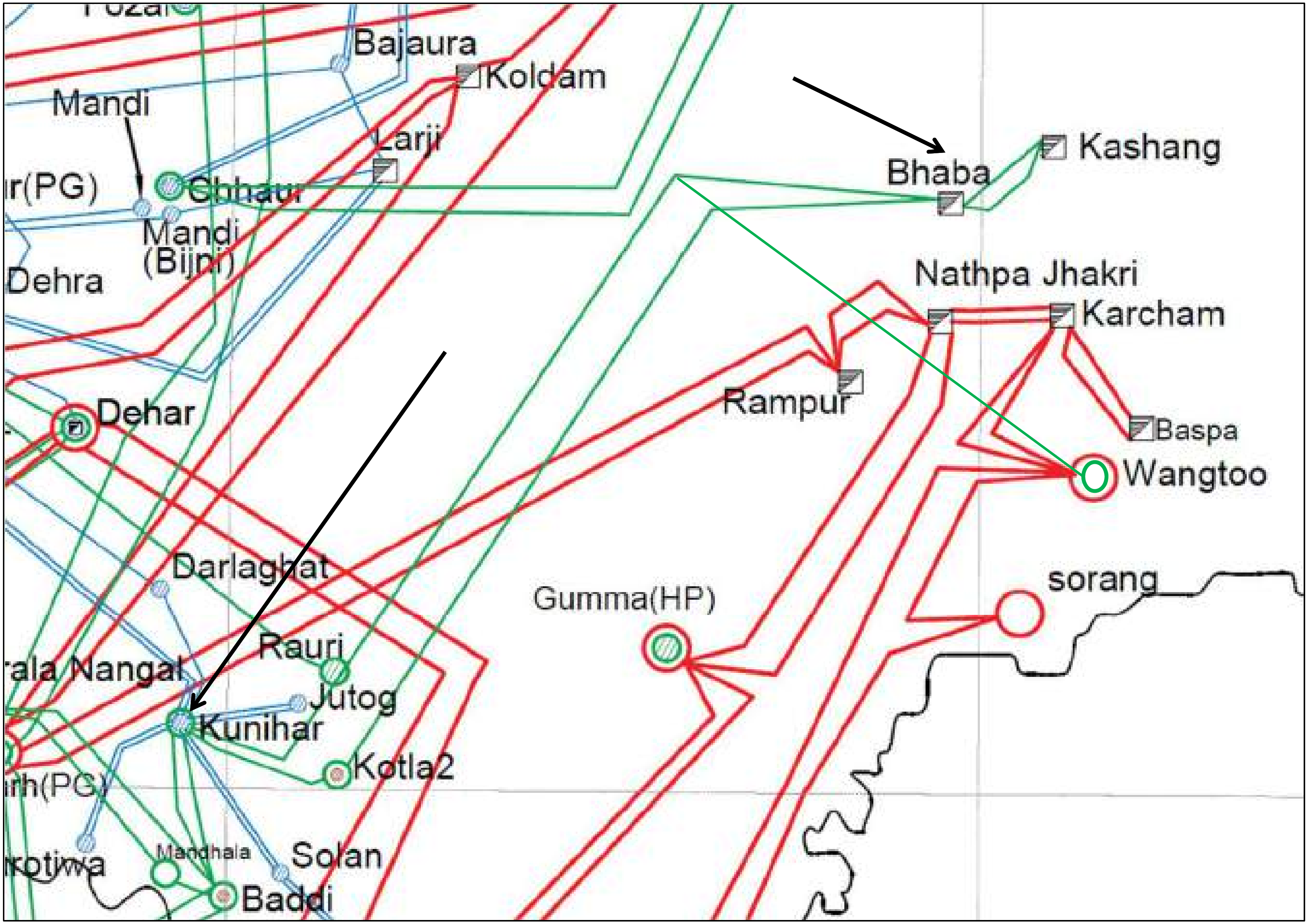
Brief of event:

- As reported, at 06:44 hrs, 220 KV Kunihar-Baddi ckt-1&2 tripped on over current earth fault protection operation. (Exact reason and location of fault yet to be shared)
- At the same time, 220 kV Jeori-Kunihar(HP) Ckt, 220 kV Kunihar-Pinjore(HP) Ckt also tripped on overvoltage.
- With the tripping of aforementioned elements load of 220/132kV Kunihar(HP) got affected.
- As per PMU, Y-B fault converted into three phase fault with **delayed clearance in 880msec is observed.**
- Further at 07:22 hrs, while restoration again multiple elements tripping occurred at Kunihar S/s and 220/132kV Kunihar S/s became dead.
- As per PMU & DR, no fault was in system at 07:22hrs.

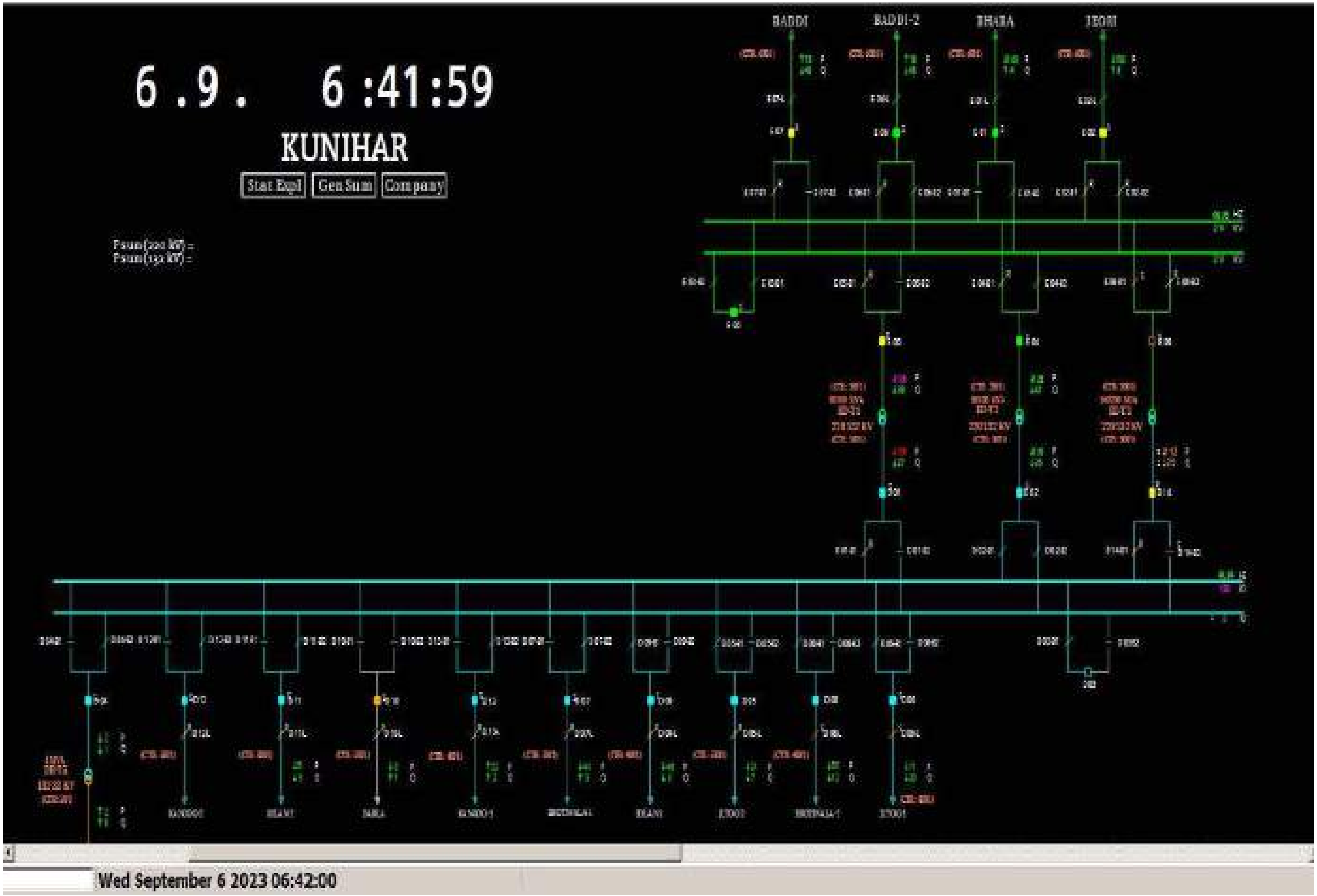
Elements tripped:

i. 220 kV Wangtoo –Bhabha-Kunihar(HP) ckt (Tconnection)
ii. 220 kV Jeori-Kunihar(HP) Ckt
iii. 220 kV Baddi-Kunihar(HP) Ckt-1
iv. 220 kV Baddi-Kunihar(HP) Ckt-2
v. 220/132kV ICT-1 at Kunihar(HP)
vi. 220/132kV ICT-2 at Kunihar(HP)
vii. 220/132kV ICT-3 at Kunihar(HP)

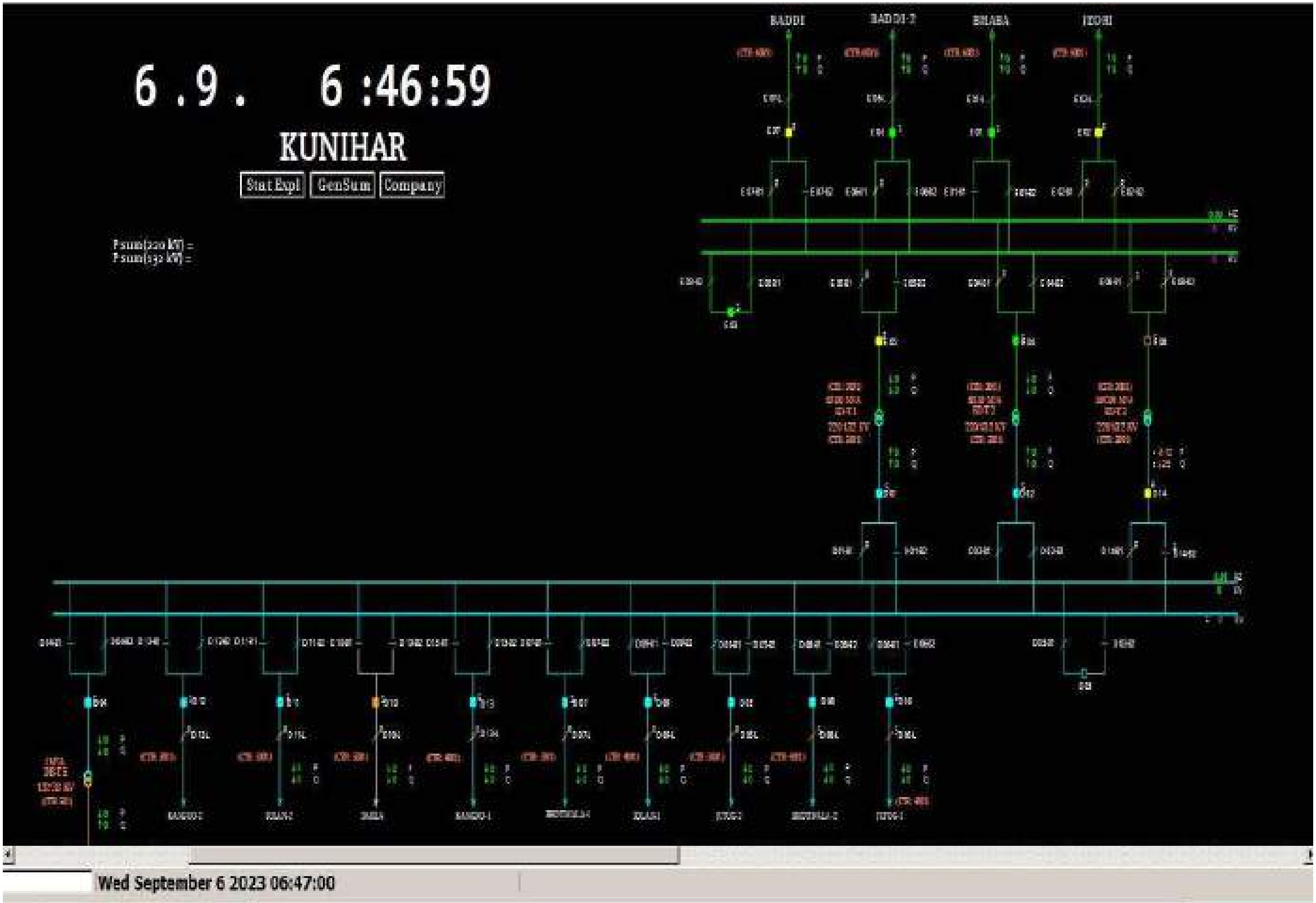
Network Diagram



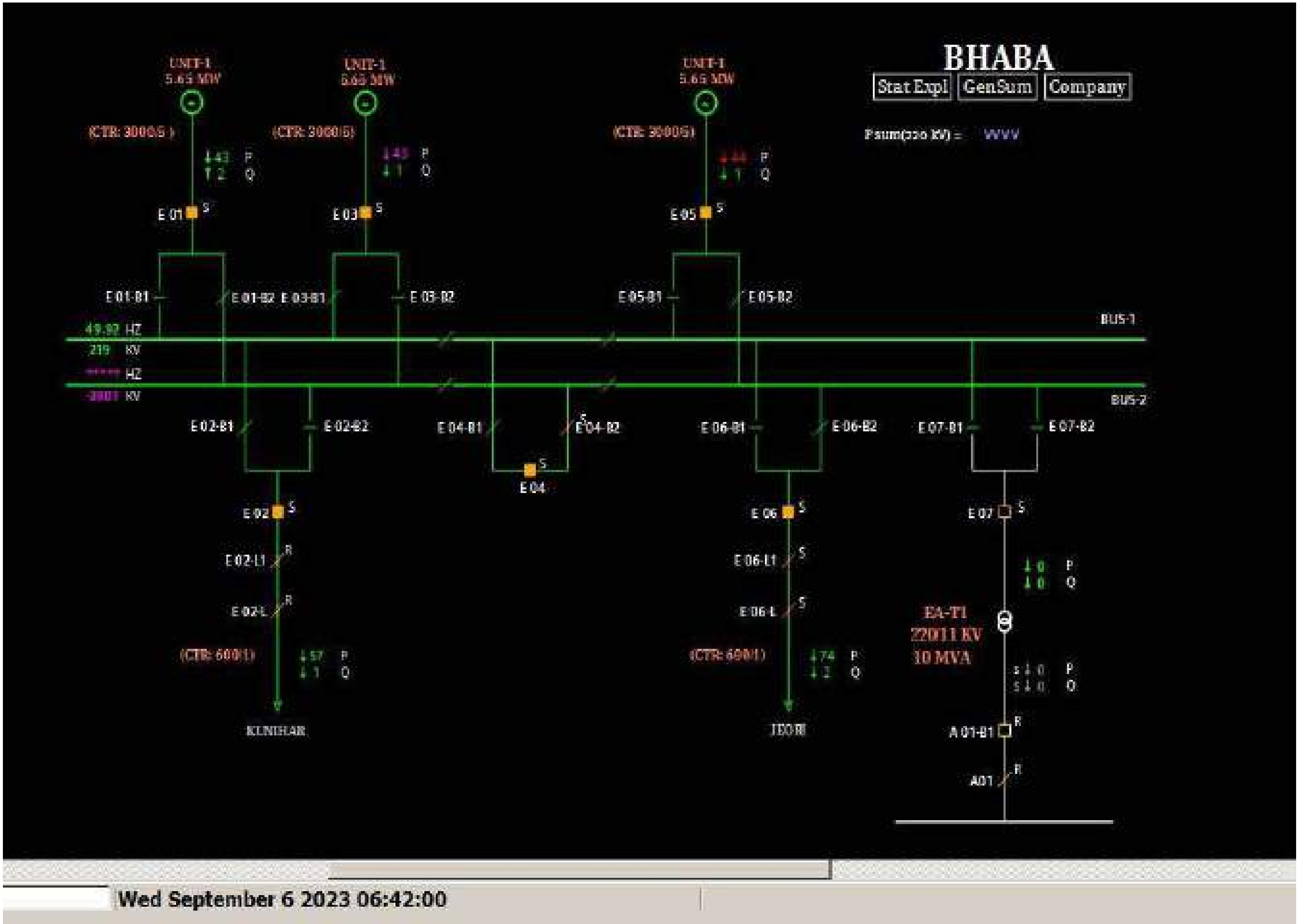
SLD of 220/132kV Kunihar(HP) before the event



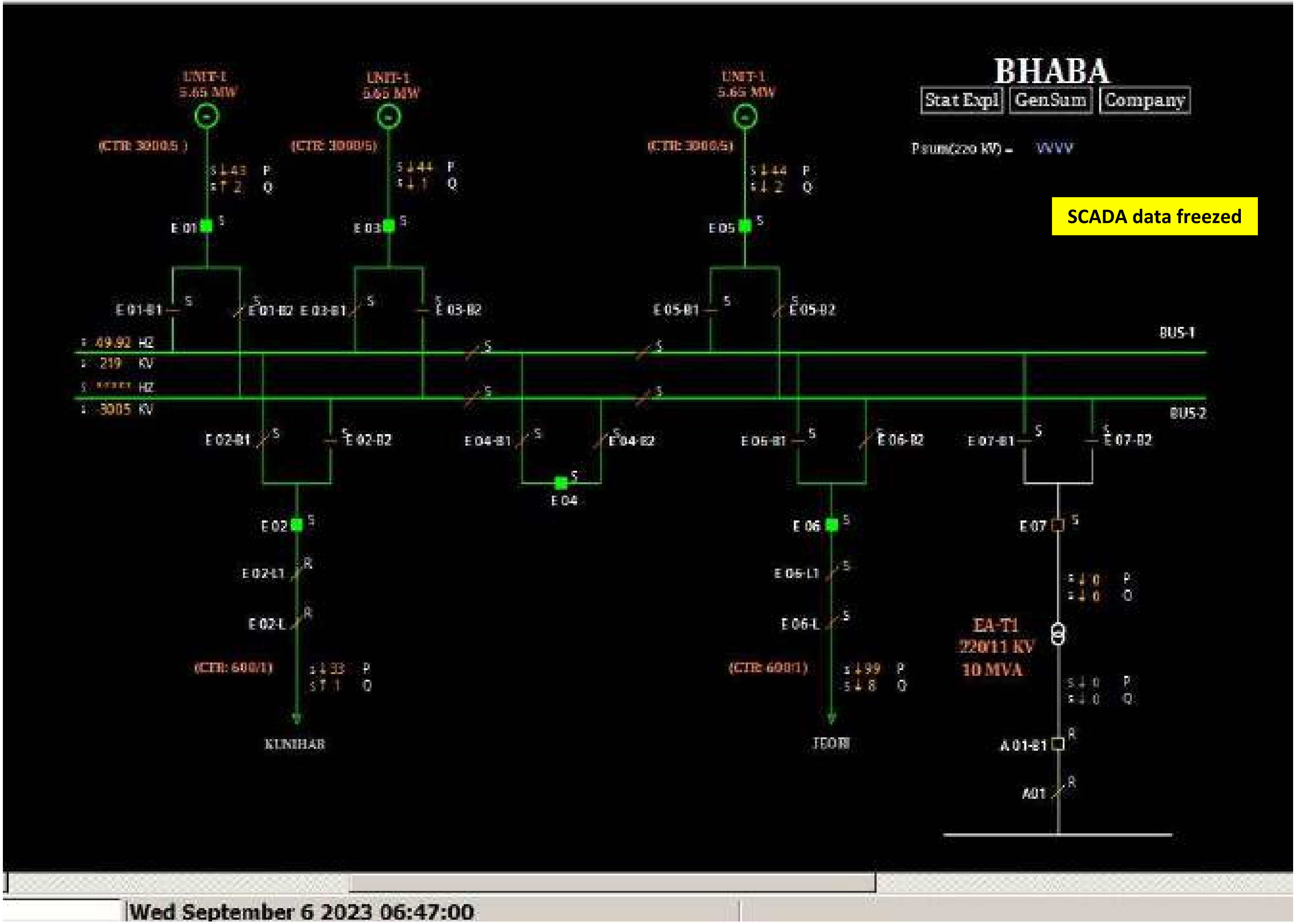
SLD of 220/132kV Kunihar(HP) after the event



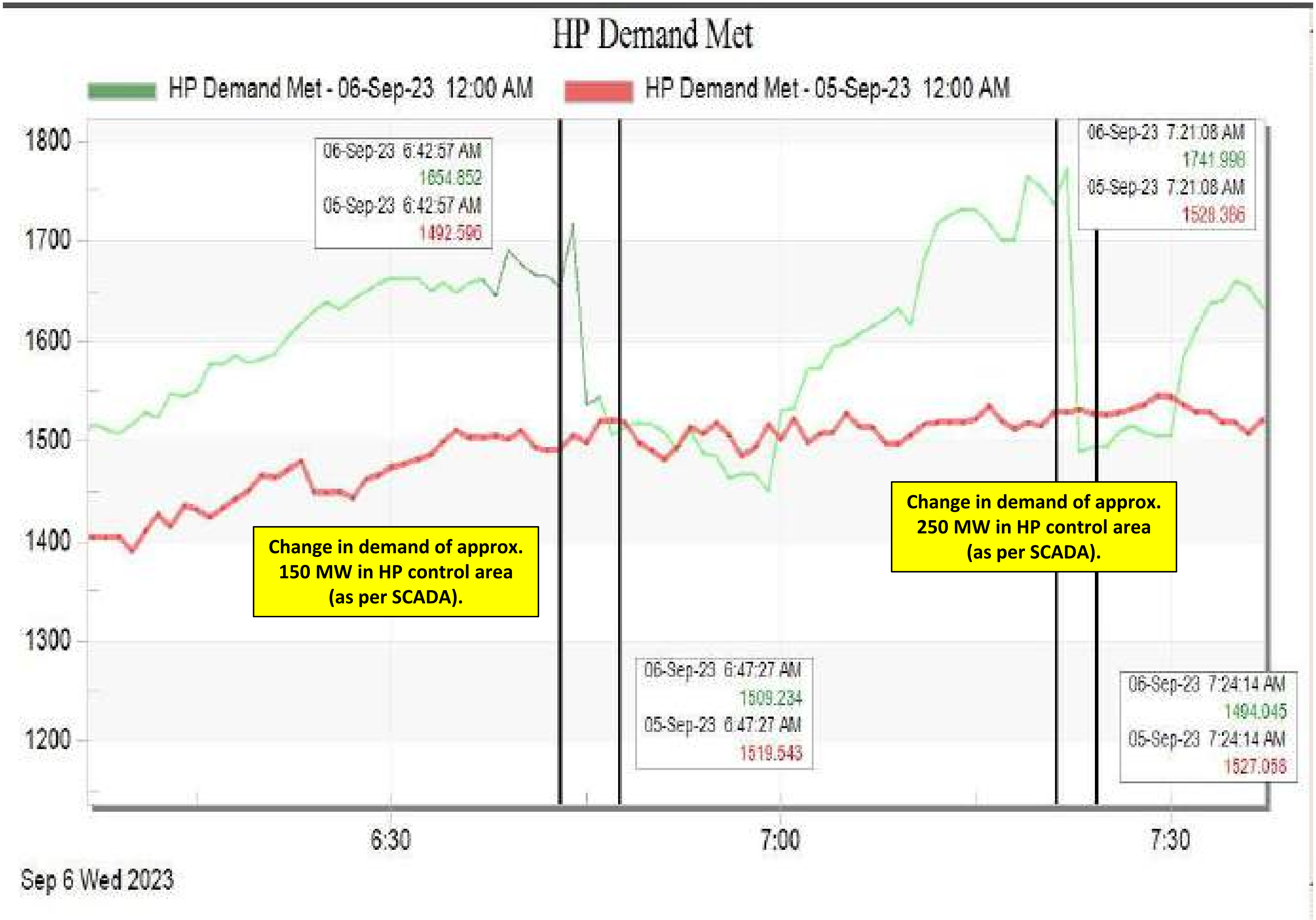
SLD of 220kV Bhaba(HP) before the event



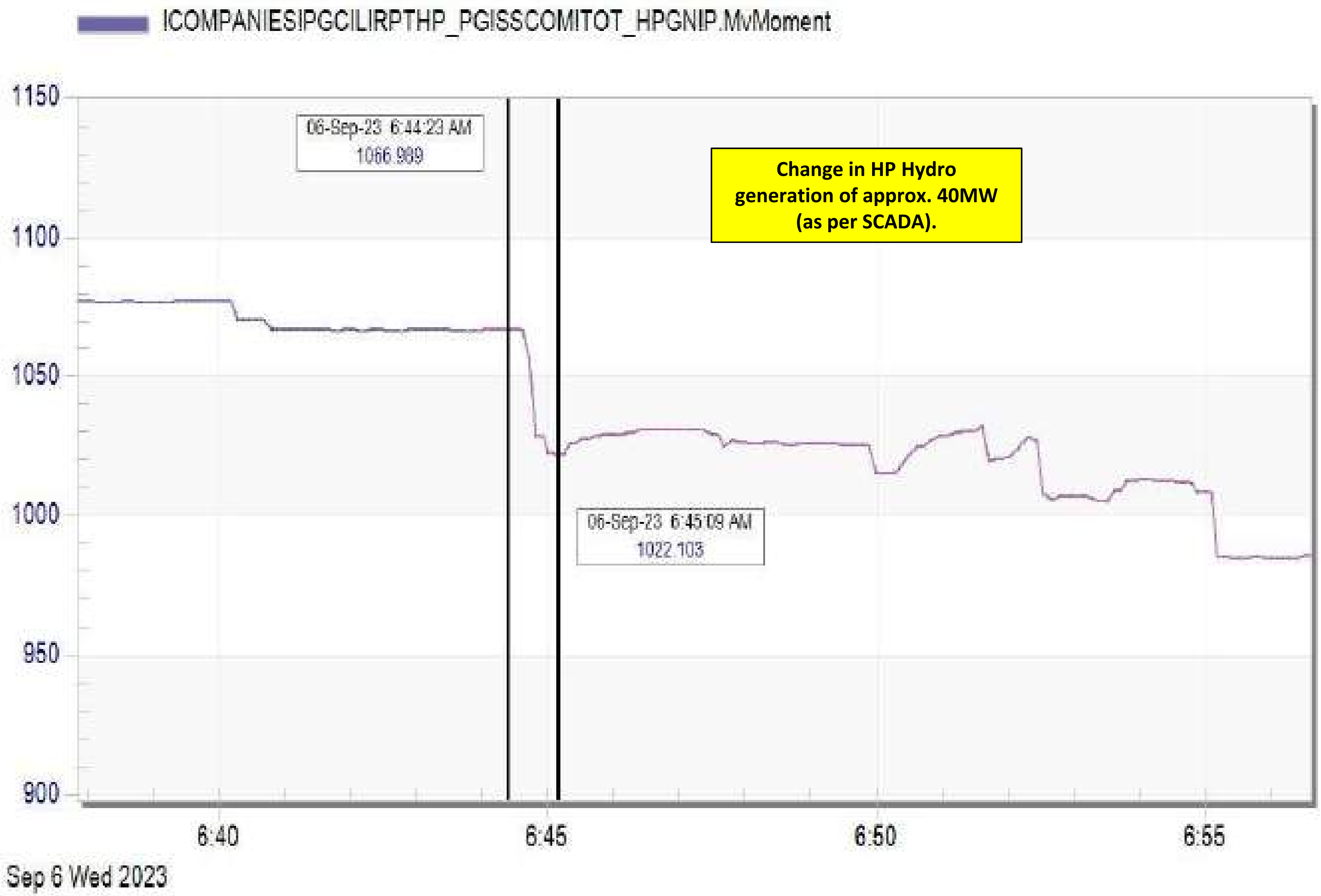
SLD of 220kV Bhaba(HP) after the event



Himachal Pradesh demand during the event



Himachal Pradesh Hydro generation during the event



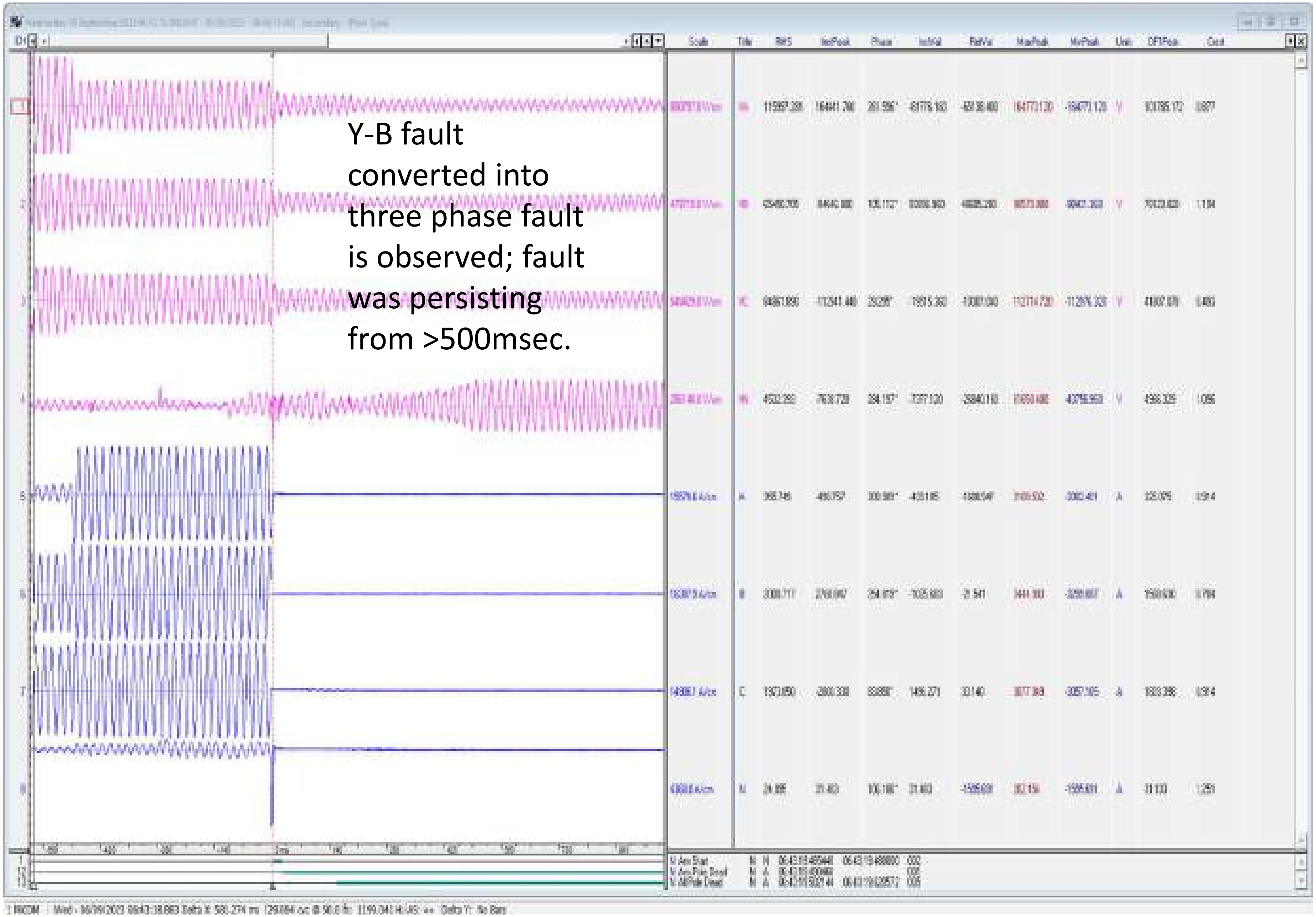
PMU Plot of frequency at Abdullapur(PG)

06:44 hrs/06-Sept-23

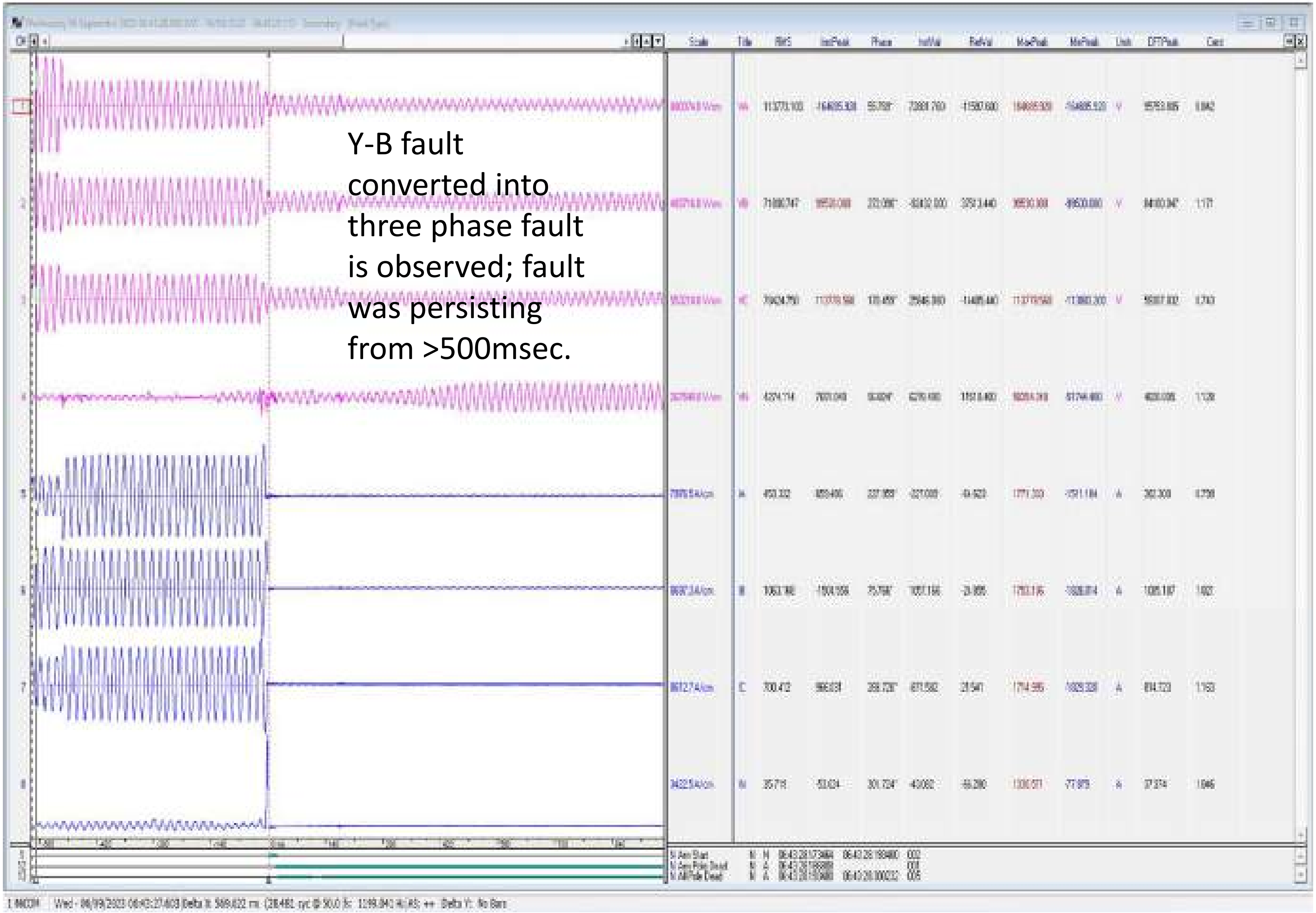
PMU Plot of phase voltage magnitude at Abdullapur(PG)

06:44 hrs/06-Sept-23

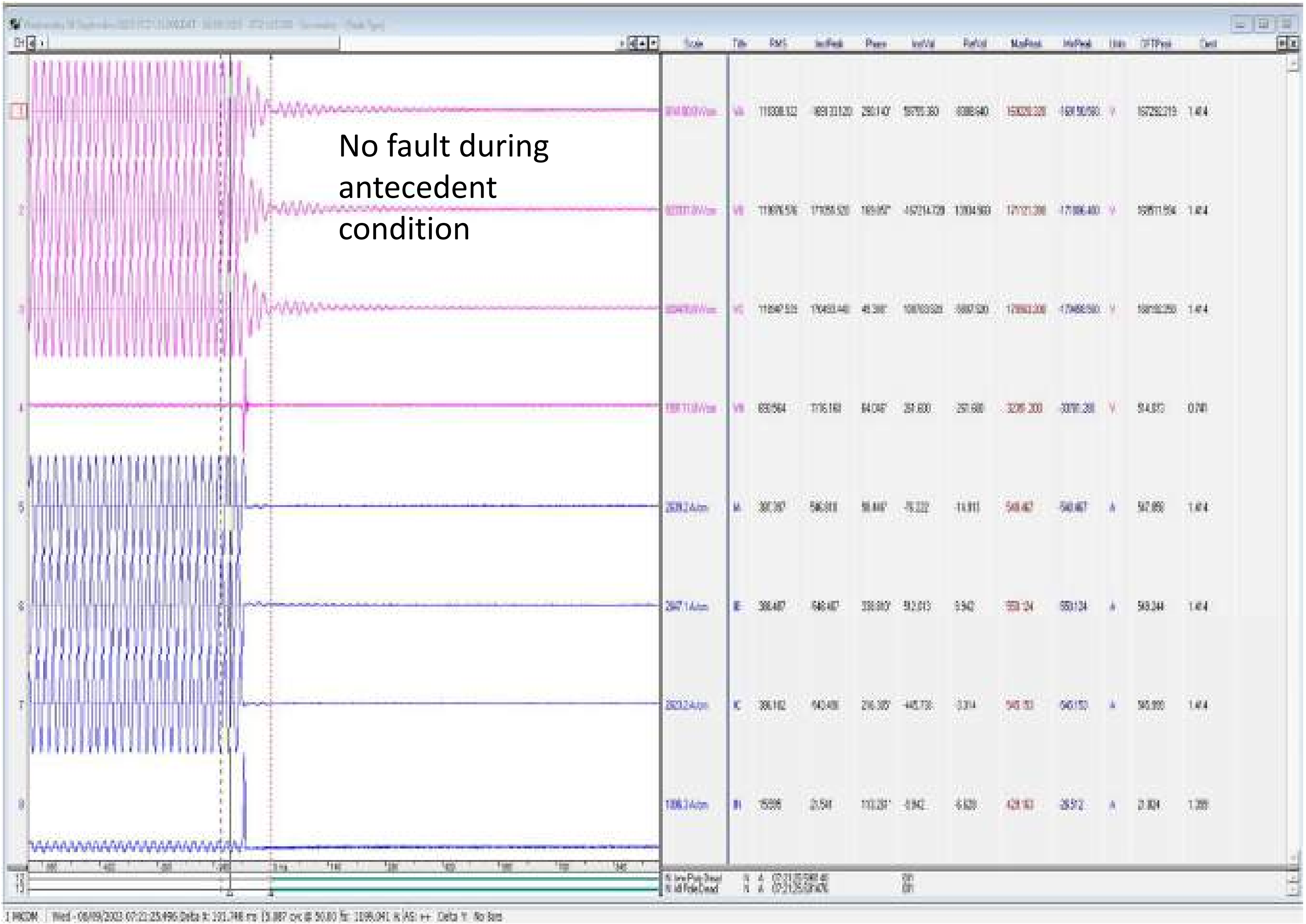
DR of 220kV Kunihar(end)-Pinjore (HP)ckt (at 06:43hrs)



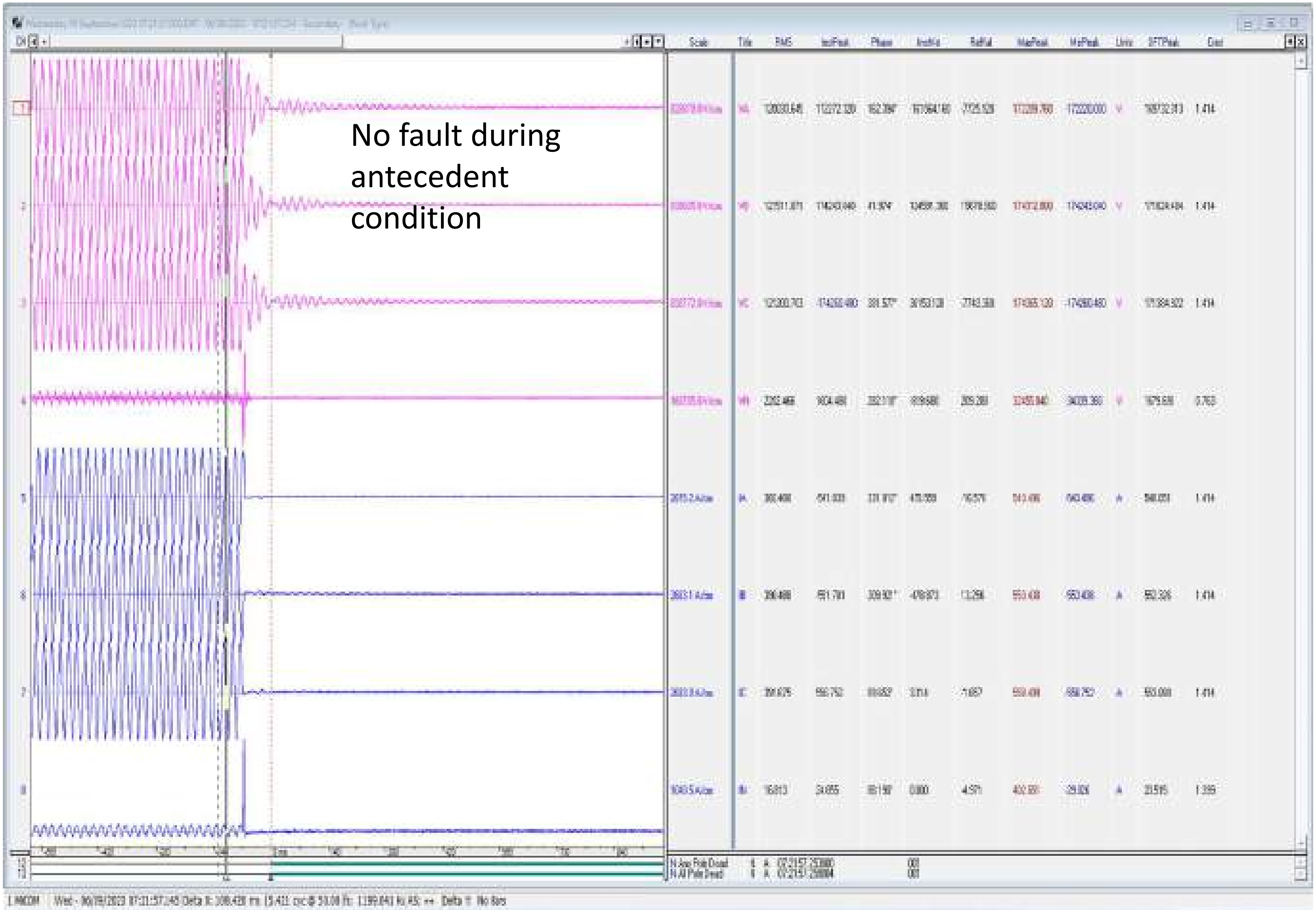
DR of 220kV Kunihar(end)-Jeori (HP)ckt (at 06:43hrs)



DR of 220kV Kunihar(end)-Pinjore (HP)ckt (at 07:22hrs)



DR of 220kV Kunihar(end)-Baddi ckt-1 (HP)ckt (at 07:22hrs)



Point of discussion

i. Exact nature and location of fault need to be shared.
ii. Reason of delayed clearance of fault also need to be shared.
iii. Over voltage protection in 220kV lines need to be kept disabled.
iv. Details of protection operation at remote substation also need to be shared.
v. SCADA data at 220kV Bhaba(HP) freezed during the event. Availability and healthiness of SCADA data need to be ensured.
vi. DR/EL need to be shared for all the tripped elements for both ends.
vii. Standard nomenclature need to be incorporated in DRs.
viii. Status of protection audit at Kunihar S/s.
ix. Remedial action taken report need to be shared.

Multiple elements tripping at 220kV Badarpur(DTL)

10th September 2023

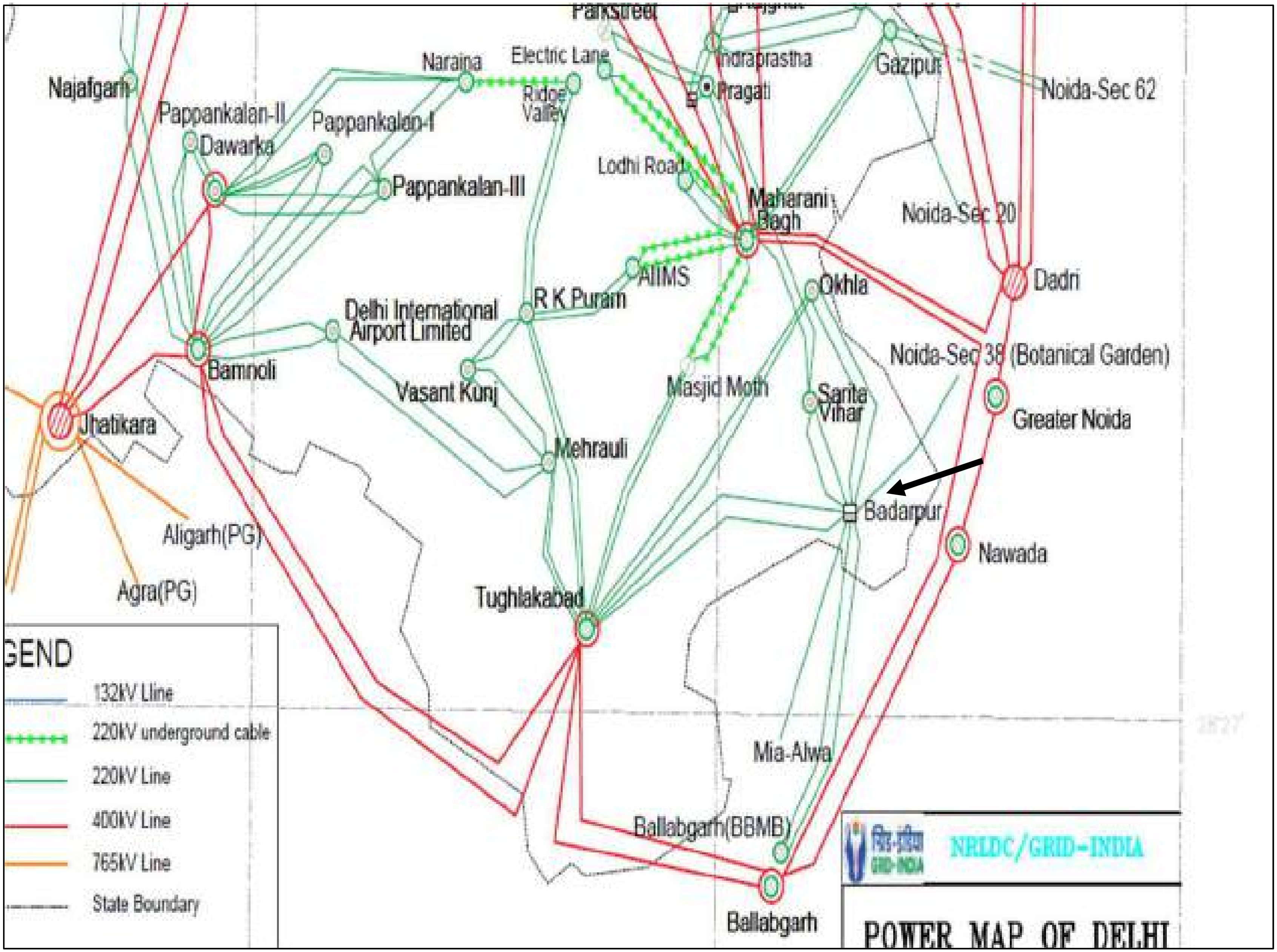
Brief of event:

- 220kV Badarpur(DTL) has double main single breaker bus scheme. It has source from 220 kV Tuglakabad-Badarpur (DTL) Ckt-1&2 and 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-1&2.
- As reported, at 17:08hrs, **R-ph conductor near wave trap of 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-2 at Badarpur end** damaged and created **R-N fault**.
- As per DR of Ballabhgarh(BB) end, R-N fault followed by Y-N & B-N fault with total fault clearance time of ~800msec is observed. Fault distance recorded at Ballabhgarh end was ~24.7km.
- As reported, on this fault, 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-1&2 tripped from Ballabhgarh(BB) end only, 220 kV Tuglakabad-Badarpur (DTL) Ckt-1&2 tripped from Badarpur end in Z-4 and 220kV Badarpur-Okhla ckt-1&2 tripped on O/C E/F protection operation.
- As per PMU at Ballabhgarh(PG), R-N fault which later converted into three phase fault with fault clearance time of ~1240msec is observed.
- With the tripping of aforementioned lines, 220kV Badarpur S/s became dead and load feeding from Badarpur to 220kV Okhla and 220kV Sarita Vihar affected.
- As reported by SLDC-Delhi, load loss of approx. 125MW is occurred in Delhi control area.
- At 17:13 hrs, 220kV bus coupler breaker at Sarita Vihar S/s and Okhla S/s was closed and load was normalized.

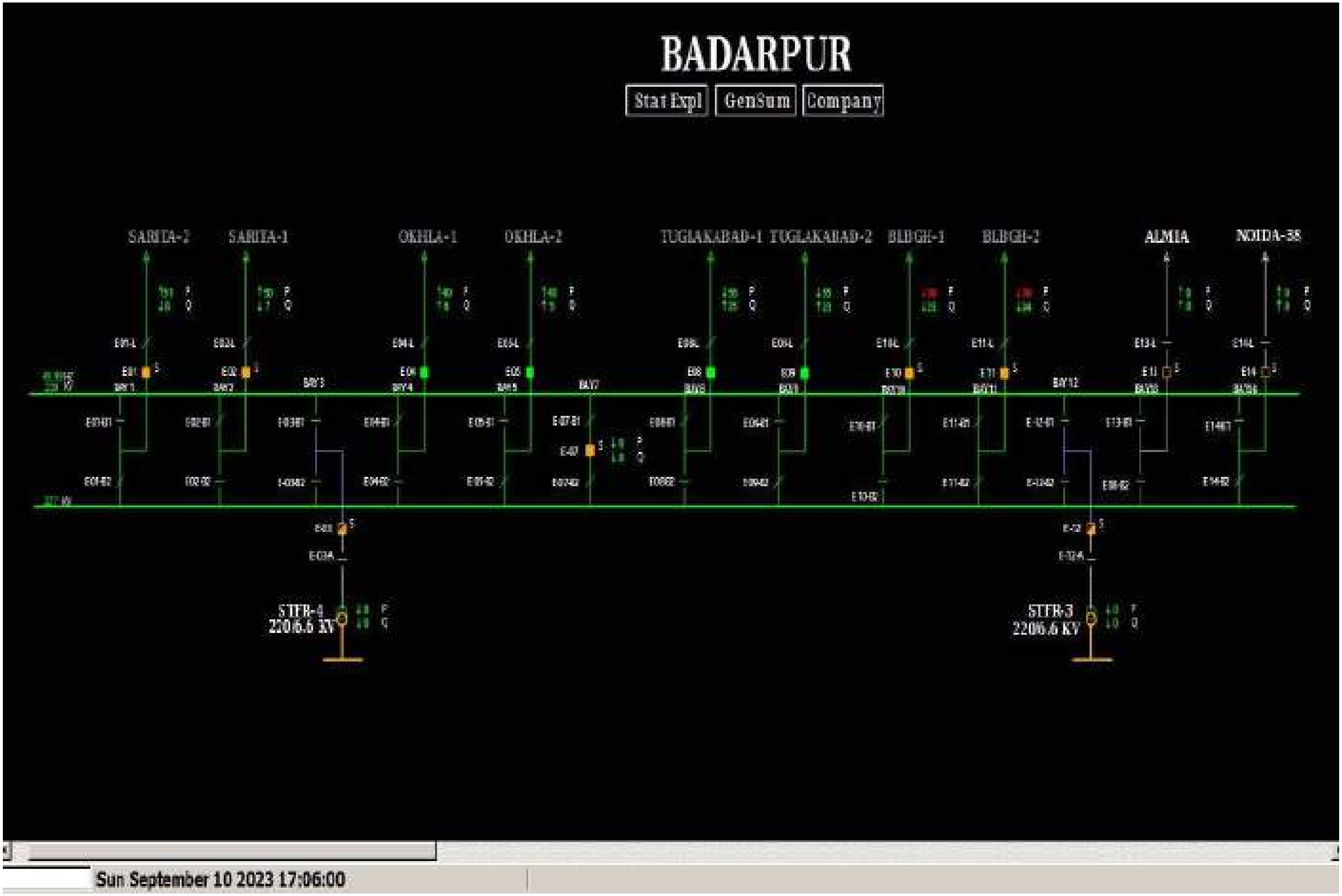
Elements tripped:

i. 220 kV Tuglakabad-Badarpur (DTL) Ckt-1
ii. 220 kV Tuglakabad-Badarpur (DTL) Ckt-2
iii. 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-1
iv. 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-2
v. 220kV Badarpur-Okhla ckt-1
vi. 220kV Badarpur-Okhla ckt-2

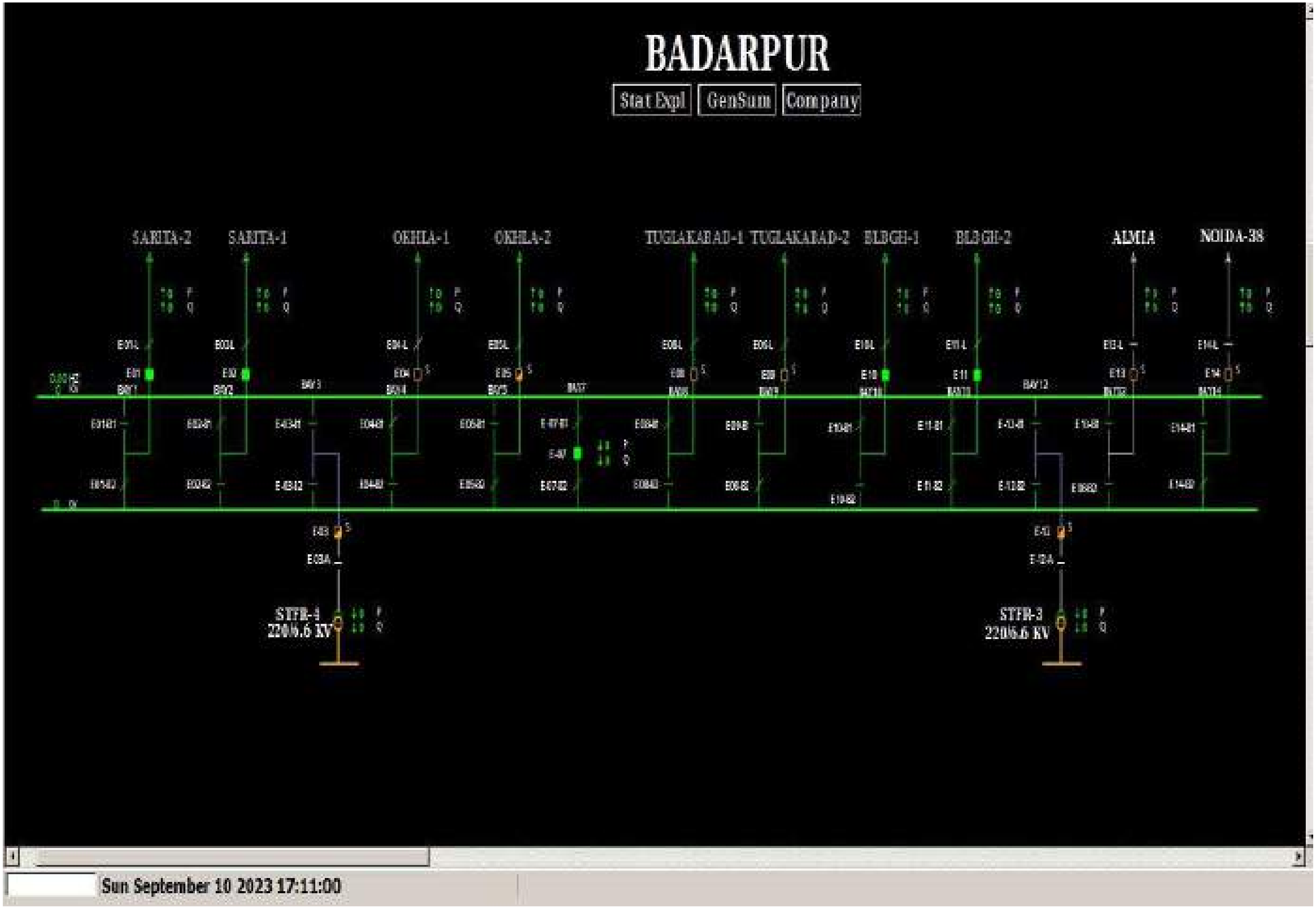
Network Diagram



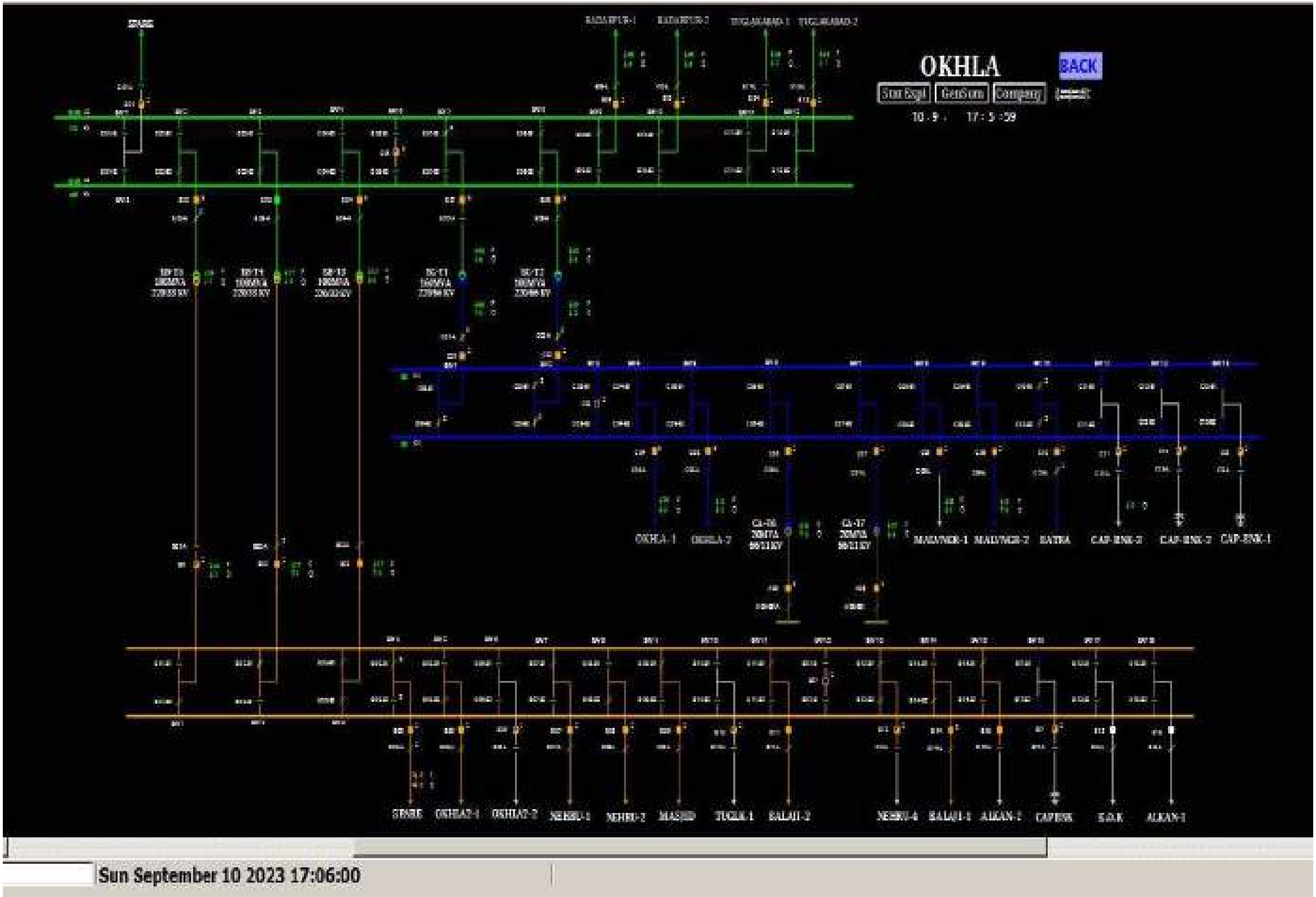
SCADA SLD of 220kV Badarpur(DTL) before the event



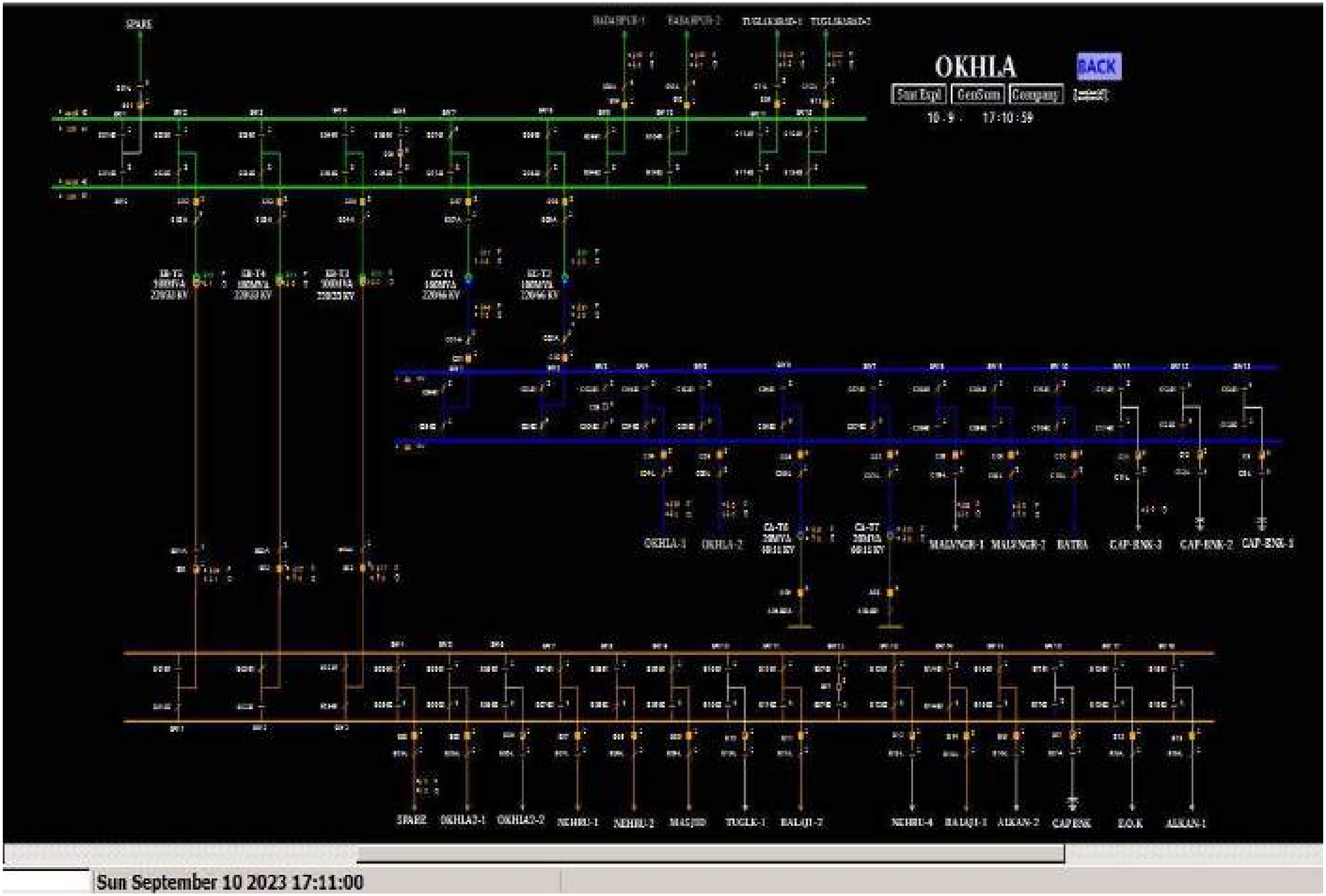
SCADA SLD of 220kV Badarpur(DTL) after the event



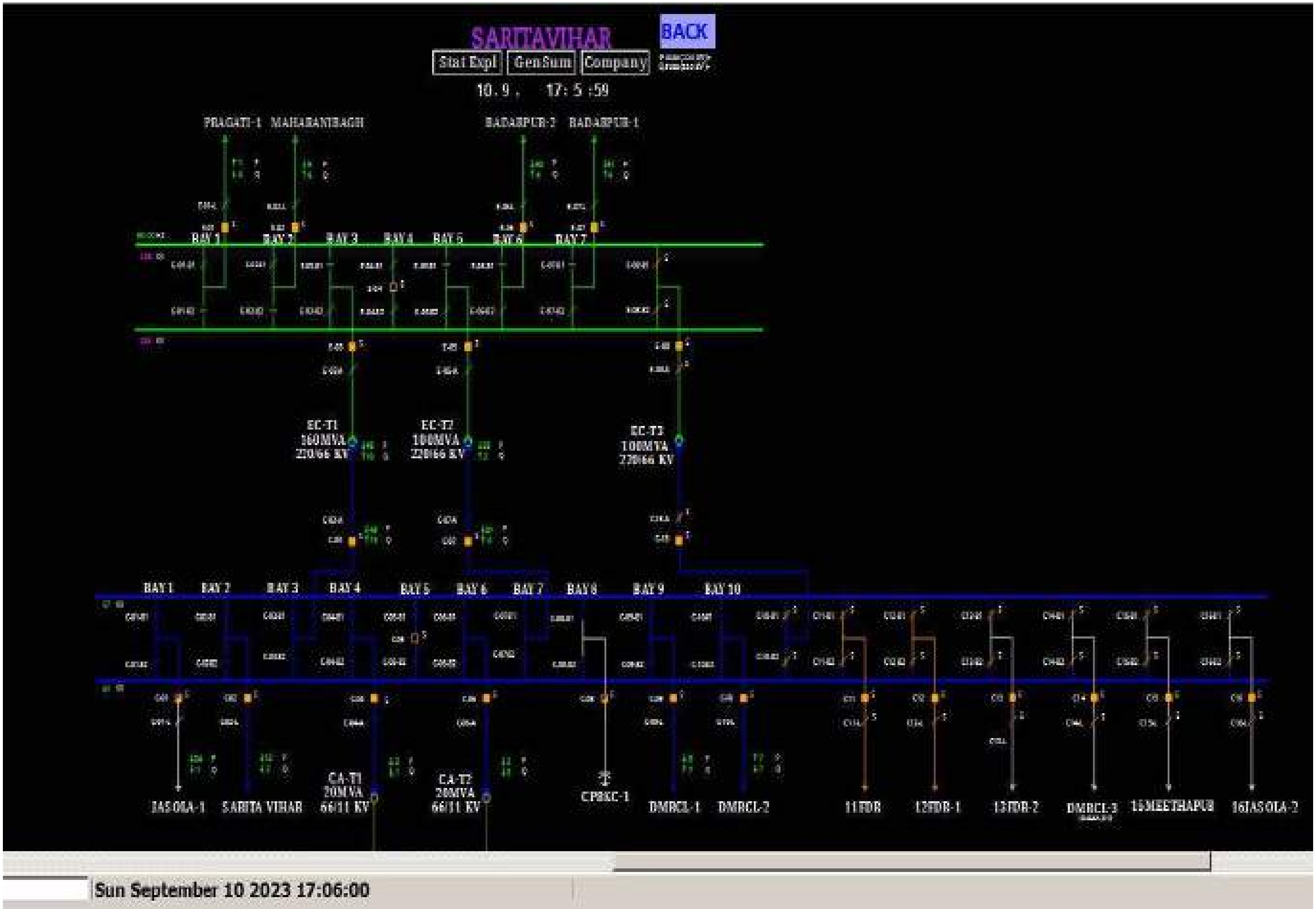
SCADA SLD of 220/66/33kV Okhla(DTL) before the event



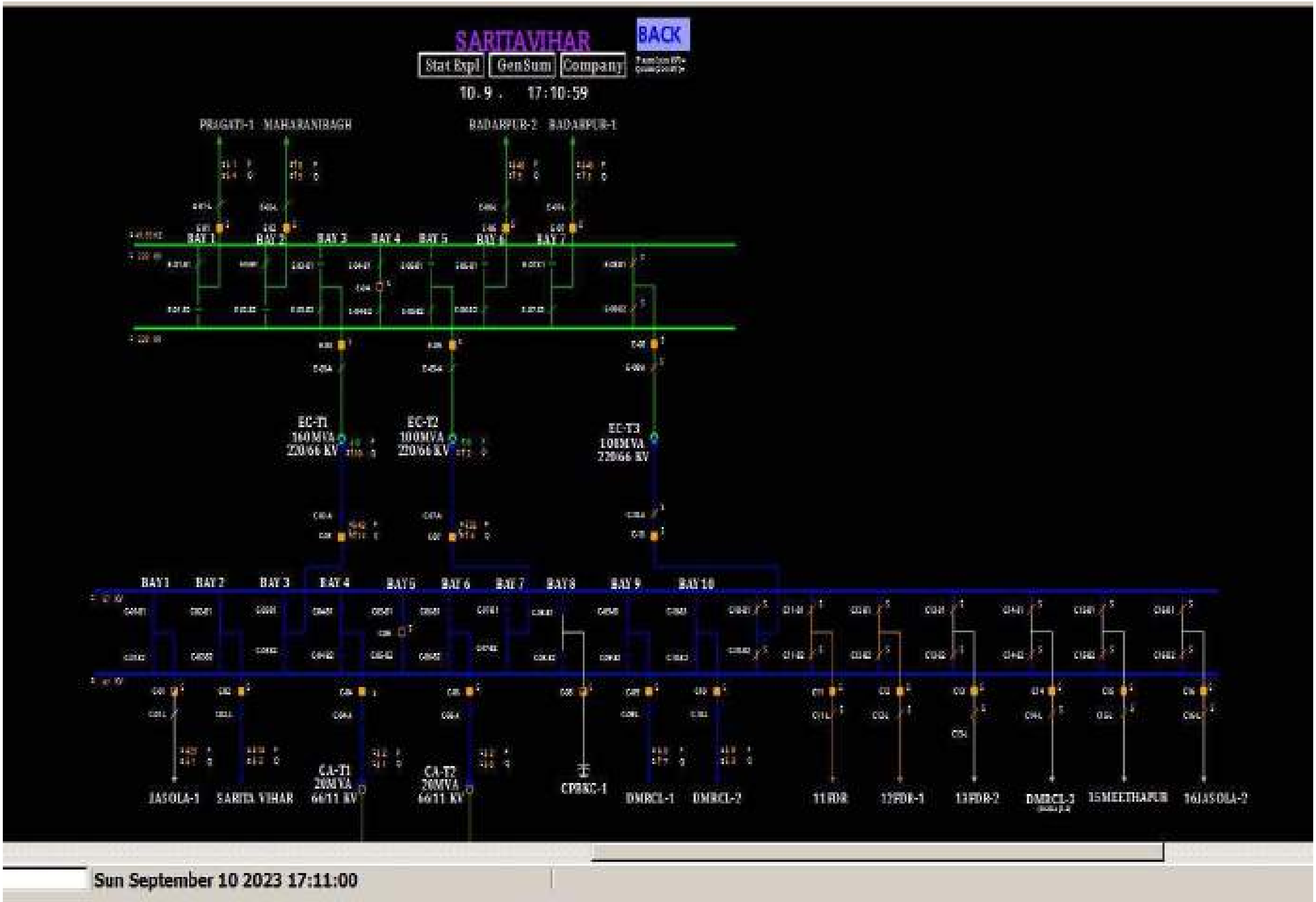
SCADA SLD of 220/66/33kV Okhla(DTL) after the event



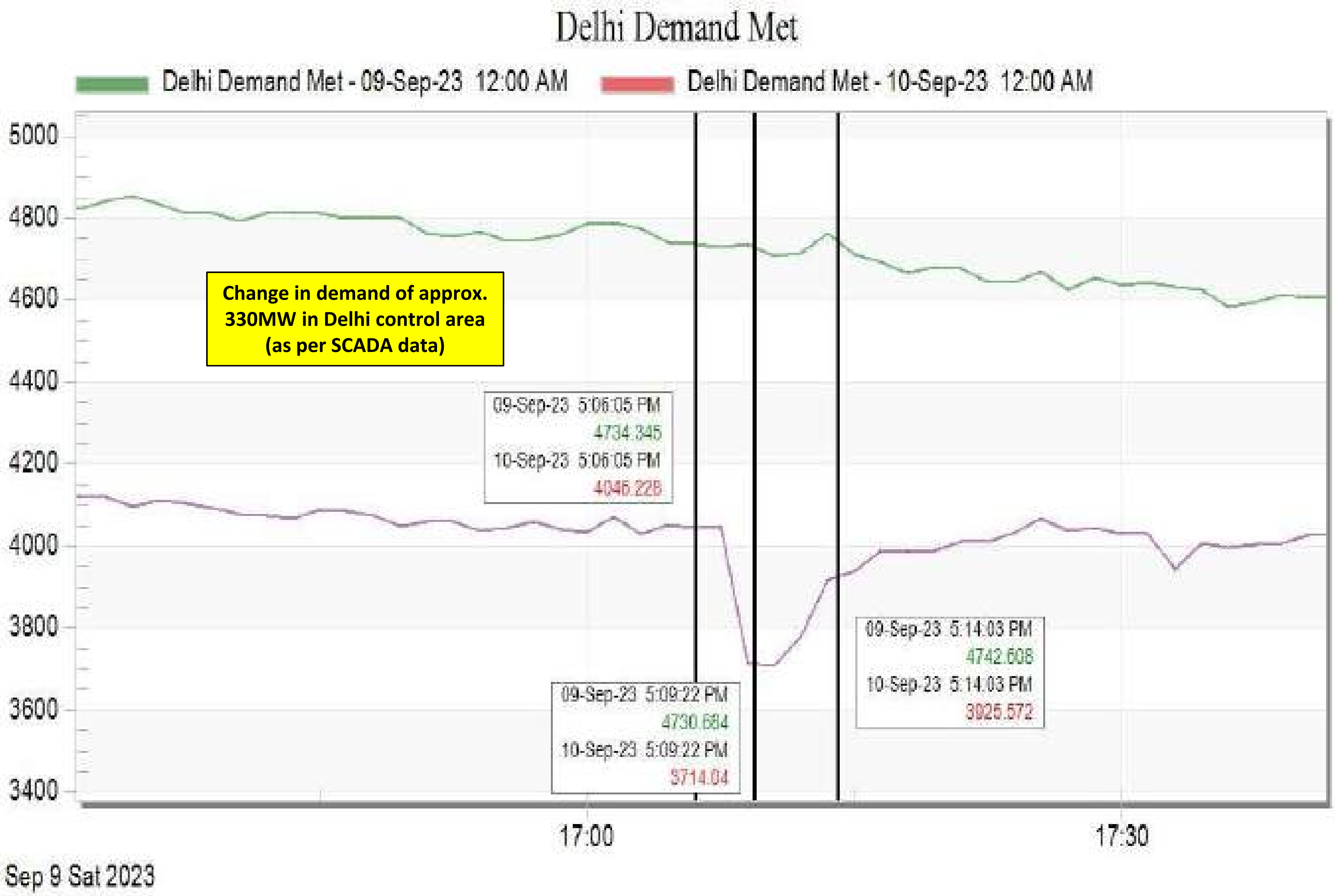
SCADA SLD of 220/66kV Sarita Vihar(DTL) before the event



SCADA SLD of 220/66kV Sarita Vihar(DTL) after the event



Delhi demand during the event



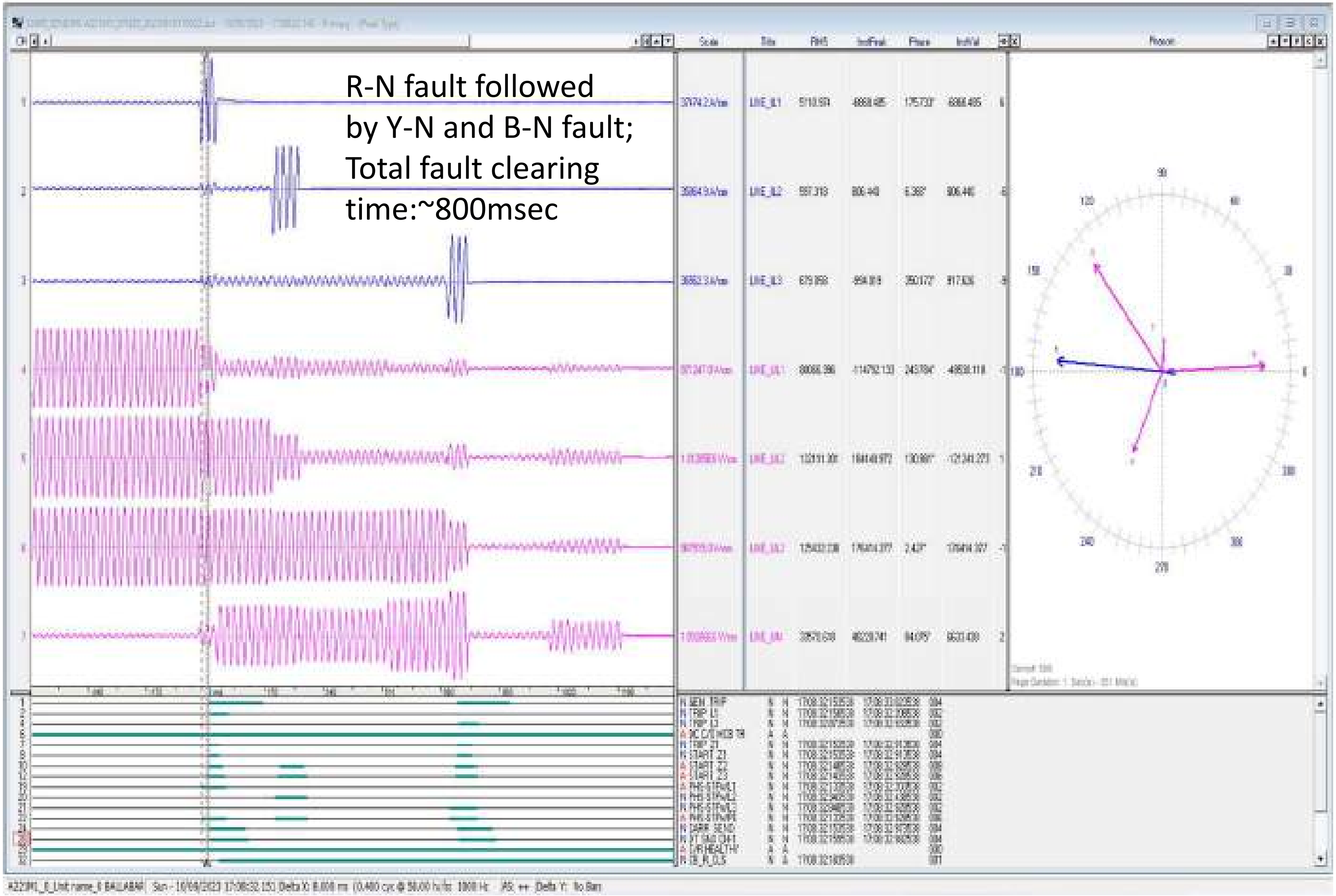
PMU Plot of frequency at Ballabhgarh(PG)

17:08 hrs/10-Sept-23

PMU Plot of phase voltage magnitude at Ballabhgarh(PG)

17:08 hrs/10-Sept-23

DR of 220kV Badarpur(DTL)-Ballabhgarh(BB)(end) ckt-2



SCADA SOE

Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remarks
17:08:32,483	BADARPUR	220	05OKHLA2	Circuit Breaker	disturbe	
17:08:32,505	BADARPUR	220	04OKHLA1	Circuit Breaker	Open	Line CB at Badarpur end of 220kV Badarpur-Okhla ckt-1 opened
17:08:32,732	BADARPUR	220	09TGKBD2	Circuit Breaker	Open	Line CB at Badarpur end of 220kV Badarpur-Tuglakabad ckt-2 opened
17:08:32,741	BADARPUR	220	08TGKBD1	Circuit Breaker	Open	Line CB at Badarpur end of 220kV Badarpur-Tuglakabad ckt-1 opened

Point of discussion

i. Exact location and nature of fault?
ii. Reason of delayed clearance of fault?
iii. DR/EL of all the tripped elements need to be shared.
iv. Why did 220 kV Ballabhgarh(BB)-Badarpur (DTL) Ckt-2 not trip from Badarpur end?
v. On which protection other circuits tripped?
vi. Final tripping report not received yet.
vii. Remedial action taken report to be shared

Multiple elements tripping at 220kV Azamgarh2(UP)

11th September 2023

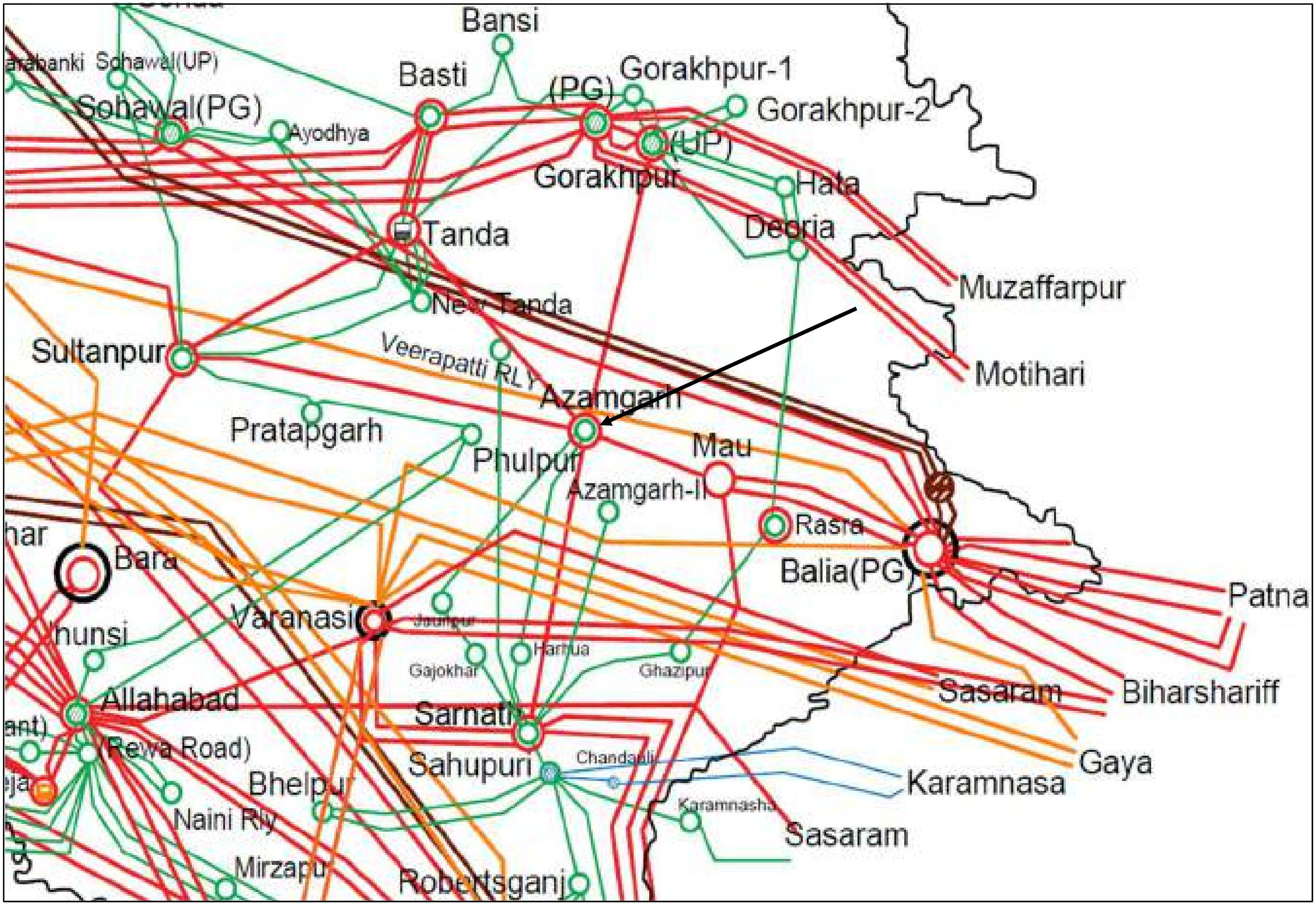
Brief of event:

- 220/132kV Azamgarh2(UP) S/s has double main transfer bus scheme at both 220 & 132 kV level.
- As reported, at **05:36 hrs, 220kV Bus-bar protection operated at Azamgarh2(UP)** which resulted into tripping of all the elements connected to 220kV Bus-1 & 2 at Azamgarh2(UP). (Exact reason of busbar protection operation yet to be shared)
- Due to loss of supply at 132kV level of Azamgarh2(UP), both 132kV Bus-1 & 2 at Azamgarh2(UP) also became dead which resulted into total blackout of 220/132kV Azamgarh2(UP) S/s.
- As per **PMU at Varanasi(PG), Y-N phase to earth fault with fault clearance time of 80ms** is observed.
- As per SCADA, change in demand of approx. 465MW is observed in UP control area.
- As reported, Y-Ph CT damage of BC/BT bay at 220 KV Side substation Hafizpur Azamgarh-1?

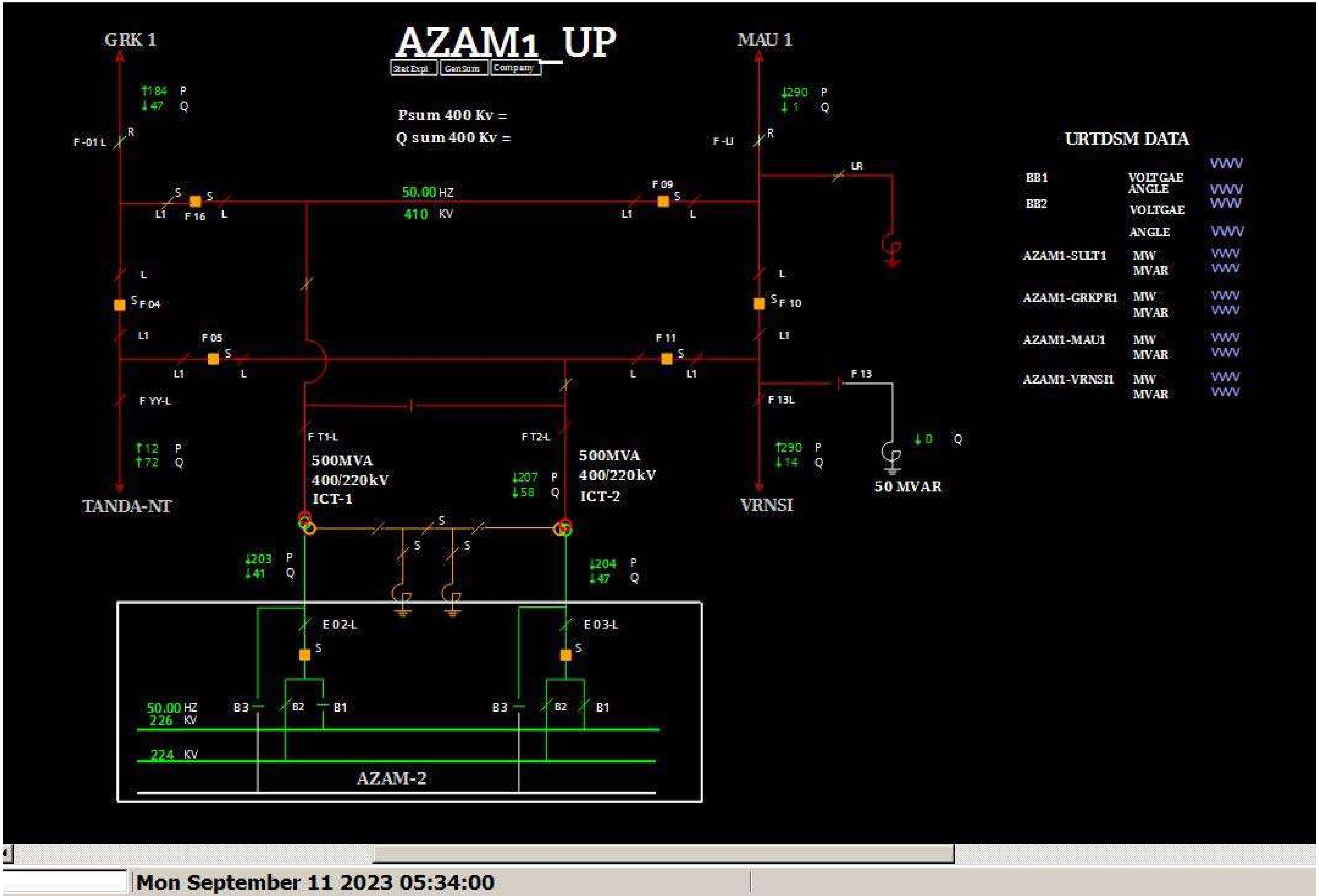
Elements tripped:

i. 400/220 kV 500 MVA ICT 1 at Azamgarh1(UP)
ii. 400/220 kV 500 MVA ICT 2 at Azamgarh1(UP)
iii. 220/132 kV 160 MVA ICT 1 at Azamgarh2(UP)
iv. 220/132 kV 200 MVA ICT 2 at Azamgarh2(UP)
v. 220/132 kV 160 MVA ICT 3 at Azamgarh2(UP)
vi. 220kV Azamgarh2-Haraua(UP) Ckt
vii. 220kV Azamgarh2-Jaunpur(UP) Ckt

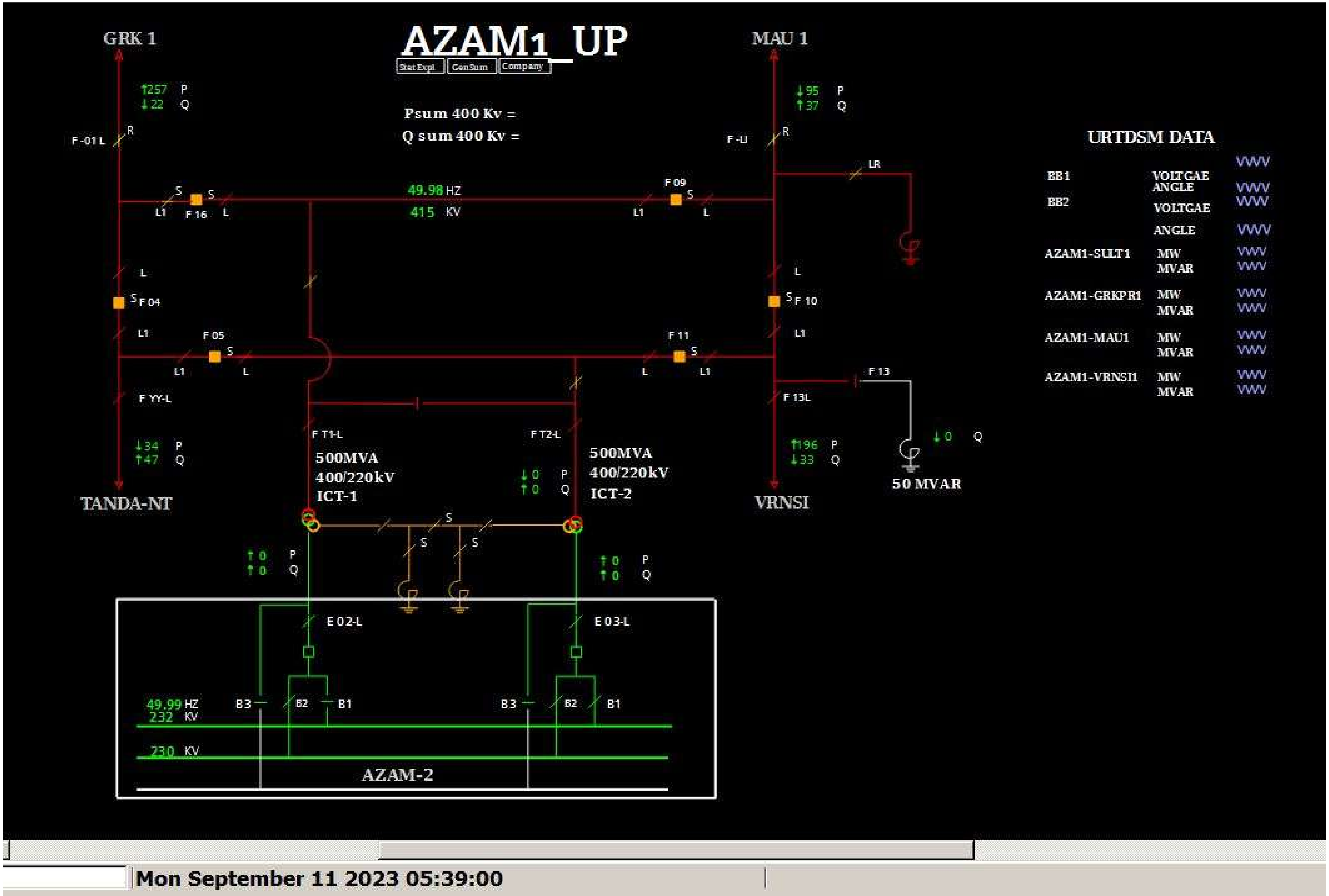
Network Diagram



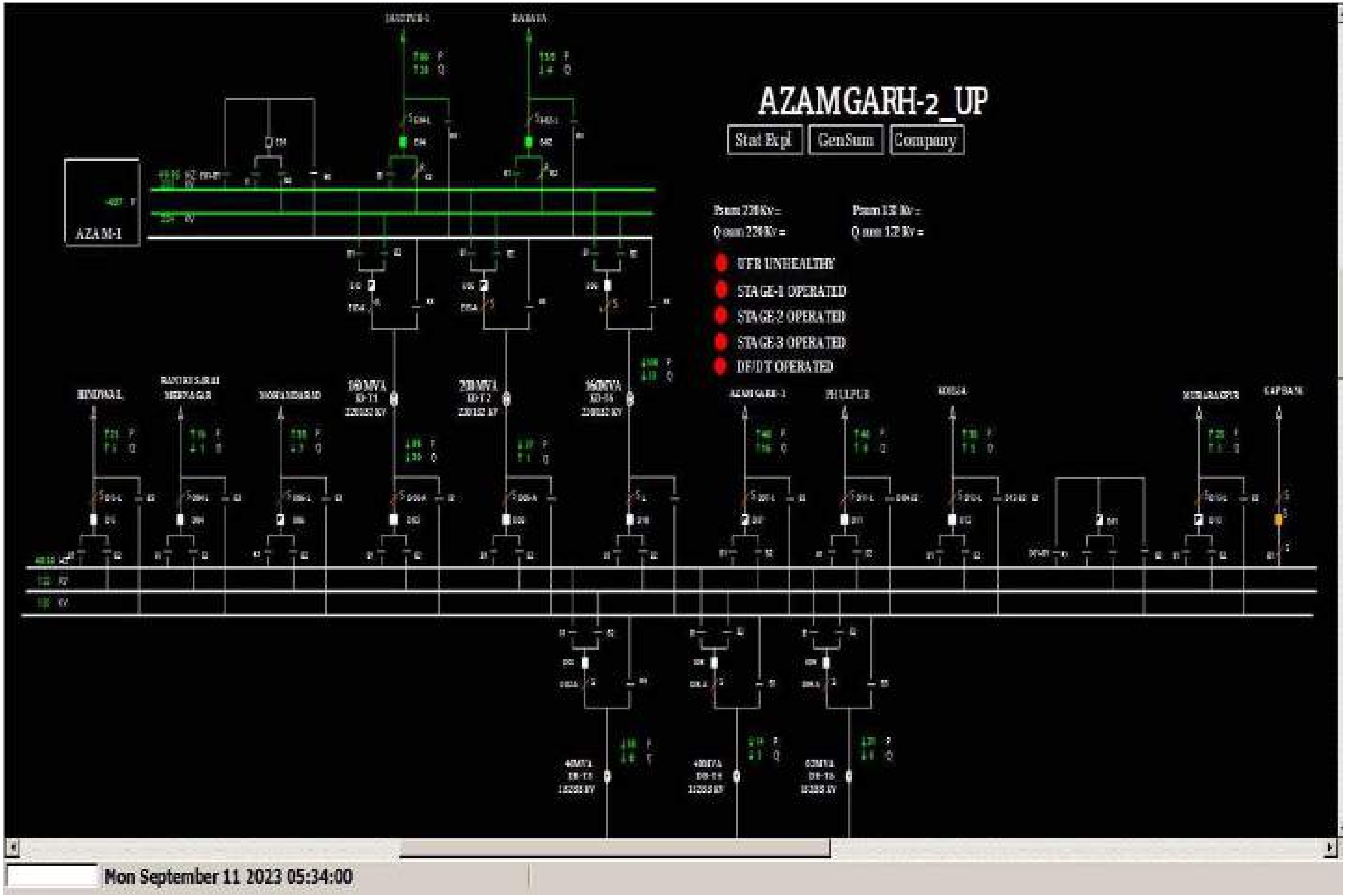
SLD of 400/220kV Azamgarh1(UP) before the event



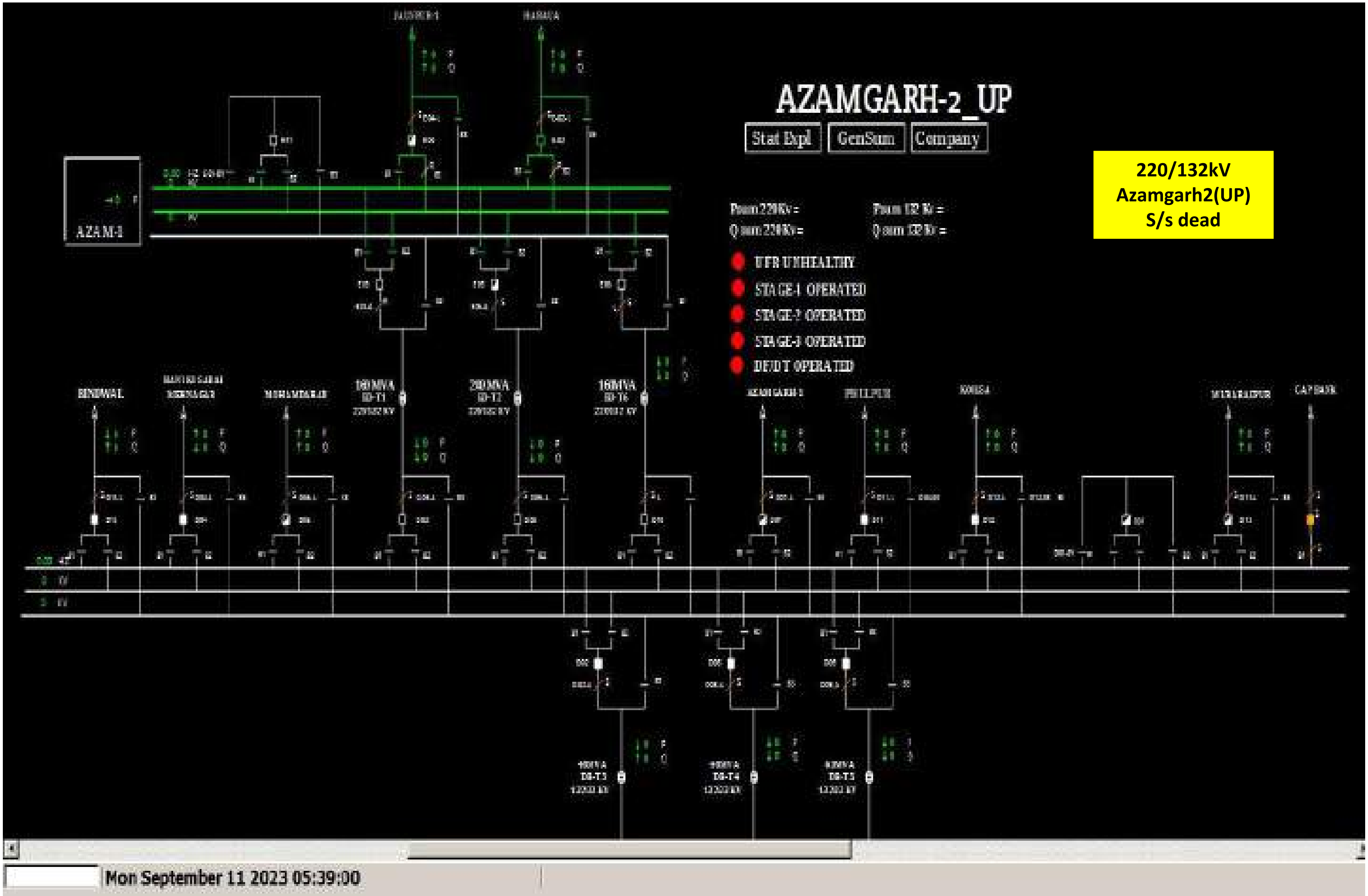
SLD of 400/220kV Azamgarh1(UP) after the event



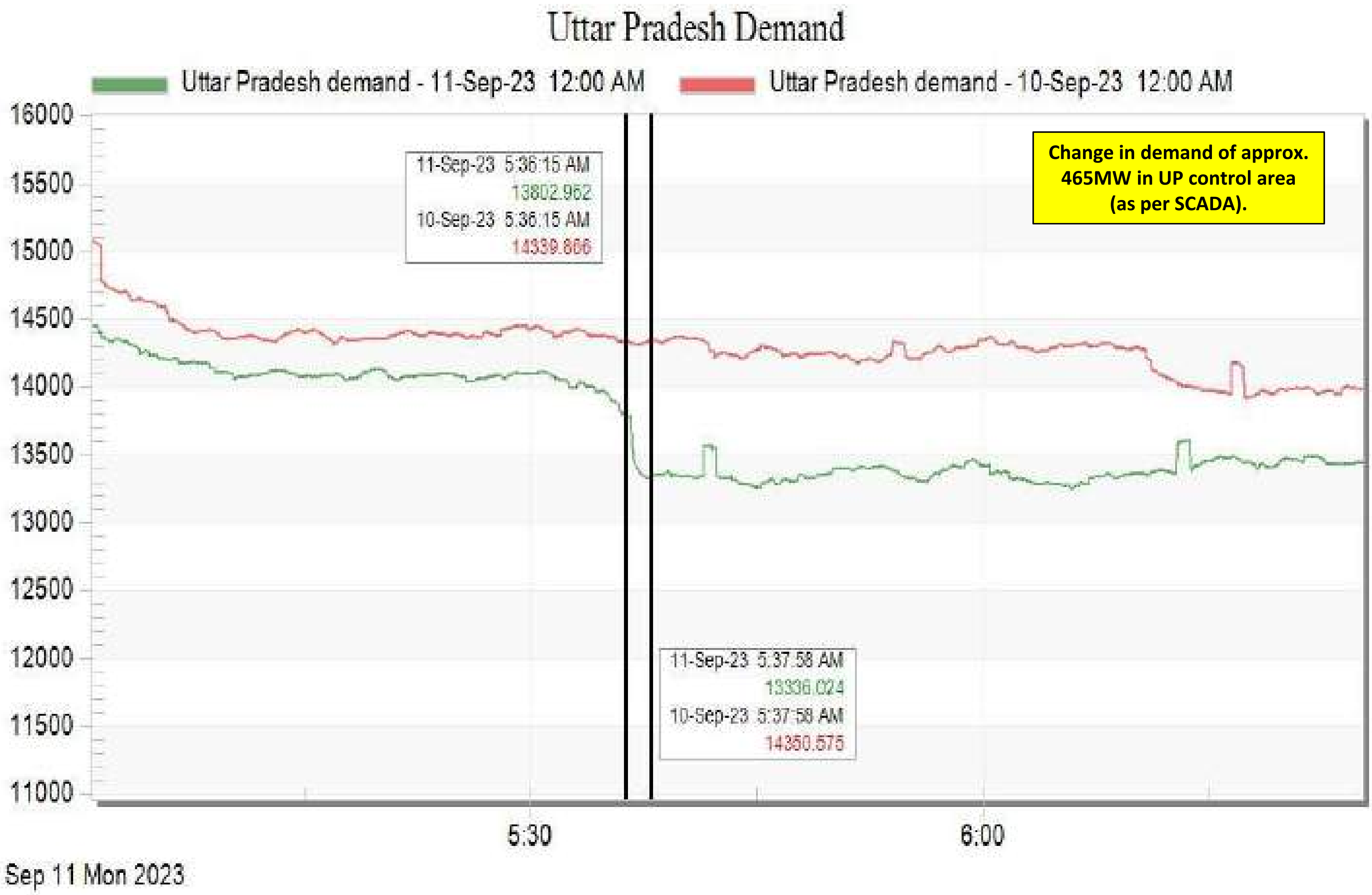
SLD of 220/132kV Azamgarh2(UP) before the event



SLD of 220/132kV Azamgarh2(UP) after the event



Uttar Pradesh demand during the event



PMU Plot of frequency at Varanasi(PG)

05:36 hrs/11-Sept-23

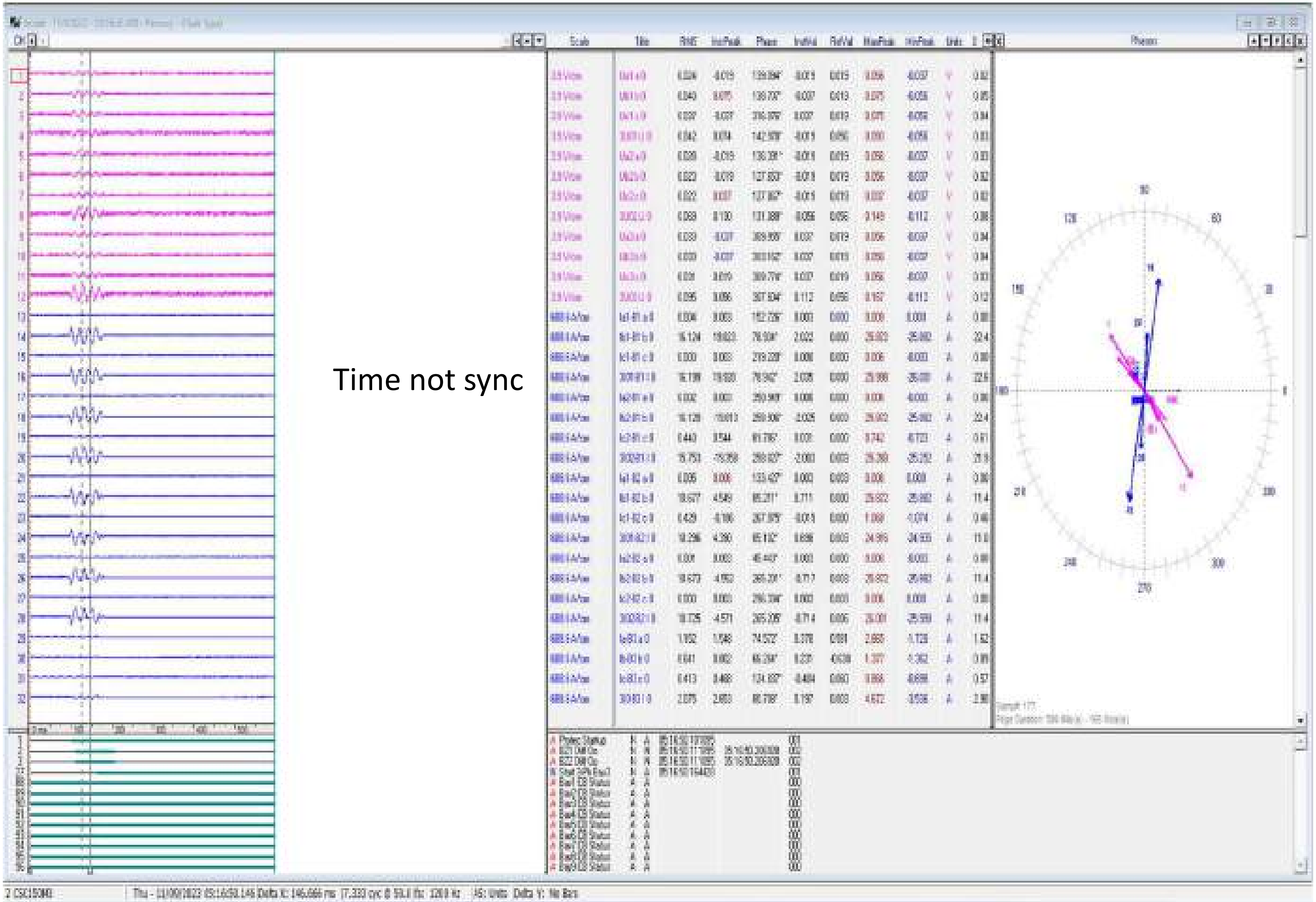
PMU Plot of phase voltage magnitude at Varanasi(PG)

05:36 hrs/11-Sept-23

SCADA SOE

Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remarks
05:36:17,670	AZAM2_UP	220kV	06T6	Circuit Breaker	Open	CB at 220kV side of 220/132 kV 160 MVA ICT 3 at Azamgarh2(UP) opened
05:36:17,685	AZAM2_UP	132kV	03T1	Circuit Breaker	Open	CB at 132kV side of 220/132 kV 160 MVA ICT 1 at Azamgarh2(UP) opened
05:36:17,686	AZAM2_UP	220kV	02HARUA	Circuit Breaker	Open	Line CB at Azamgarh2(UP) end of 220kV Azamgarh2-Haraua(UP) Ckt opened
05:36:17,686	AZAM2_UP	132kV	05T2	Circuit Breaker	Open	CB at 132kV side of 220/132 kV 200 MVA ICT 2 at Azamgarh2(UP) opened
05:36:17,693	AZAM2_UP	220kV	04JUNPR1	Circuit Breaker	Open	Line CB at Azamgarh2(UP) end of 220kV Azamgarh2-Jaunpur(UP) Ckt opened
05:36:17,697	AZAM2_UP	132kV	10T6	Circuit Breaker	Open	CB at 132kV side of 220/132 kV 160 MVA ICT 3 at Azamgarh2(UP) opened
05:36:17,715	AZAM2_UP	220kV	03T1	Circuit Breaker	Open	CB at 220kV side of 220/132 kV 160 MVA ICT 1 at Azamgarh2(UP) opened
05:36:38,778	AZAM1_UP	220kV	02T1	Circuit Breaker	Open	CB at 220kV side of 400/220 kV 500 MVA ICT 1 at Azamgarh1(UP) opened
05:36:39,942	AZAM1_UP	220kV	03T2	Circuit Breaker	Open	CB at 220kV side of 400/220 kV 500 MVA ICT 2 at Azamgarh1(UP) opened
05:36:47,000	AZAM2_UP	220kV	04JUNPR1	Circuit Breaker	disturbe	

DR received from UP



Time not sync

Point of discussion

i. Exact nature and location of fault?
ii. Exact reason of busbar protection operation need to be shared.
iii. Why did element connected to both the 220kV bus trip?
iv. DR/EL of all the elements need to be shared for both the ends.
v. Remedial action taken report need to be shared.

Multiple elements tripping at 400kV Obra-B(UP)

13th September 2023

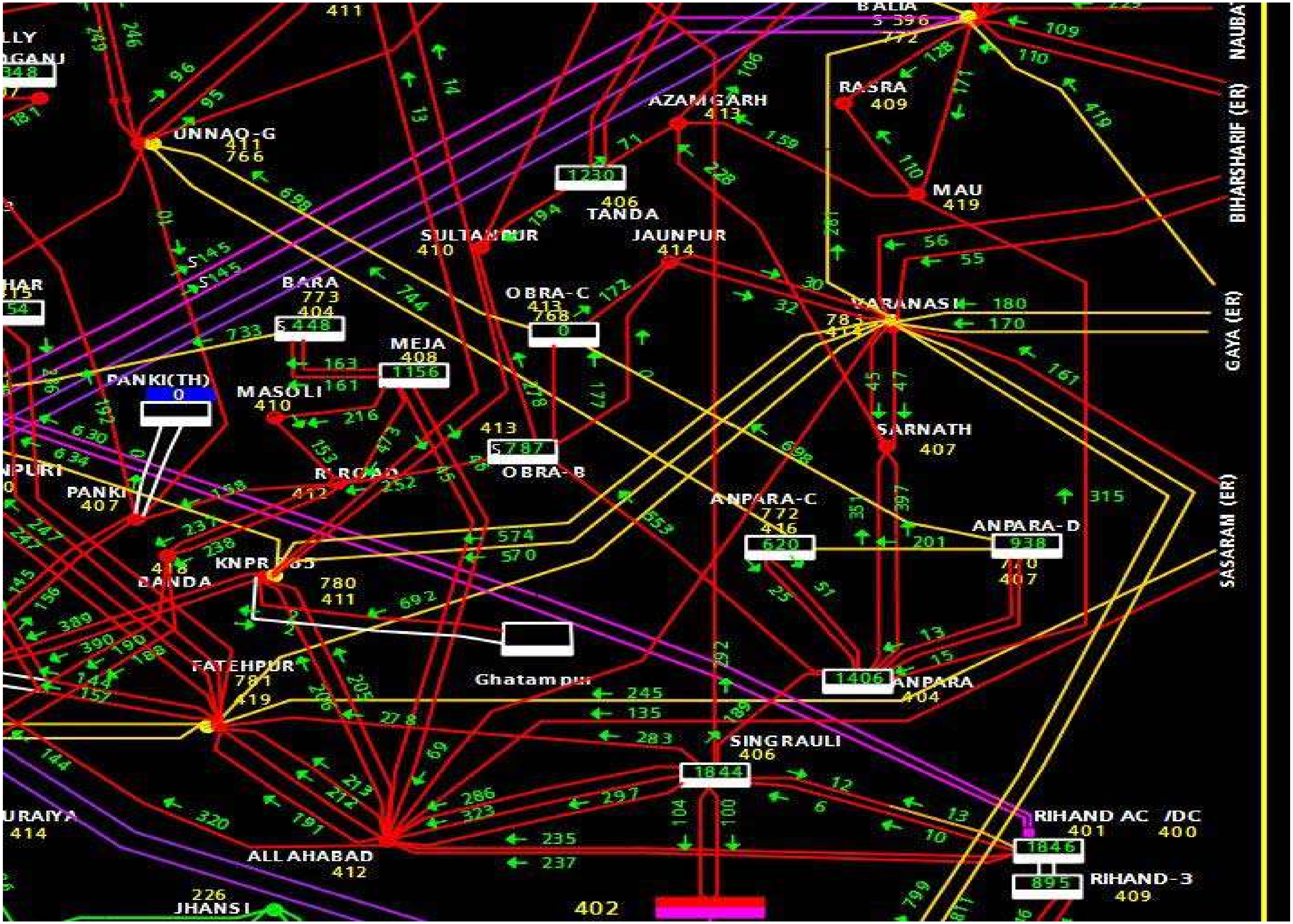
Brief of event:

- During antecedent condition, 200 MW Obra TPS - UNIT 12 was running through station transformer and generating approx. 124MW.
- As reported, at 07:50 hrs, 400/220 KV 315 MVA ICT-1 at Obra-B(UP) tripped on **R-ph differential protection operation due to blast of 220kV R phase bushing of transformer**. Firefighting system installed to protect ICT from fire, operated automatically and protected the complete transformer from the spreading of fire and further damage to other equipment and ICT itself.
- At the same time, 400/220 KV 315 MVA ICT-2 and 240 MVA ICT-3 at Obra-B(UP) also tripped on over-current earth-fault protection operation.
- During the same time, “SPS related to overloading of remaining ICT after tripping of any ICT at Obra TPS” operated and 220kV Obra-A(UP)-Rewa Road(UP) Ckt-1 & 2 and 220kV Obra-A(UP)-Mirzapur(UP) Ckt tripped.
- As per PMU at Allahabad(PG), R-N phase to earth fault with fault clearance time of 80ms is observed.
- As per SCADA, change in demand of approx. 345MW is observed in UP control area.
- As reported by SLDC-UP, load loss of approx. 308MW is observed in UP control area and generation loss of approx. 124MW is observed at Obra-B(UP).

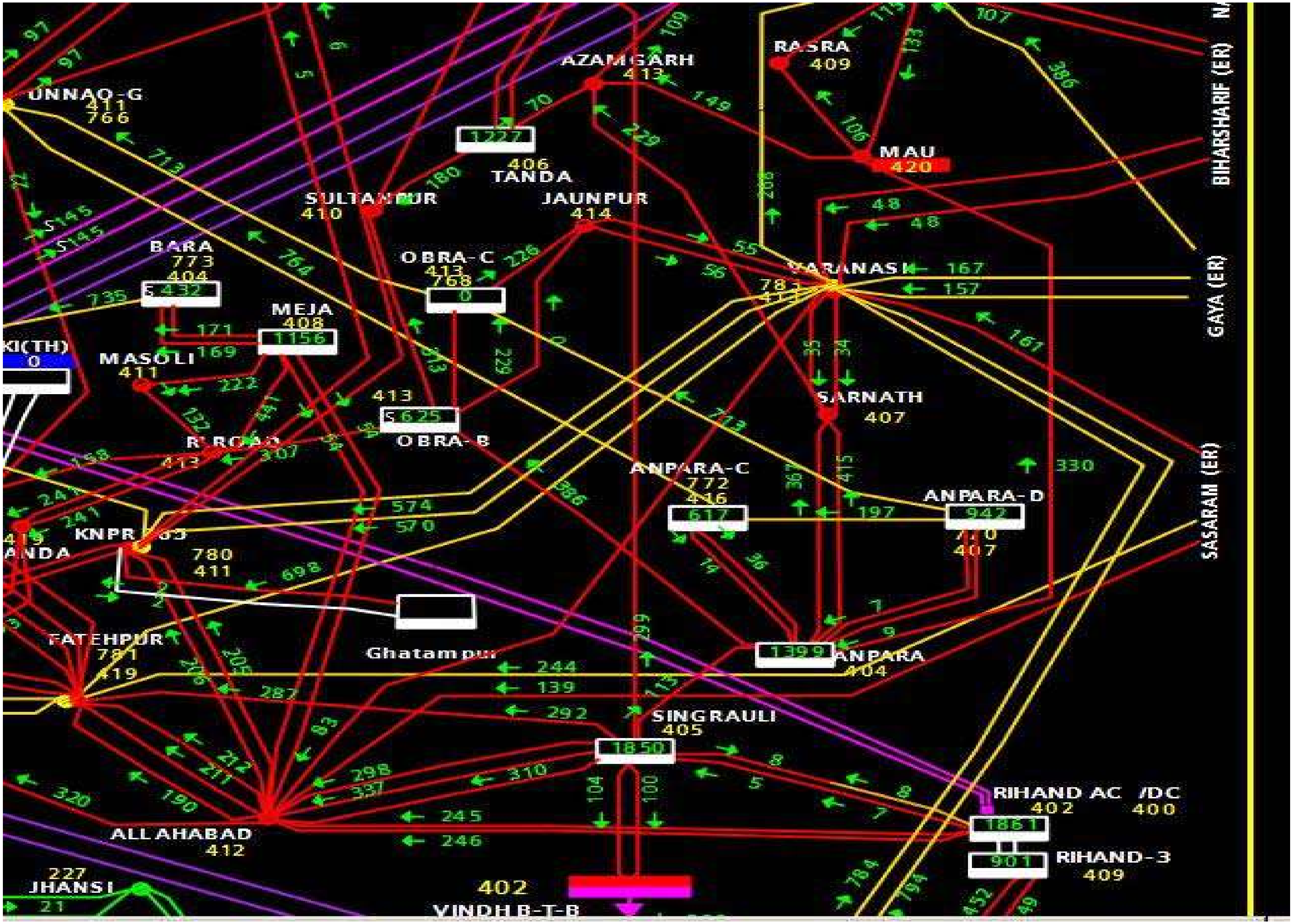
Elements tripped:

i. 400/220 KV 315 MVA ICT-1 at Obra-B(UP)
ii. 400/220 KV 315 MVA ICT-2 at Obra-B(UP)
iii. 400/220 KV 240 MVA ICT-3 at Obra-B(UP)
iv. 200 MW Obra TPS - UNIT 12
v. 220kV Obra-A(UP)-Rewa Road(UP) Ckt-1
vi. 220kV Obra-A(UP)-Rewa Road(UP) Ckt-2
vii. 220kV Obra-A(UP)-Mirzapur(UP) Ckt

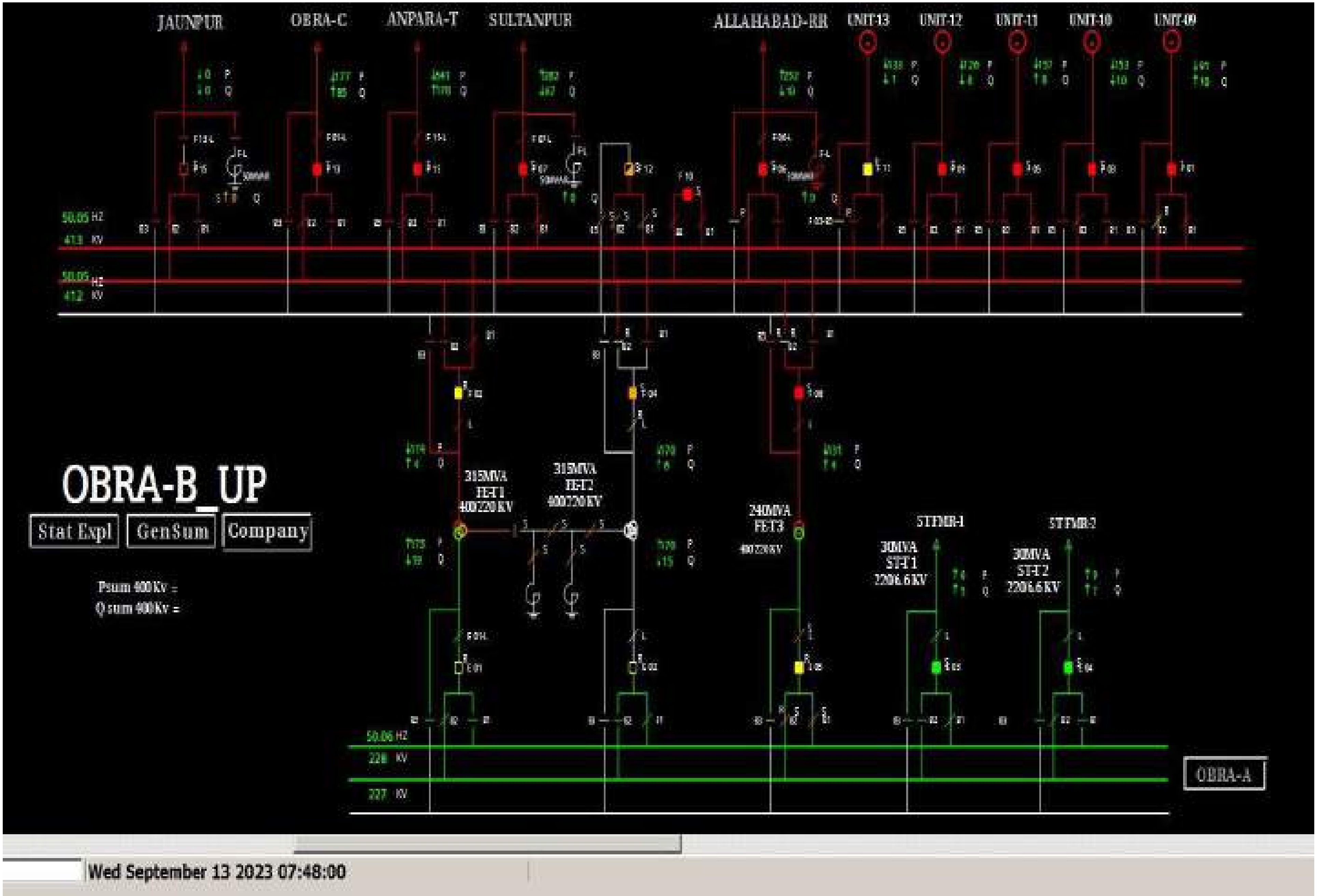
Network Diagram before the event



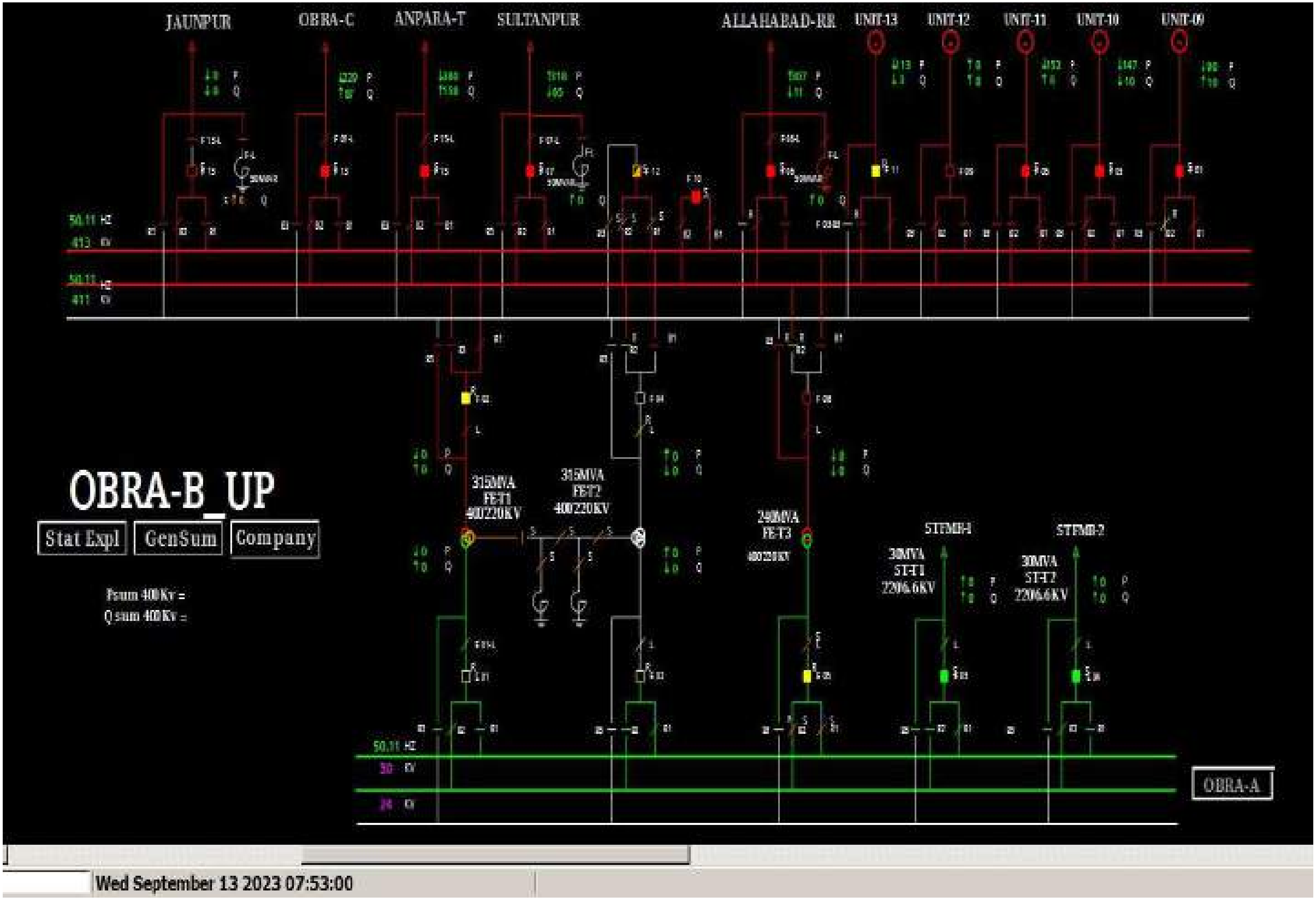
Network Diagram after the event



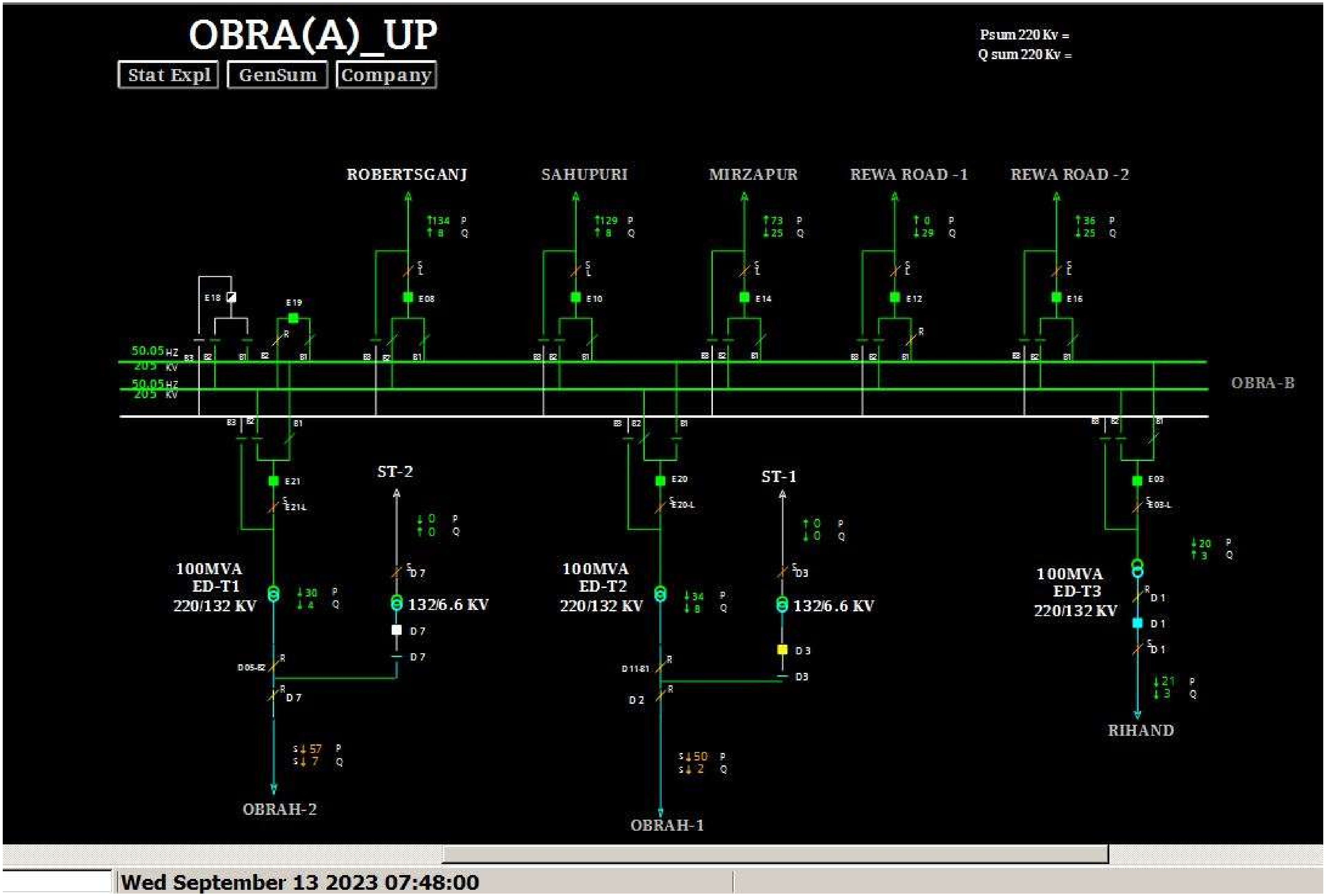
SLD of 400/220kV Obra-B(UP) before the event



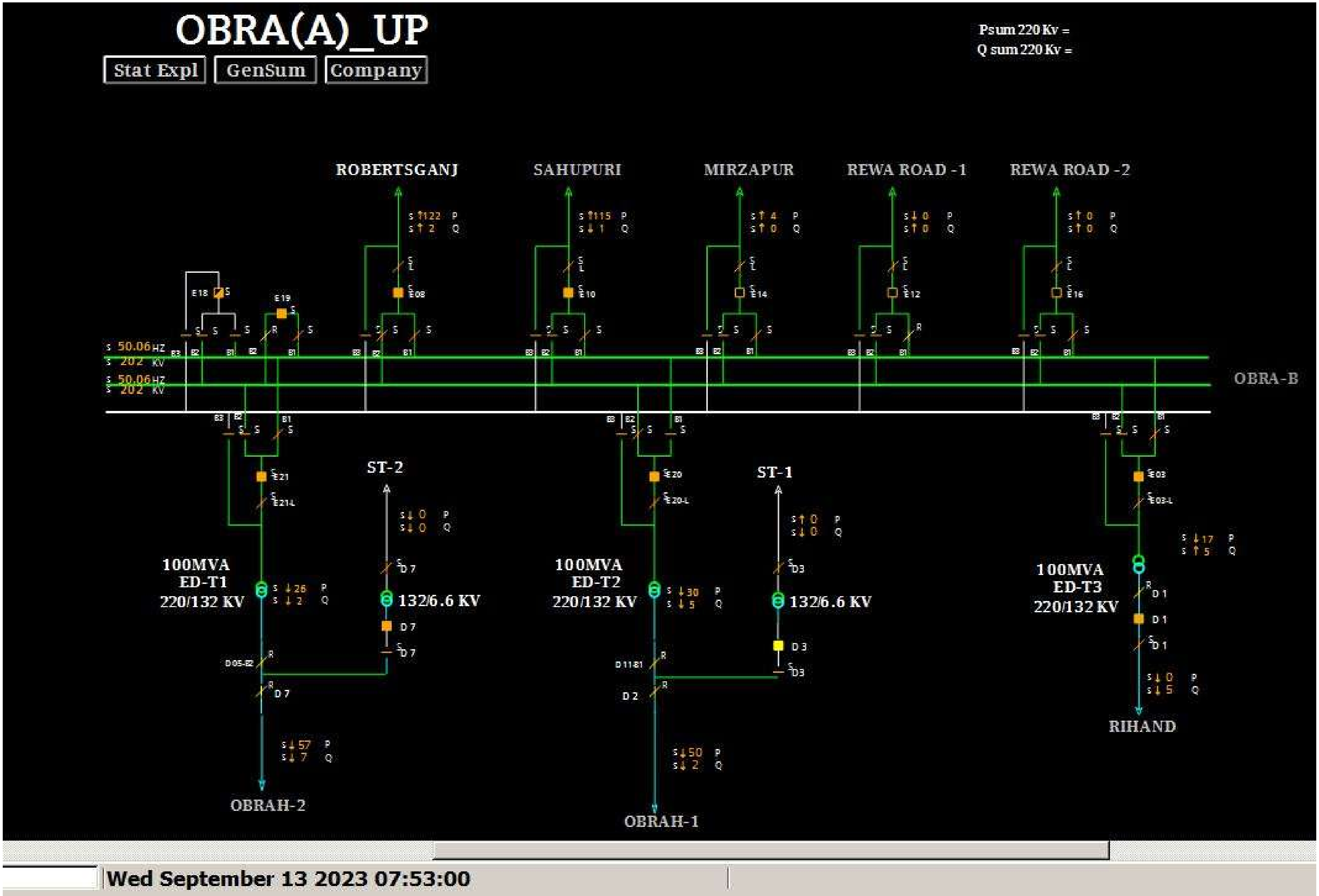
SLD of 400/220kV Obra-B(UP) after the event



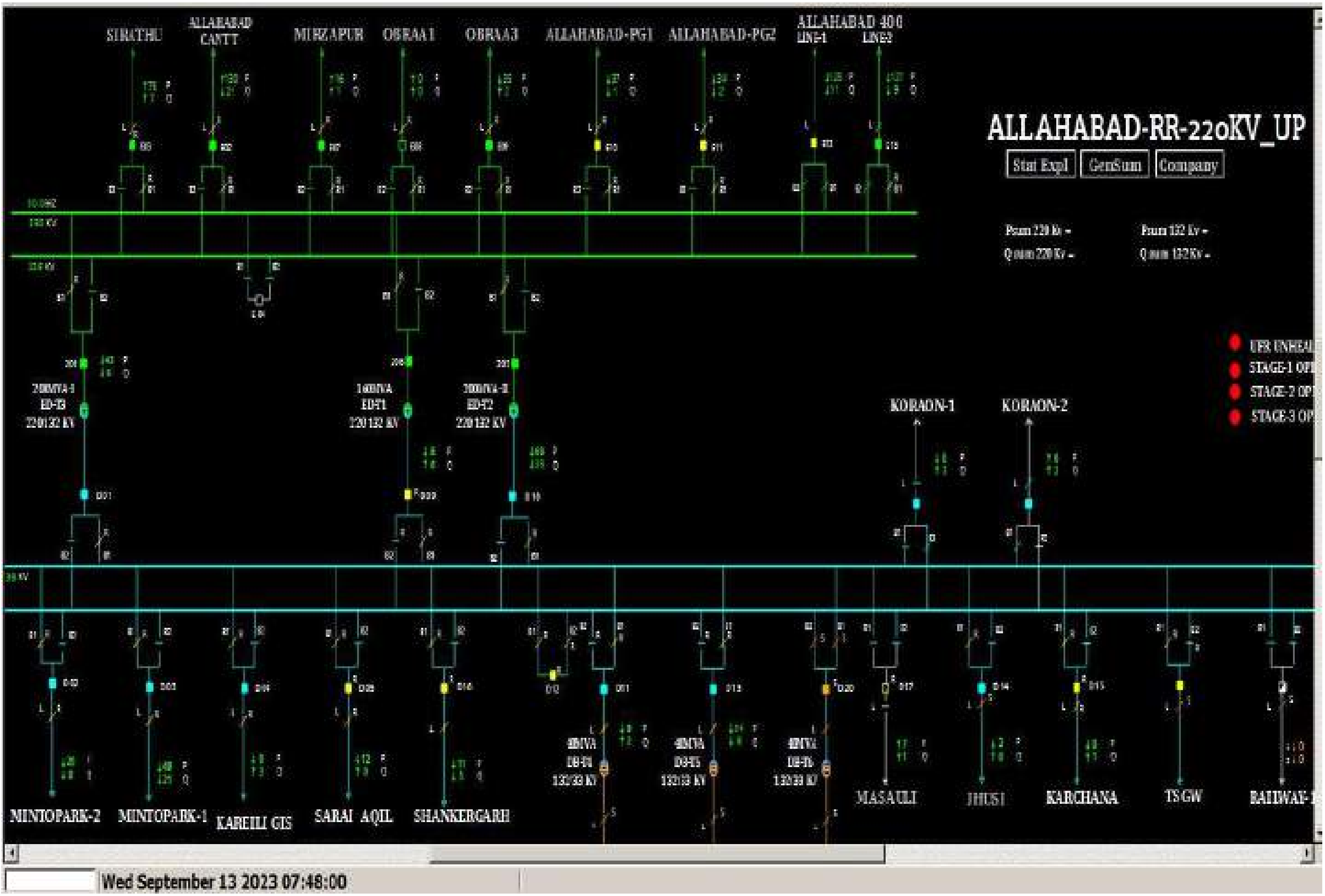
SLD of 220/132kV Obra-A(UP) before the event



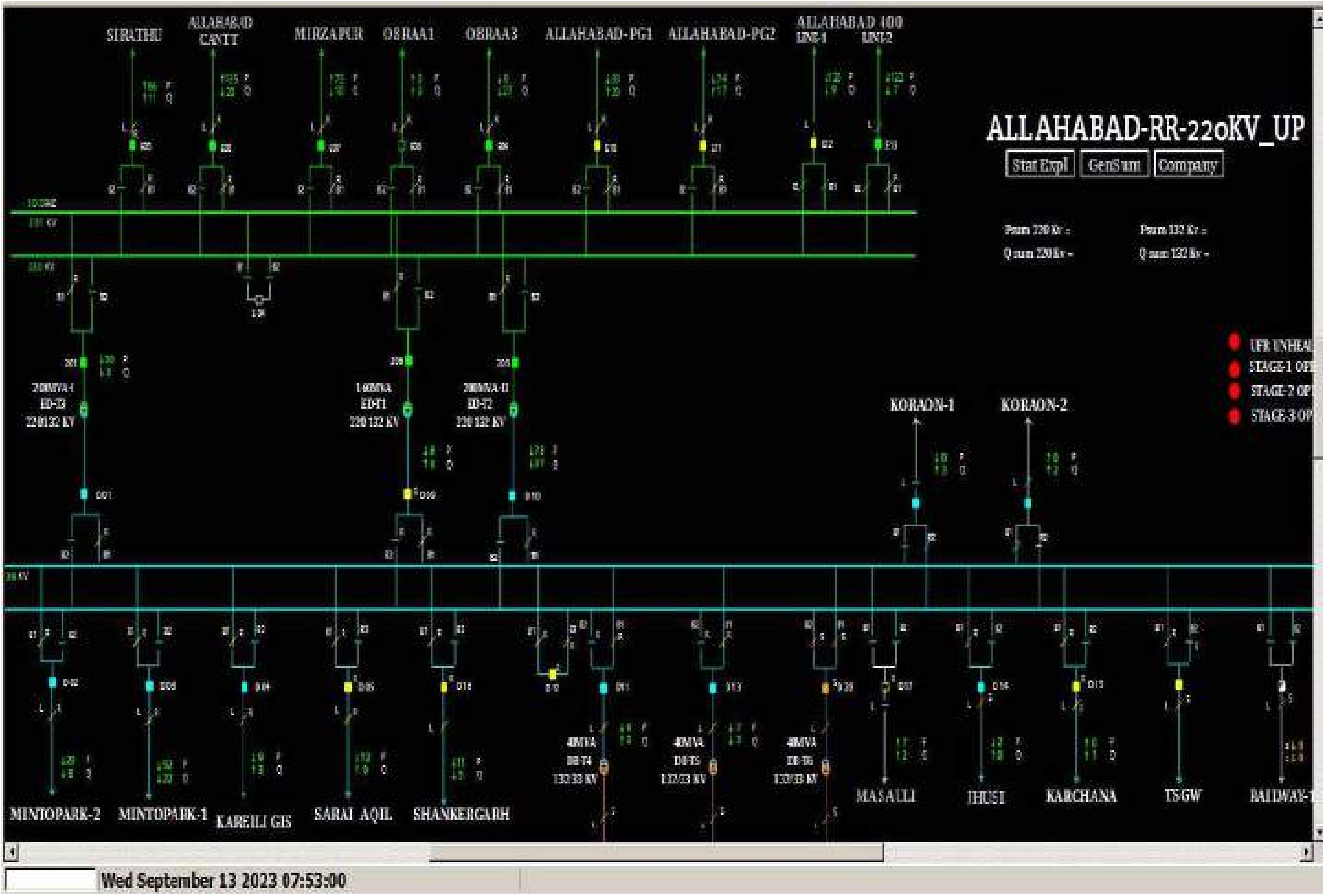
SLD of 220/132kV Obra-A(UP) after the event



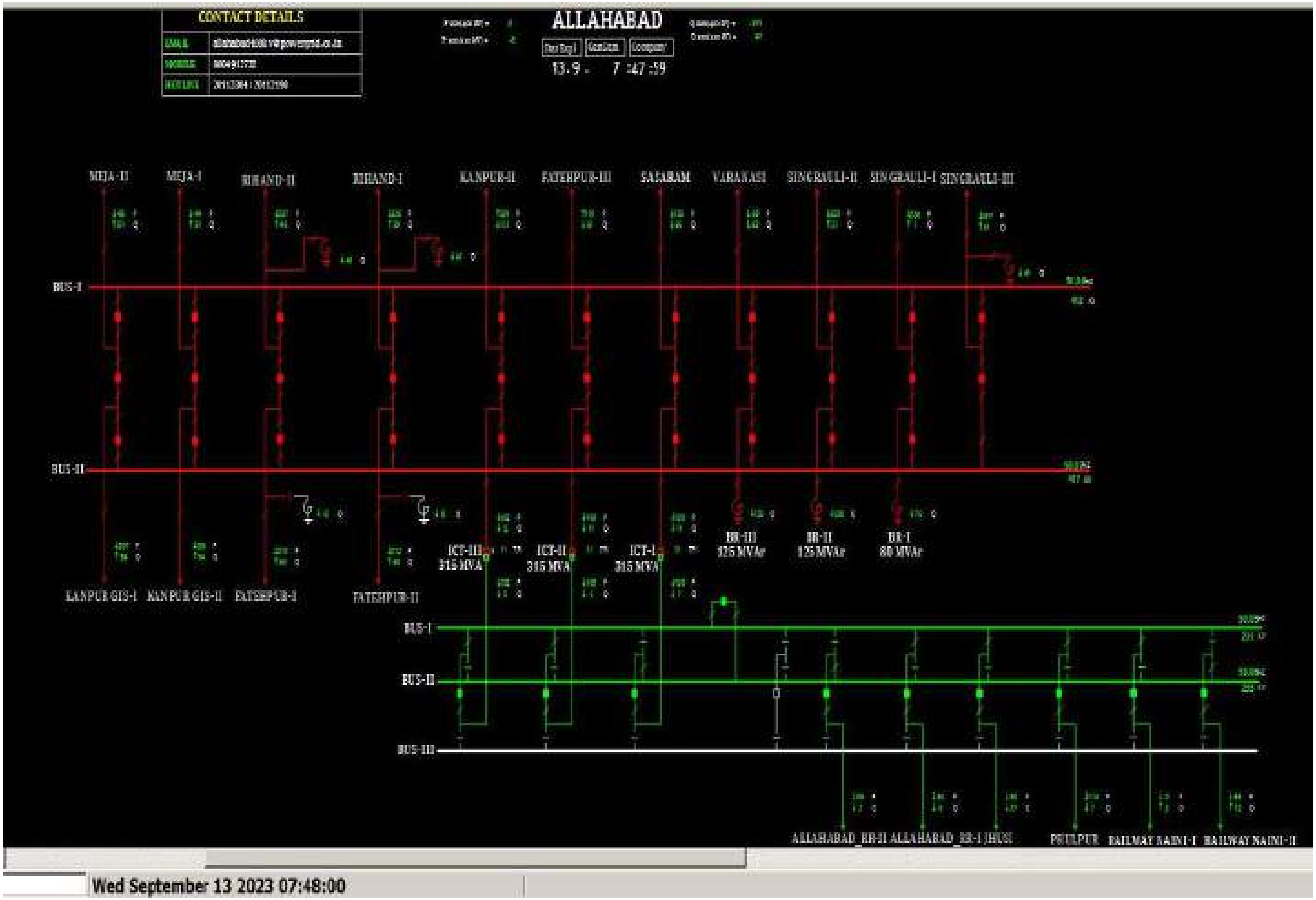
SLD of 220/132kV Rewa Road(UP) before the event



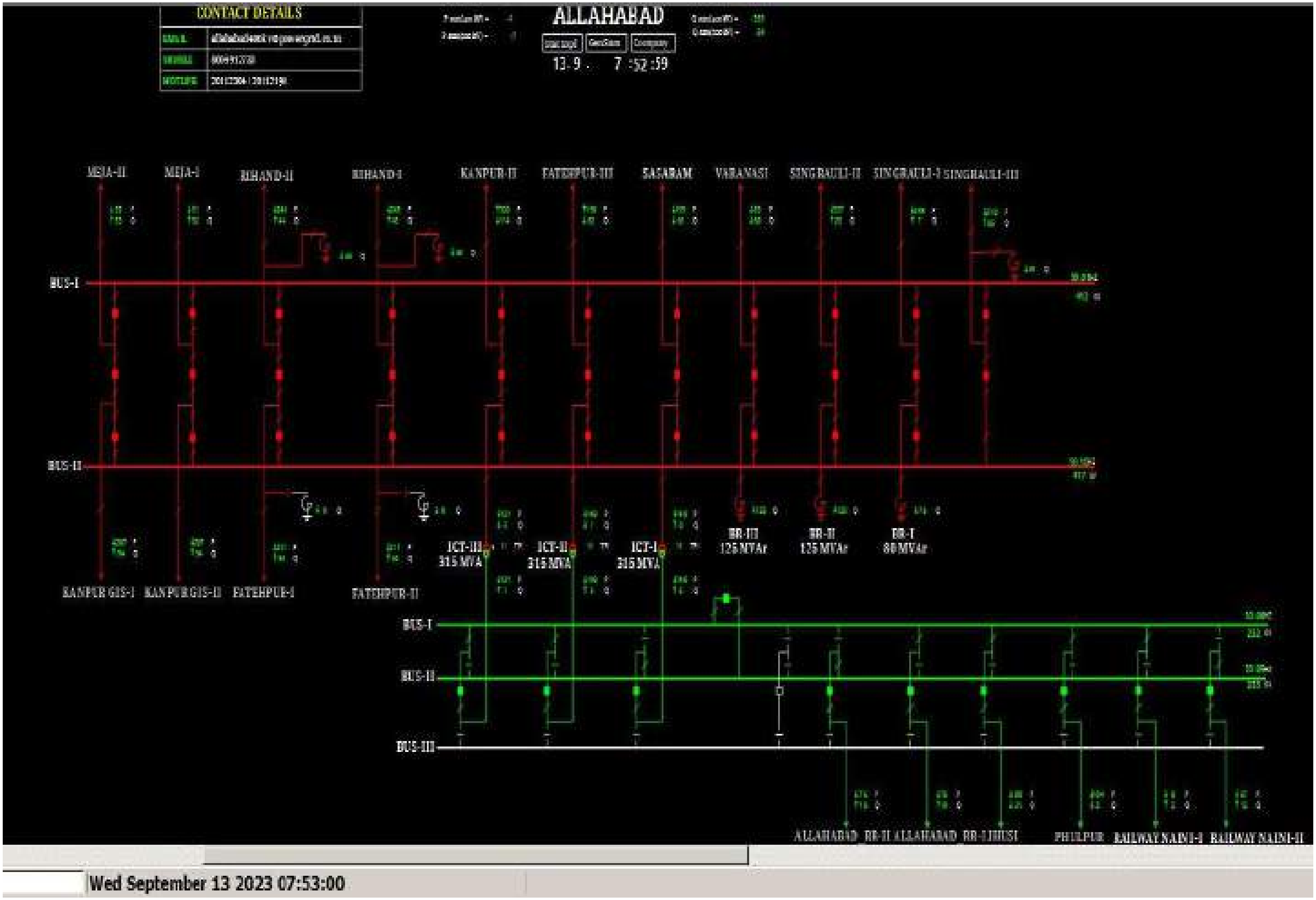
SLD of 220/132kV Rewa Road(UP) after the event



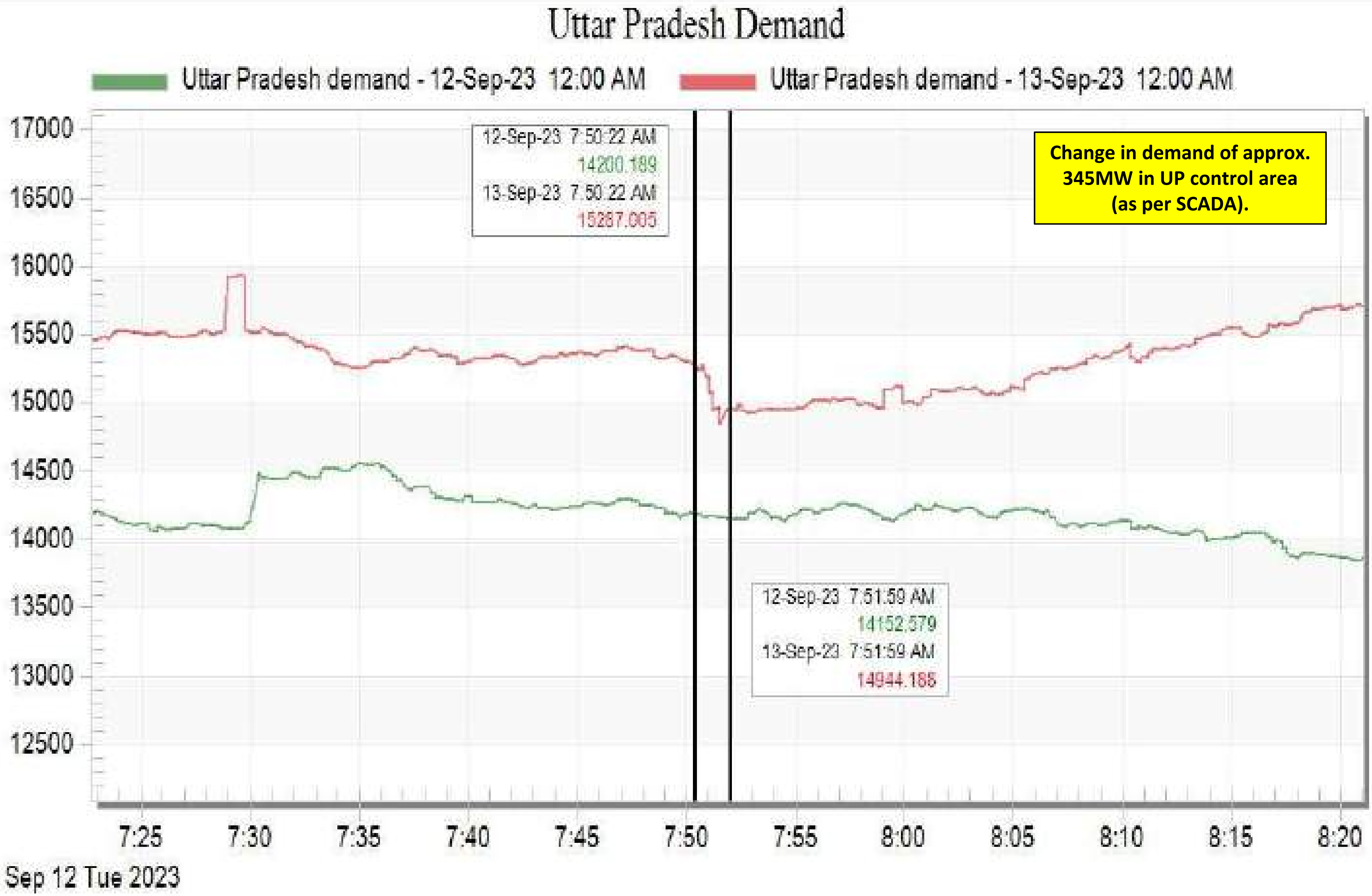
SLD of 400/220kV Allahabad (PG) before the event



SLD of 400/220kV Allahabad (PG) after the event



Uttar Pradesh demand during the event

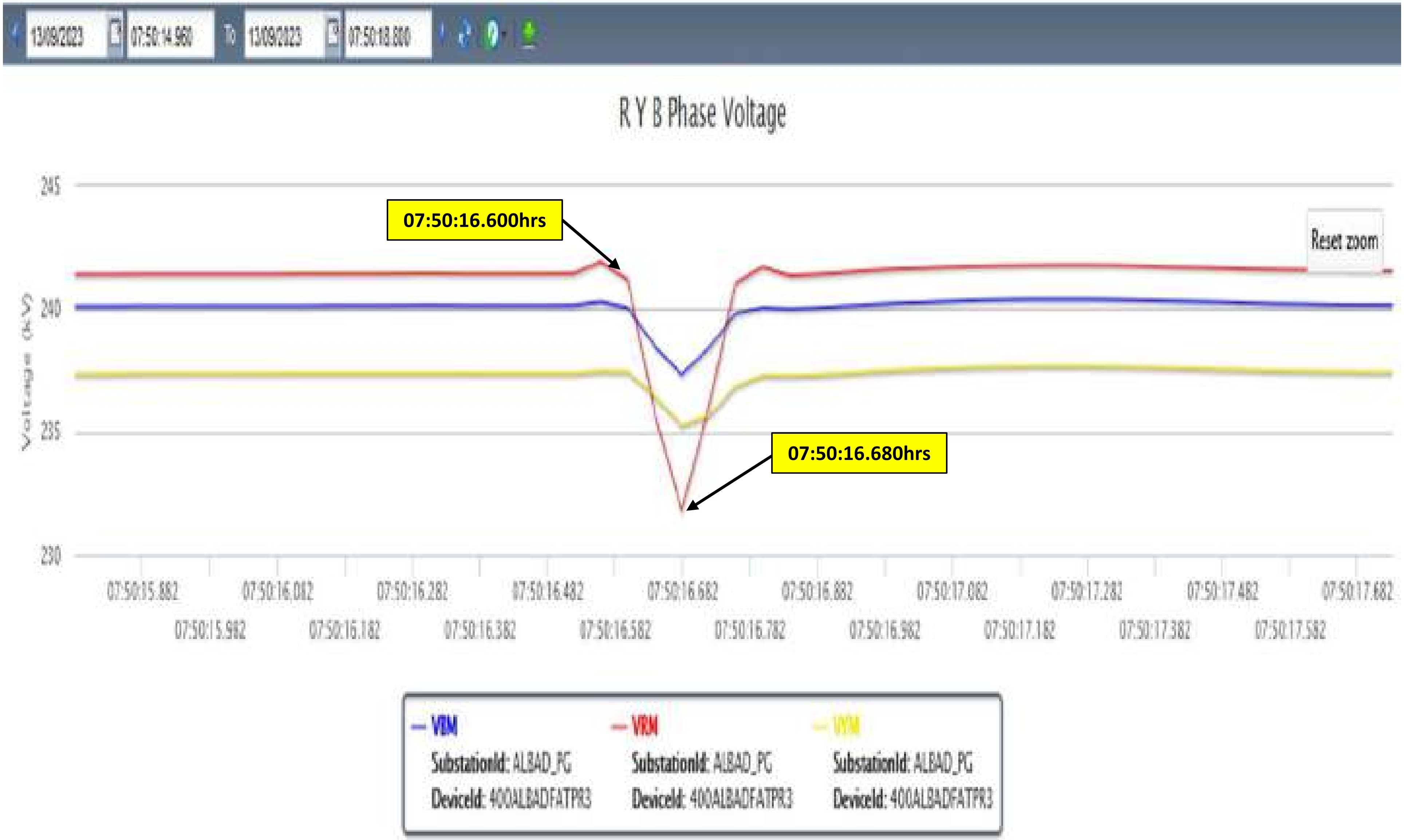


PMU Plot of frequency at Allahabad(PG)

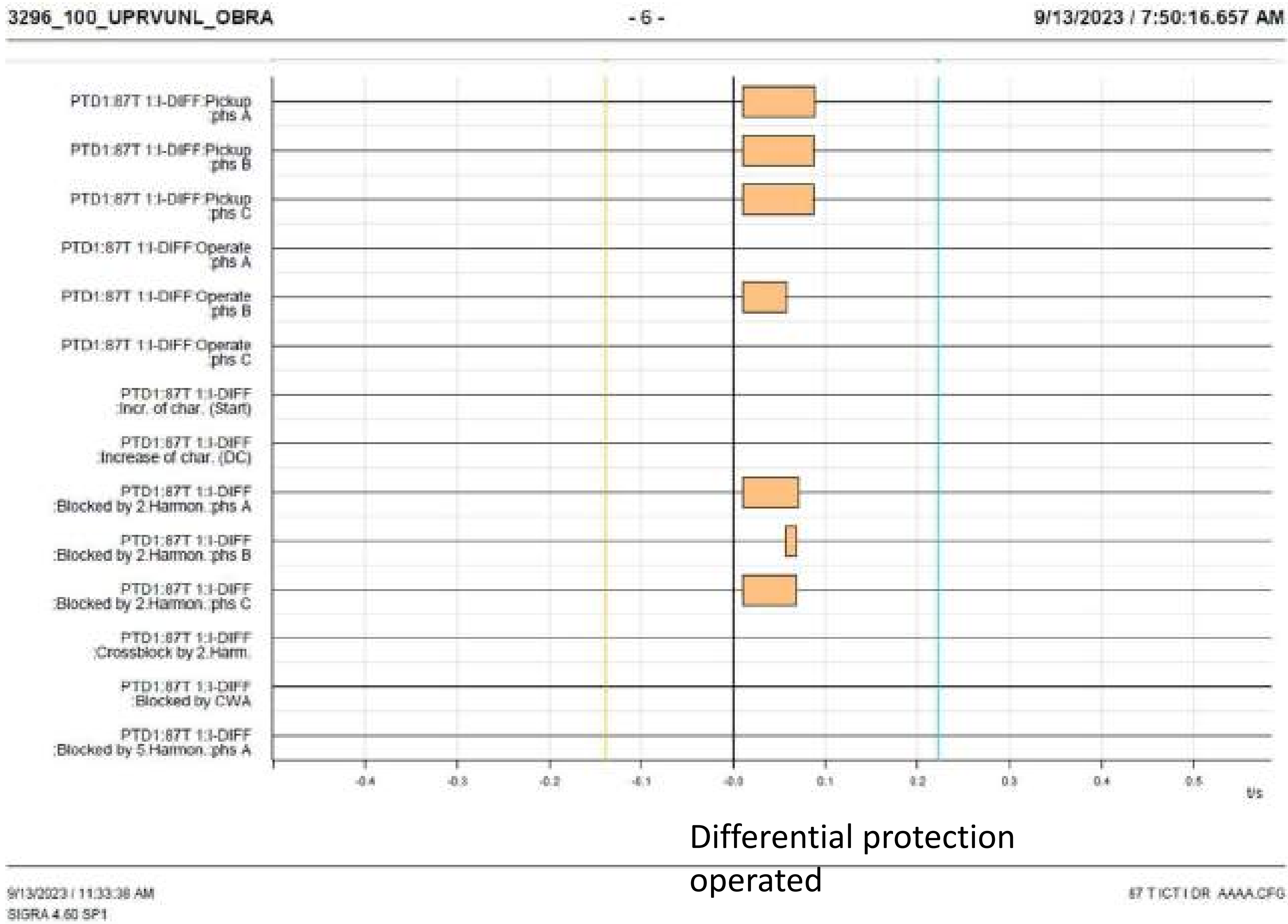
07:50 hrs/13-Sept-23

PMU Plot of phase voltage magnitude at Allahabad(PG)

07:50 hrs/13-Sept-23

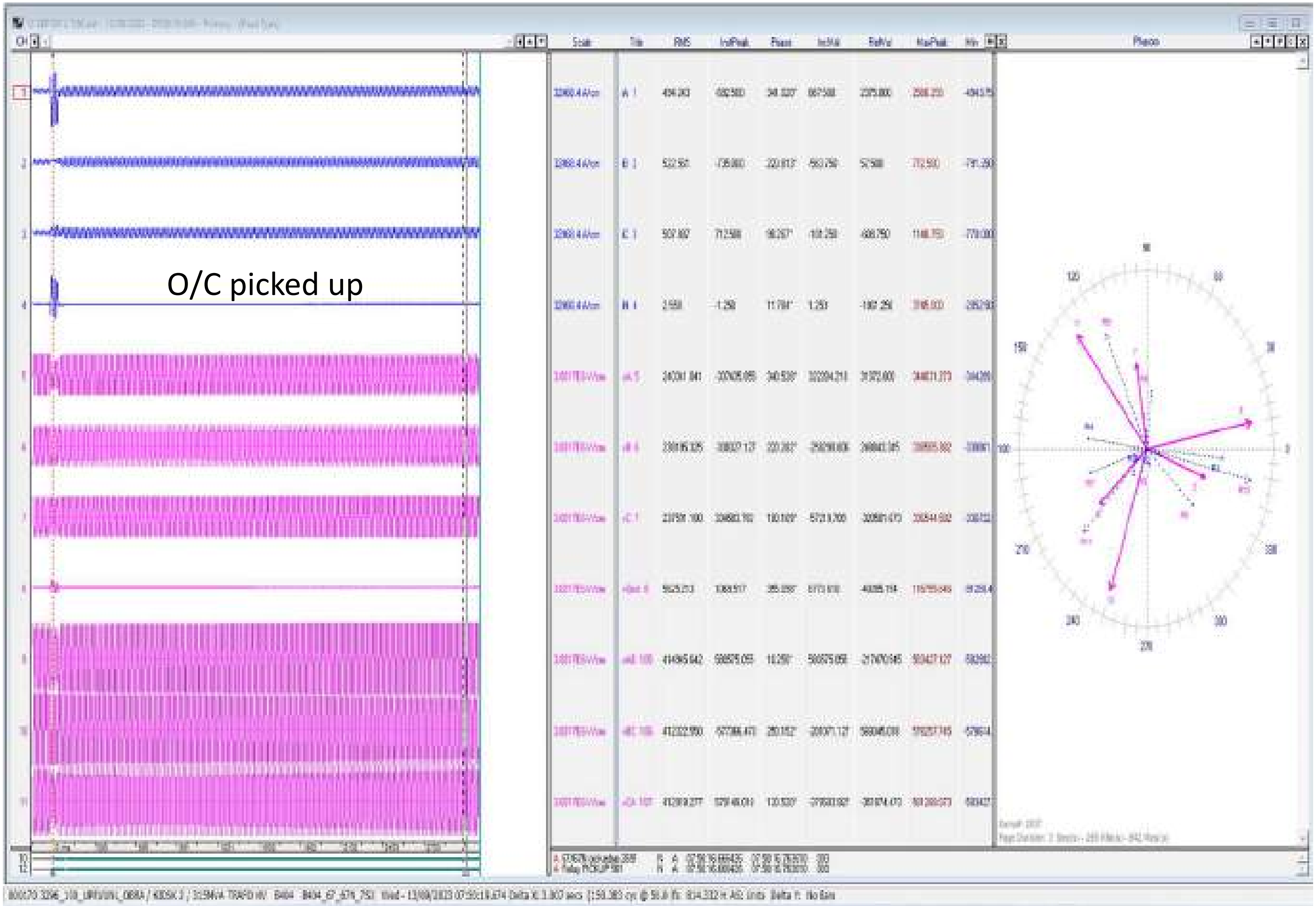


DR of 400/220kV 315MVA ICT-1



Differential protection operated

DR of 400/220kV 315MVA ICT-3



SCADA SOE

Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remarks
07:50:18,000	OBRAB_UP	400kV	08T3	Circuit Breaker	Open	CB at 400kV side of 400/220kV 240MVA ICT-3 at Obra-B(UP) opened
07:50:22,733	OBRAA_UP	220kV	16ALHA23	Circuit Breaker	Open	CB at Obra-A(UP) side of 220kV Obra-A(UP)-Rewa Road(UP) Ckt-2 opened
07:50:22,753	OBRAA_UP	220kV	14MRZP2	Circuit Breaker	Open	CB at Obra-A(UP) side of 220kV Obra-A(UP)-Mirzapur(UP) Ckt opened
07:50:22,941	OBRAA_UP	220kV	12ALHA21	Circuit Breaker	Open	CB at Obra-A(UP) side of 220kV Obra-A(UP)-Rewa Road(UP) Ckt-1 opened
07:50:40,266	OBRAB_UP	400kV	04T2	Circuit Breaker	Open	CB at 400kV side of 400/220kV 315MVA ICT-2 at Obra-B(UP) opened
07:51:10,079	OBRAB_UP	400kV	09U12	Circuit Breaker	Open	CB of 200 MW Obra TPS - UNIT 12 opened

Logic of SPS at Obra S/s

ICT Details: 2 x 315 MVA + 1 x 240 MVA = 870 MVA

Case 1: If Load (Current) on all the three ICTs is above 95% of rated current, then after a delay of 05 sec for Group-1 and 02 mins for Group-2, following elements will be tripped in respective sequential priority:

Element details for tripping during SPS operation Case-1

Group-1

1. 220 kV Obra-Rewa road Ckt – 1 & 2

Group-2

1. 220 kV Obra-Mirzapur Line

Case 2: If Load (Current) on all the three ICTs is above 105% of rated current, then following elements will be tripped instantaneously:

Element details for tripping during SPS operation Case-2

1. 220 kV Obra-Rewa road Ckt – 1 & 2
2. 220 kV Obra-Mirzapur Line

Case 3: If Load (Current) on any of the ICTs is above 70% of rated current, and other 315 MVA ICT trips on Protection/Fault then following elements will be tripped instantaneously:

Element details for tripping during SPS operation Case-2

1. 220 kV Obra-Rewa road Ckt – 1 & 2
2. 220 kV Obra-Mirzapur Line

Point of discussion

i. As per SCADA, loading of ICTs before the incident were within permissible limit. Hence, it is suspected that loading of ICT-2 and 3 increased above 70% of rated current after tripping of ICT-1 and due to tripping of ICT-3 (as per SCADA SOE) SPS Case-3 operated. Exact sequence of the event need to be shared.
ii. Why did 400/220kV ICT-2&3 trip as fault was in ICT-1?
iii. DR/EL of all the elements need to be shared for both the ends.
iv. DR of 240MVA ICT not available
v. Remedial action taken report need to be shared.

INCIDENT OF 315 MVA 400/220KV ICT-I, DATED 13 SEPTEMBER, 2023

PRESENTED BY

5X200 MW, EMD-I, BTPS, OBRA

400KV ELEMENT STATUS JUST BEFORE TRIPPING

- 400 KV BUS-I :- 200 MW UNIT-9,11 & 13, 315 MVA 400/220KV ICT-I, 400kV Obra--Sultanpur line
- 400 KV BUS-II :- 200MW Unit-10 & 12, 315MVA 400/220kV ICT-II, 240MVA,400/220kV ICT-III, 400kV Obra-Rewa Road line, 400 KV OBRA B to C, 400kV Obra-Anpara line.

HISTORY OF 315 MVA 400/220 KV ICT-I

- This 315MVA, ICT-I (M/S EMCO make, 2011) was earlier stored in 400kV Moradabad substation after dismantling due to capacity augmentation at Moradabad. It was transported, Erected and commissioned by UPPTCL in Obra substation which was finally charged on 14.04.2018.
- 220 KV B phase bushing got damaged in august 2021. After replacing the bushing and restoration work of ICT, finally ICT charge at 02.02.2022

DETAIL OF INCIDENT

All of sudden 315MVA, 400/220/33kV ICT-I tripped on Differential Protection Trip (R Phase Trip) at 07.50.16.156 on.13.09.2023 with following flags

- Differential Protection R, Phase Trip.
- Buccholz, PRV Trip, 86.1, 86.2 Operated.
- Fault Current 400 KV side = 2.9 KA, 220KV Side= 16.5KA.
- After checking on site its R phase bushing found damaged and its appears from the above that due to blast of 220KV R phase bushing of transformer, other nearby bushings 220KV Y and B phase got damaged. Firefighting system installed to protect ICT from fire, operated automatically and protected the complete transformer from the spreading of fire and further damage to other equipment and ICT itself. Apart from this, the CISF Fire Fighting Wing of Obra also put out fire tenders immediately to extinguish the fire.

Tripping of Other Elements

- 315MVA, 400/220/33kV ICT-II=400KV E/F & O/C OPTD (Ir=2.5 KA).
- 240MVA, 400/220/33kV ICT-III=400KV E/F&O/C OPTD (Ir=2.4 KA).
- 220 KV BUS- I & II: During Fire incident all three ICT tripped and no supply source available due to this both Bus dead.
- 30 MVA Station-I & II : Both station supply dead due to failure of 220 KV Bus-I&II
- 200MW UNIT-12 =Unit was running on station (due to problem in 6.6 KV UAT incomer breaker) and tripped due to failure of ST supply.
- SPS Tripping : 220 KV 0bra-Rewa Road -I, II & Natwa Line tripped due to operation of SPS protection.
- 220 kv Obra-Robertsganj Line, 220 KV Obra-Sahupuri Line & 100 MVA ICT (All three ICT) dead due to no availability of power source.

THANK YOU

Multiple elements tripping at 220kV Hissar_IA(HR)

05th October 2023

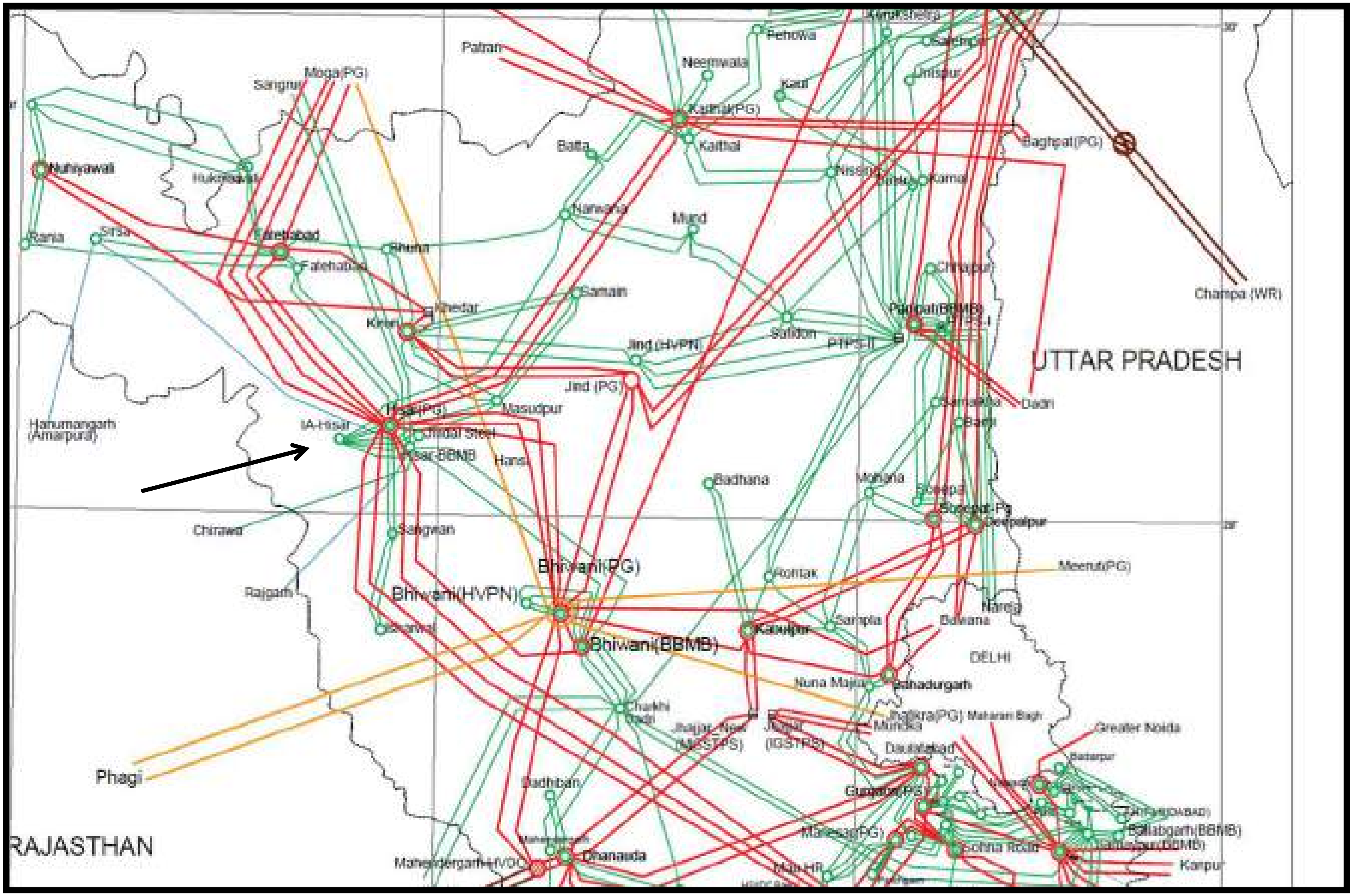
Brief of event:

- During antecedent condition, 220kV Hissar_IA(Har)-Masudpur Ckt 1 & 2 and 220/132kV 100MVA ICT-1 at Hissar_IA(Har) were already in open condition.
- As reported, at 09:28hrs, sparking was observed on the **B-phase of 220 kV Bus Isolator of 220kV Hissar_IA(Har)-Hissar(PG) ckt-1 at Hissar_IA(Har) end.**
- As per DR at Hissar_IA(Har), Bus Bar differential protection operated at 220kV level of Hissar_IA(Har) which led to tripping of all the elements connected to both the buses. (Exact reason of tripping of both the buses yet to be shared)
- Due to tripping of all the elements connected to both the buses, both 220kV Bus-1 & 2 at Hissar_IA(Har) and eventually the complete 220kV Hissar_IA(Har) S/s became dead.
- As per PMU at Hissar(PG), B-N phase to earth fault with fault clearing time of 80ms is observed.
- As per SCADA, change in demand of approx. 90MW is observed in Haryana control area.

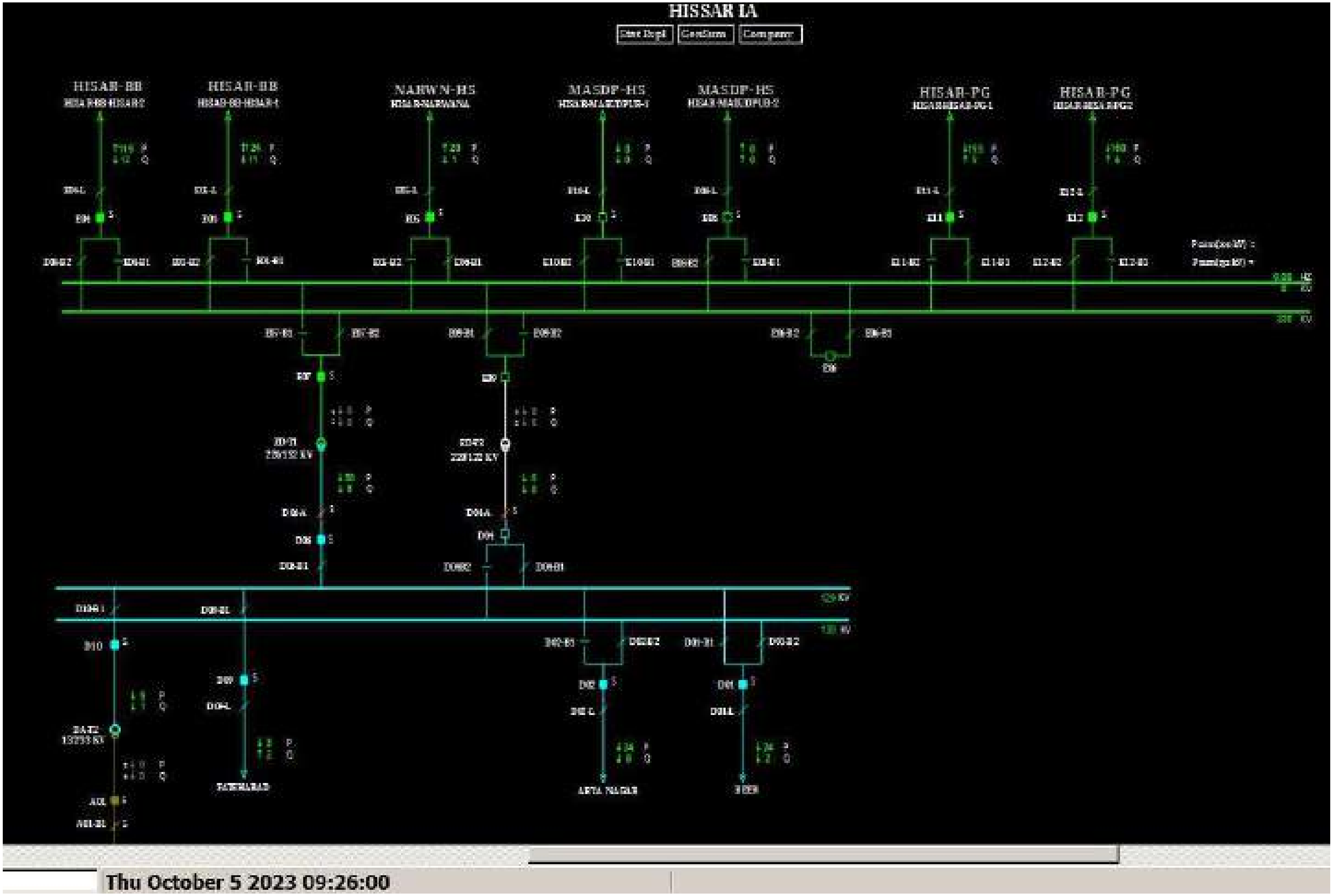
Elements tripped:

i. 220kV Hissar_IA(Har)-Narwana ckt
ii. 220kV Hissar(BB)-Hissar_IA(Har) ckt-1
iii. 220kV Hissar(BB)-Hissar_IA(Har) ckt-2
iv. 220kV Hissar_IA(Har)-Hissar(PG) ckt-1
v. 220kV Hissar_IA(Har)-Hissar(PG) ckt-2
vi. 220/132kV 100MVA ICT-1 at Hissar_IA(Har)

Network diagram

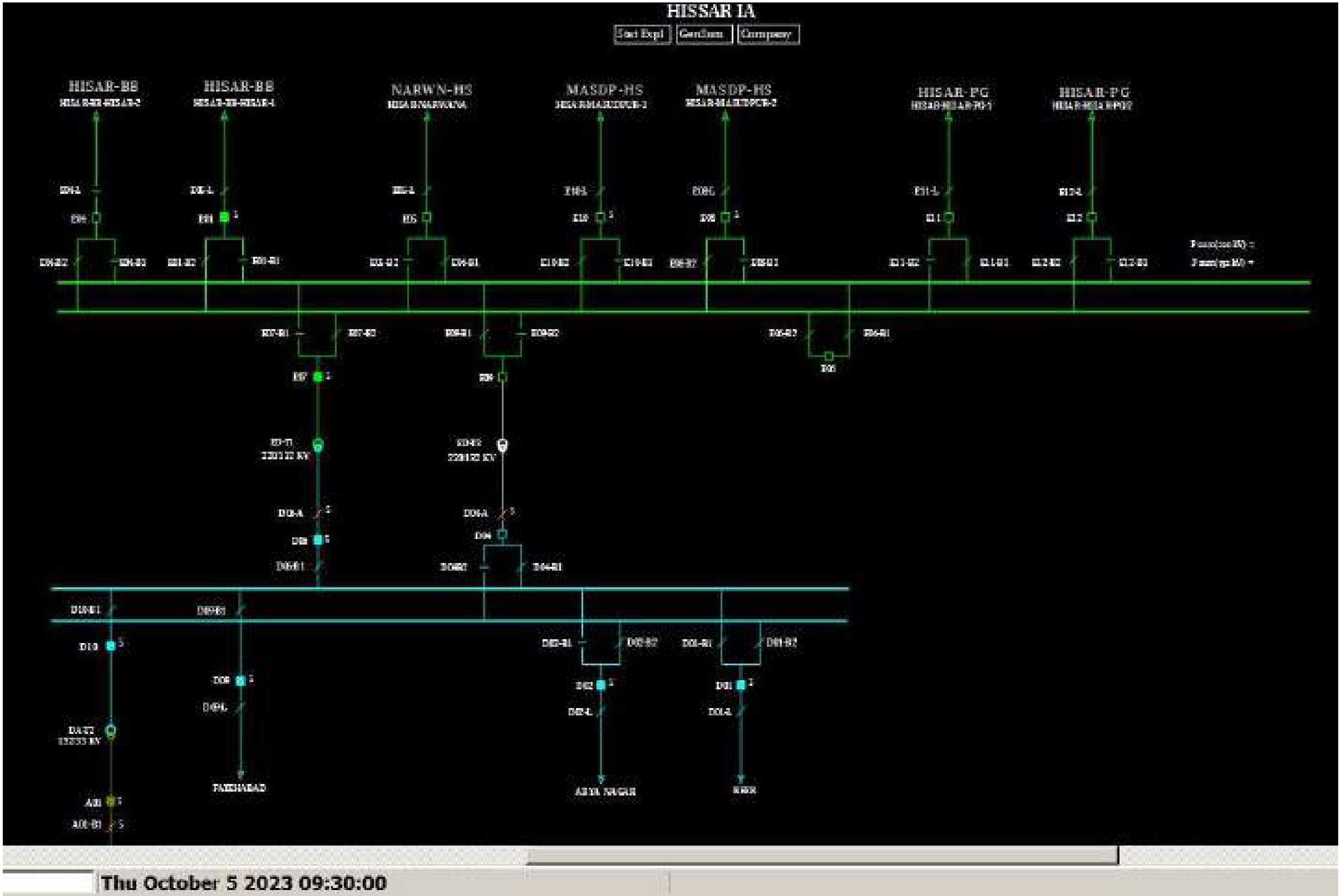


SLD of 220/132kV Hissar_IA(HR) before the event

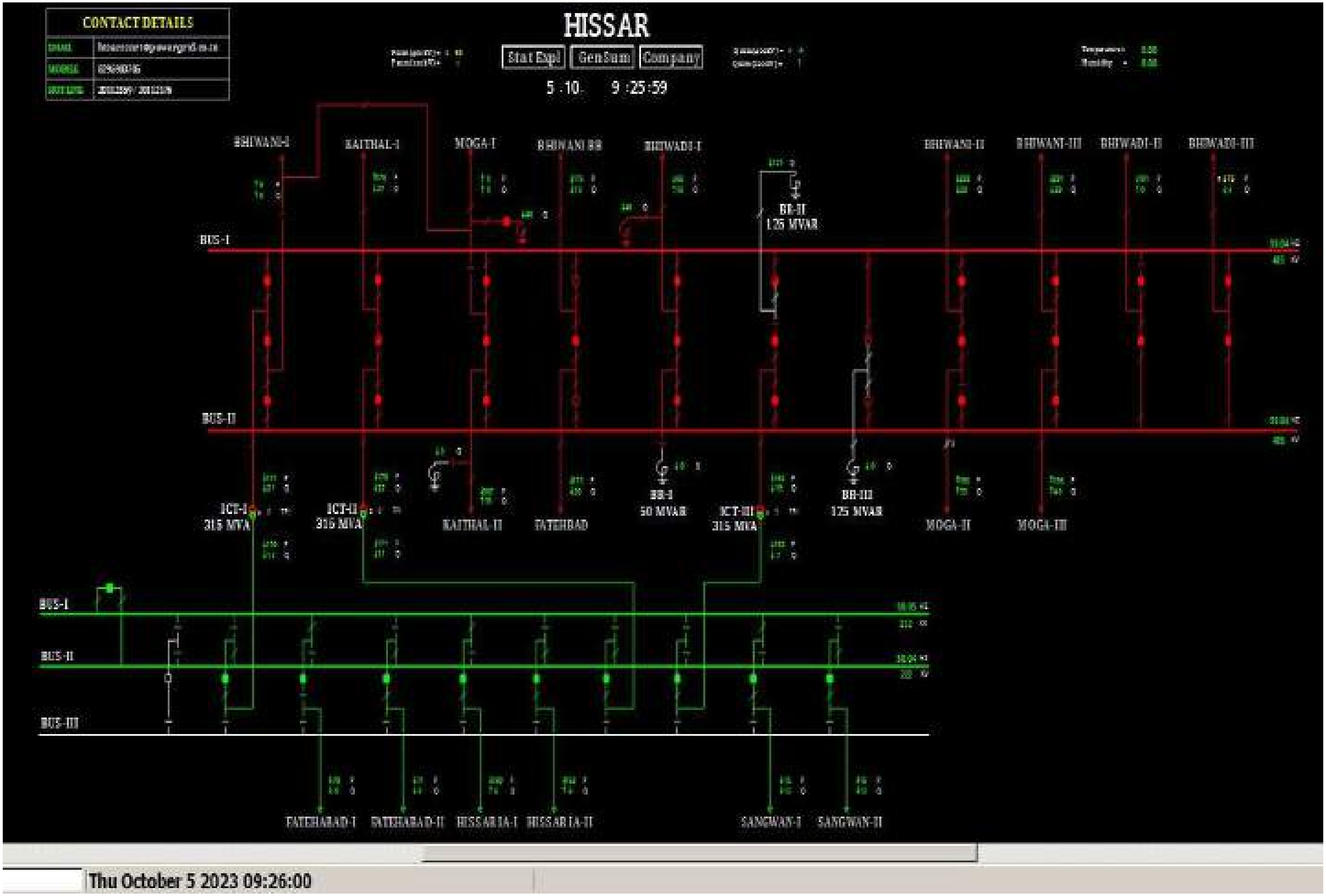


Thu October 5 2023 09:26:00

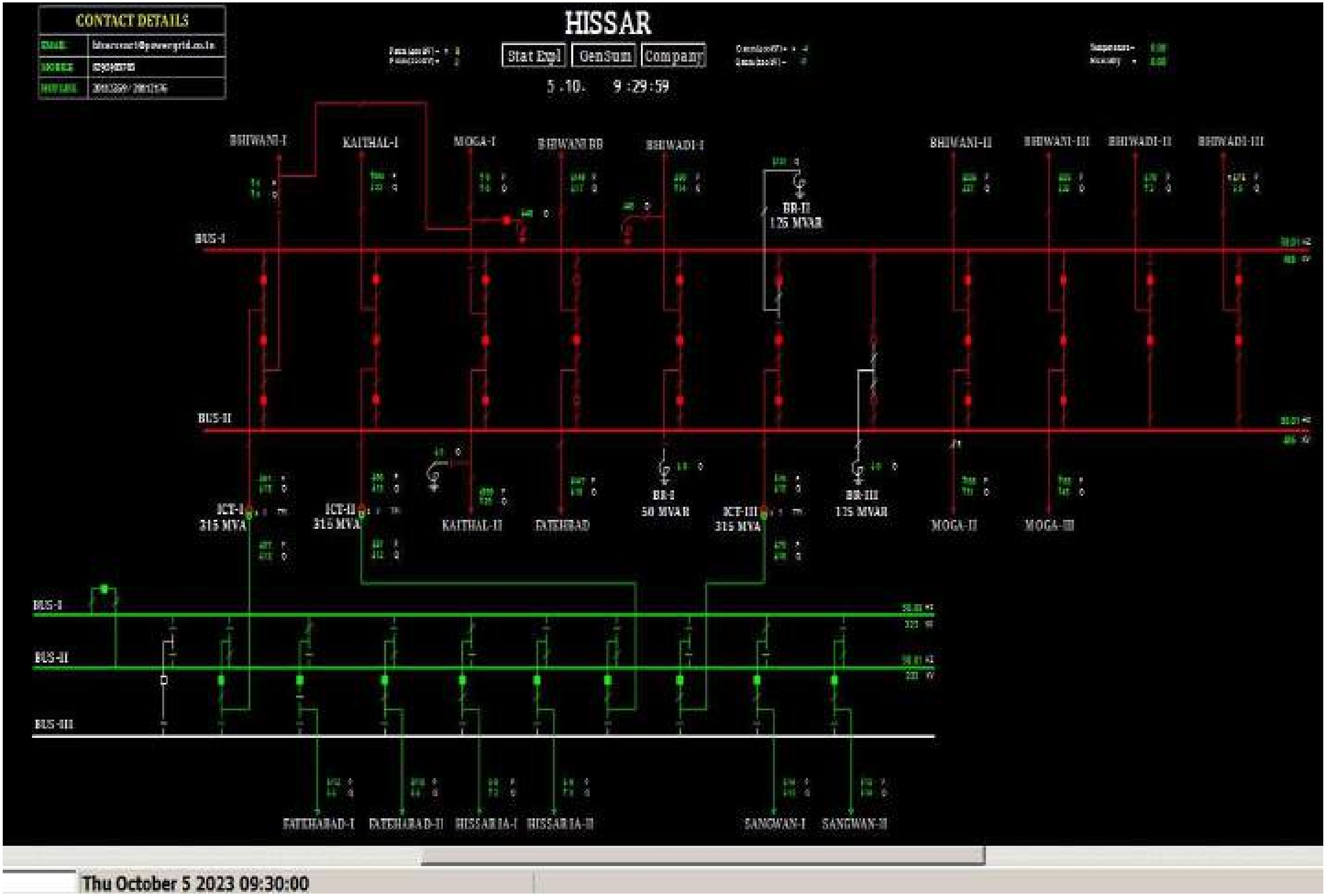
SLD of 220/132kV Hissar_IA(HR) after the event



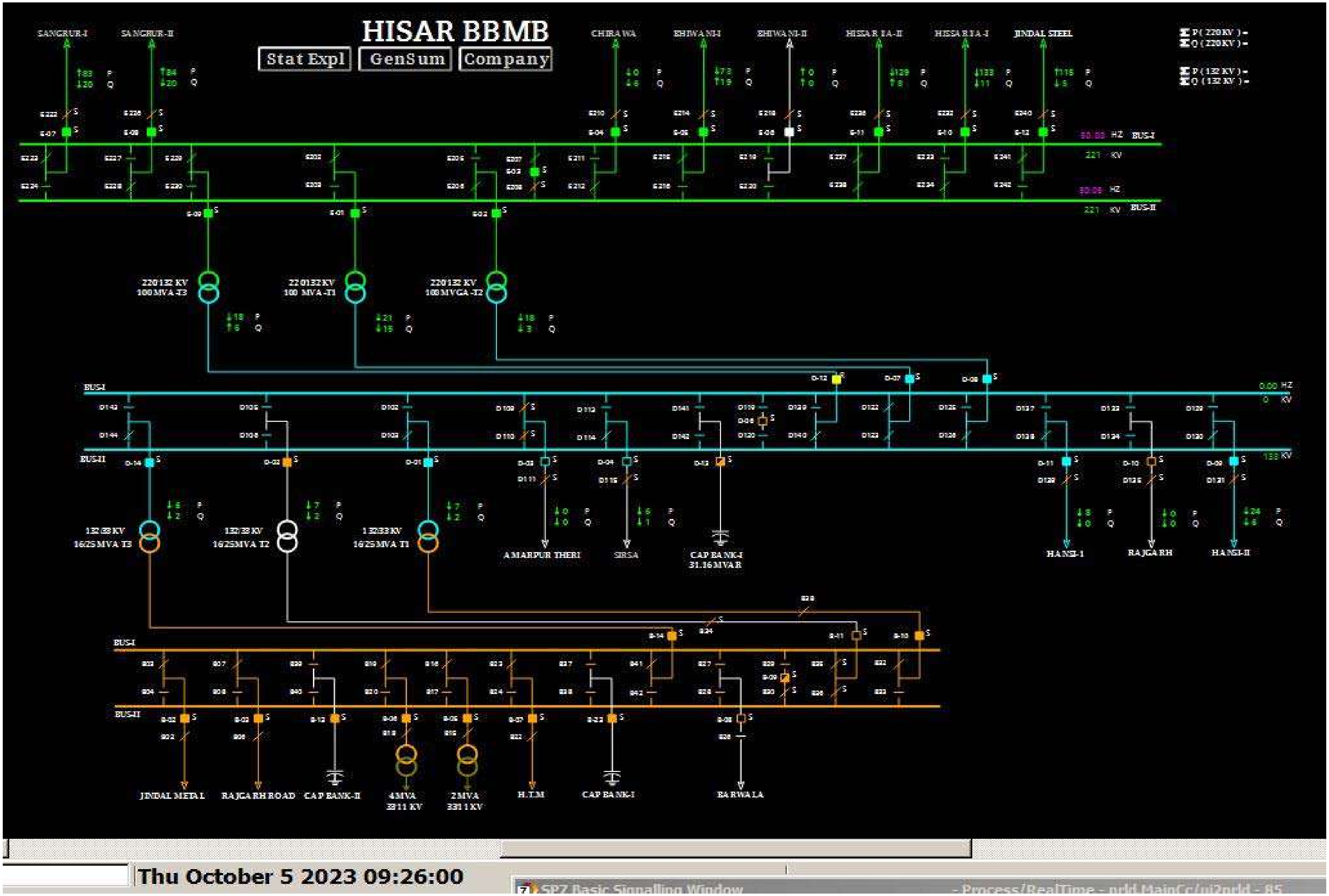
SLD of 400/220kV Hissar(PG) before the event



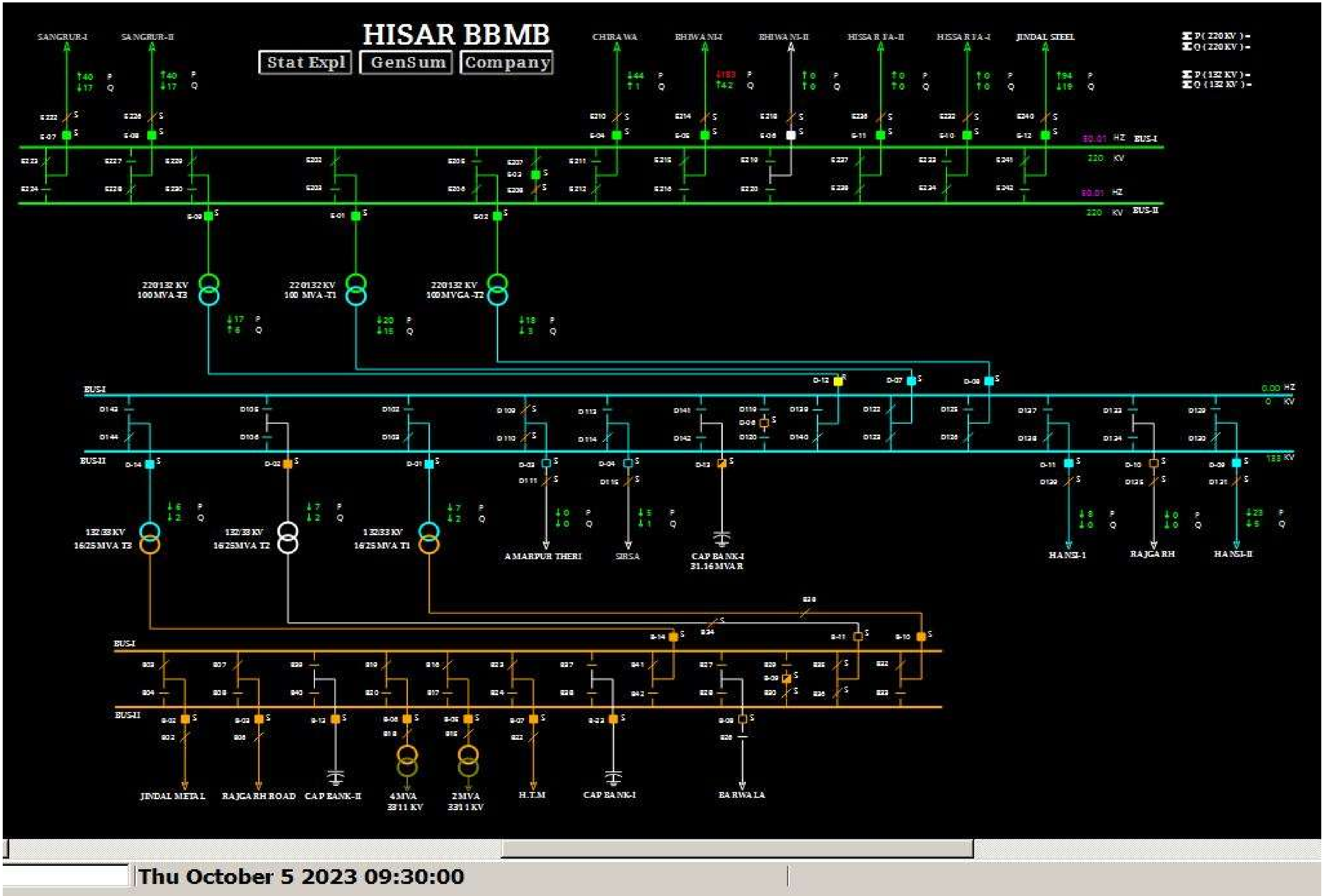
SLD of 400/220kV Hissar(PG) after the event



SLD of 220/132kV Hissar(BB) before the event

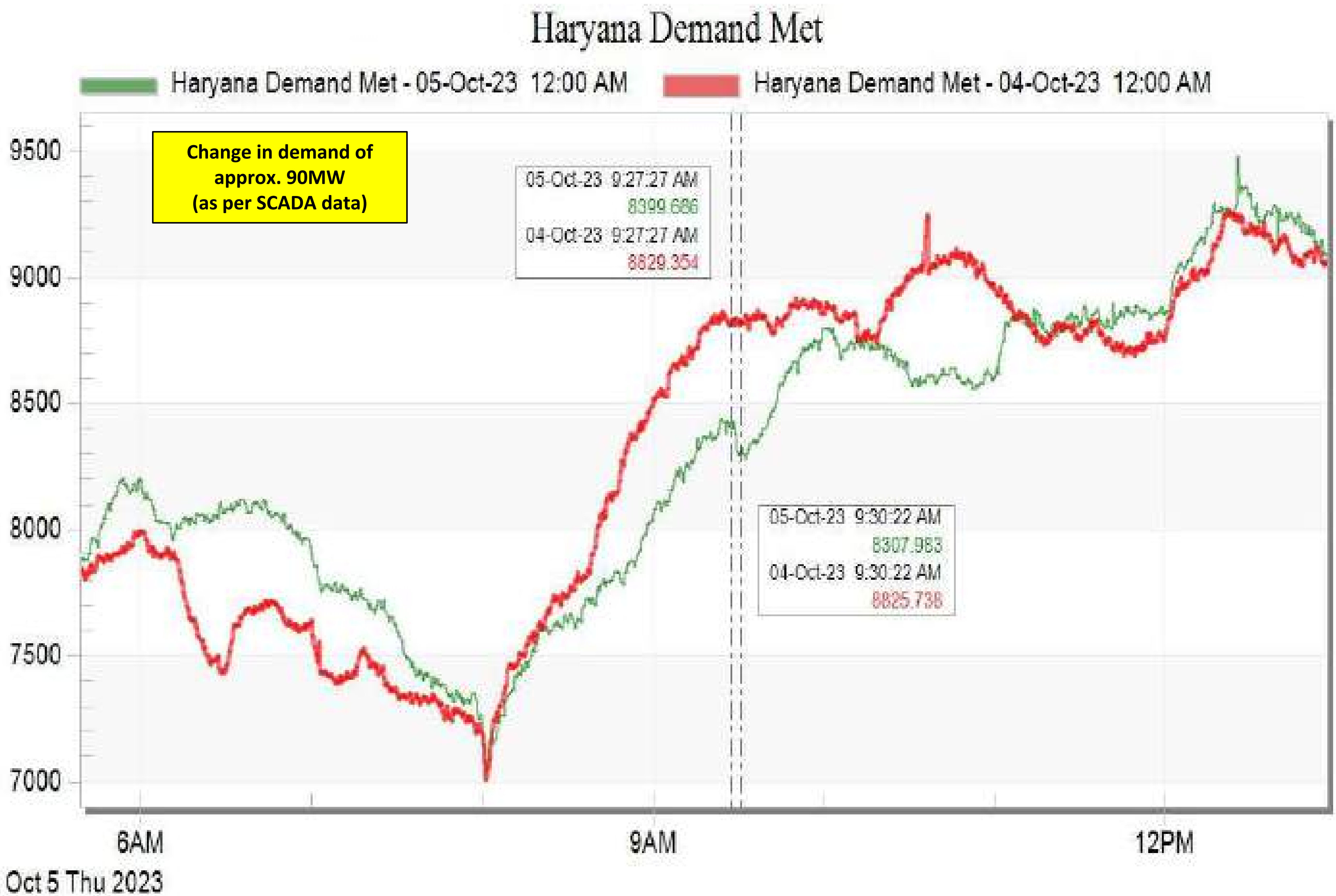


SLD of 220/132kV Hissar(BB) after the event



Thu October 5 2023 09:30:00

Haryana demand during the event

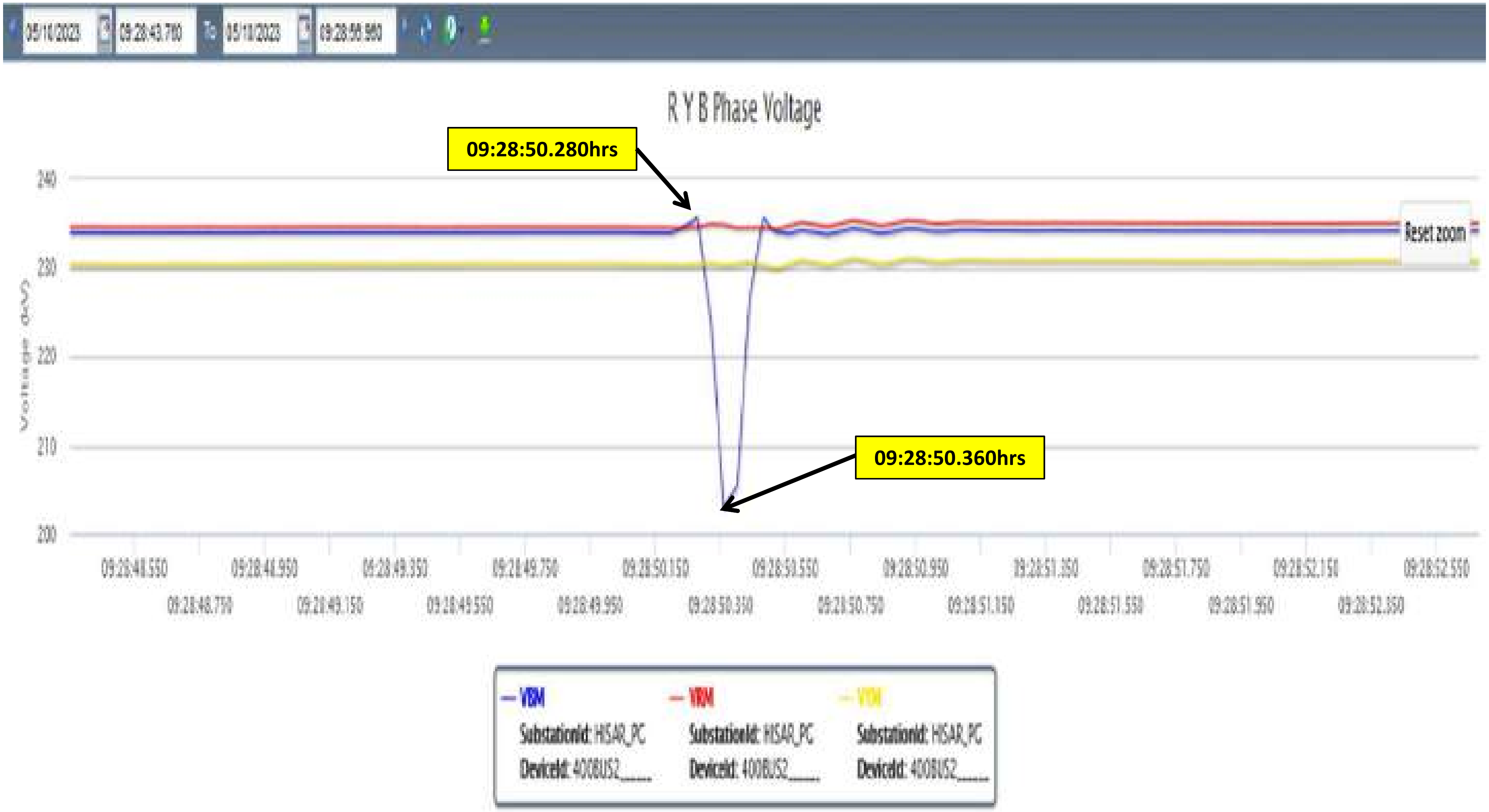


PMU Plot of frequency at Hissar(PG)

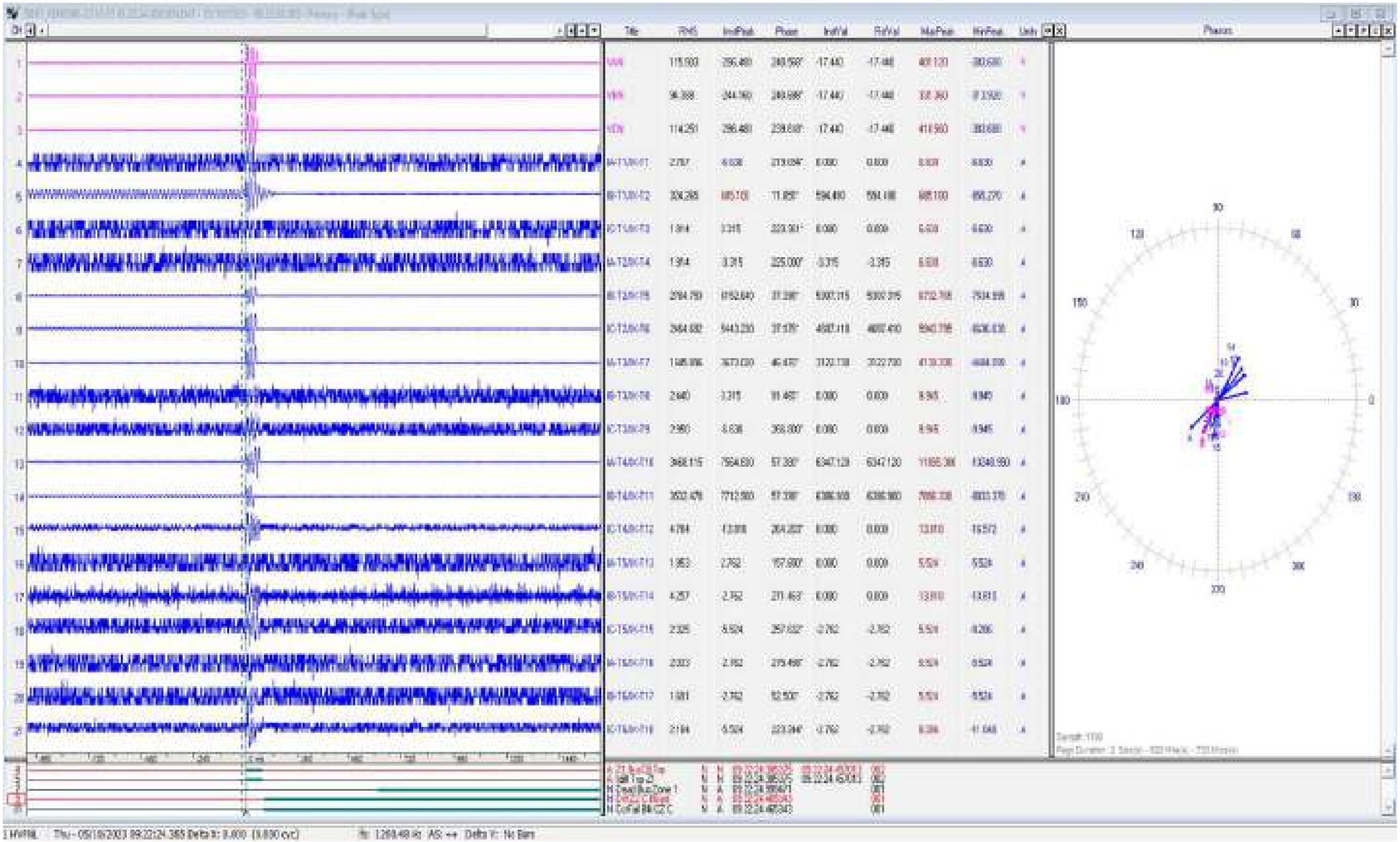
09:28hrs/05-Oct-23

PMU Plot of phase voltage magnitude at Hissar(PG)

09:28hrs/05-Oct-23

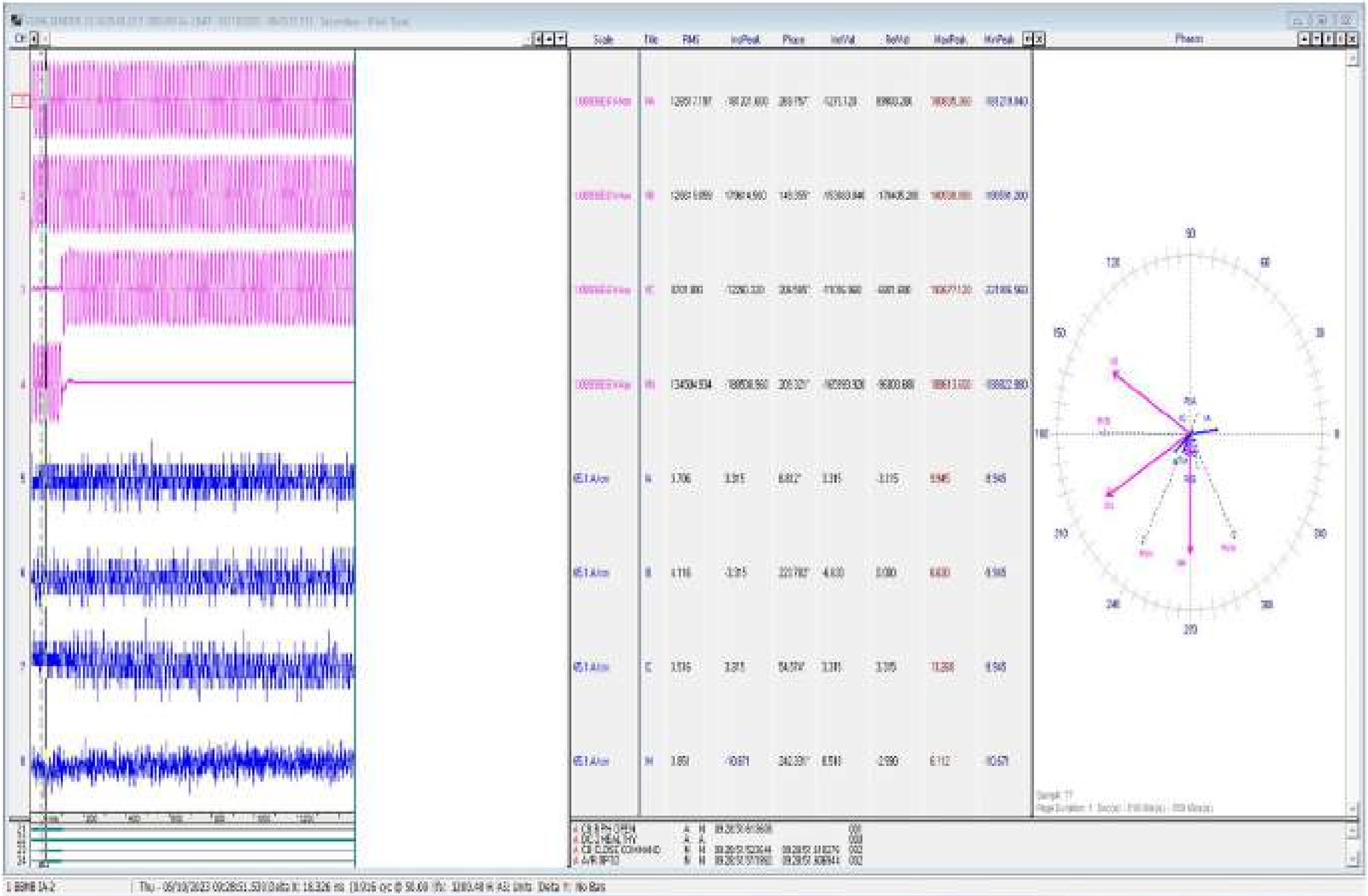


DR of 220 KV Bus bar differential at Hissar IA(HV)



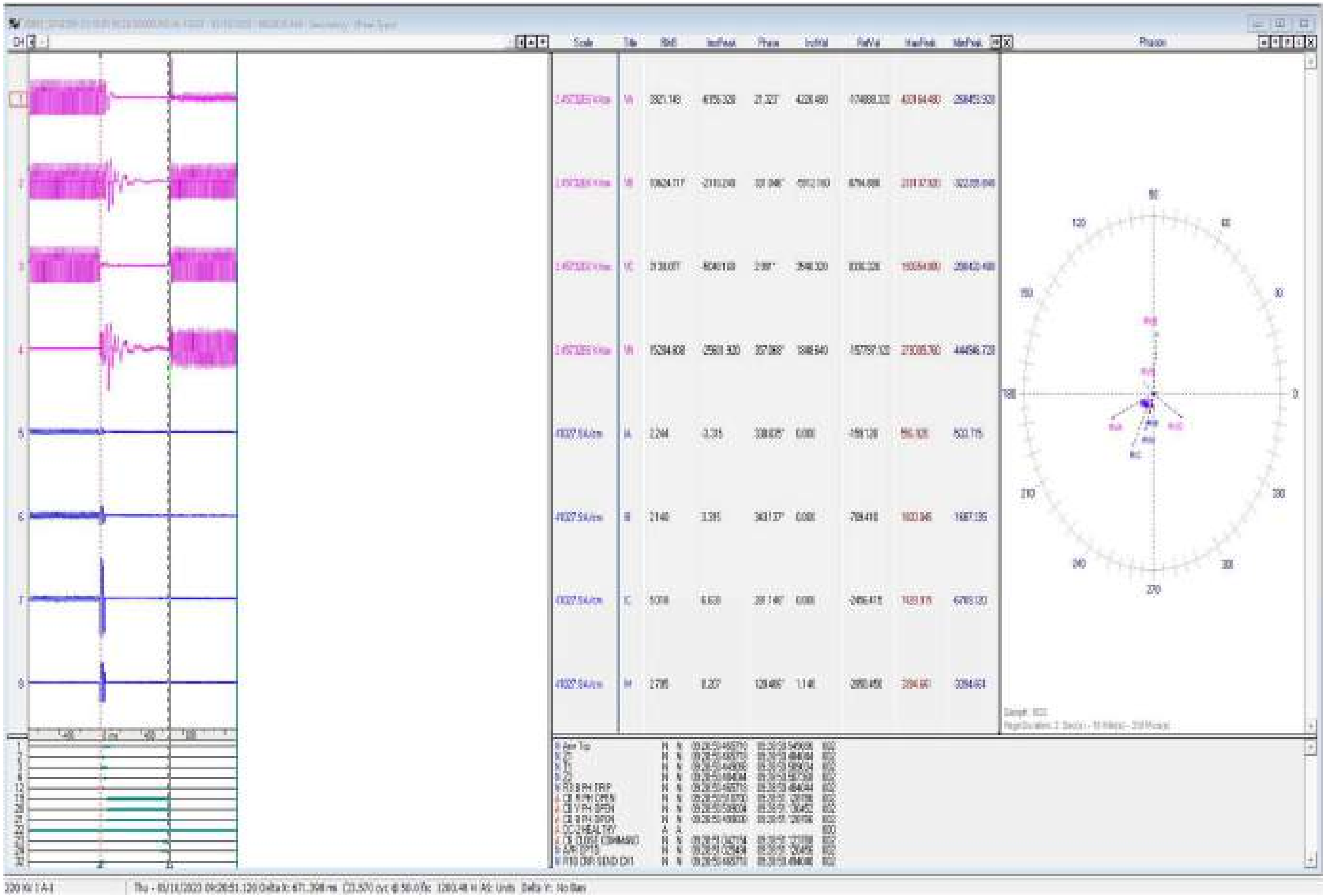
- ✓ Bus bar differential operated
- ✓ Time sync. issue is observed

DR of 220kV Hissar(BB)-Hissar_IA(Har) ckt-2 at Hissar BB



- ✓ B phase A/R operation is observed

DR of 220kV Hissar(BB)-Hissar_IA(Har) ckt-1 at Hissar BB



- ✓ 3-ph tripped from Hissar_BB end, after~500msec line closed from remote end

SCADA SOE

Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remark
09:28:50,399	HISAR_HS	220kV	12HISPG2	Circuit Breaker	Open	Line CB at Hissar IA(HV) end of 220 KV Hissar(PG)-Hissar IA(HV) (PG) Ckt-2 opened
09:28:50,407	HISAR_HS	220kV	05NARWN	Circuit Breaker	Open	Line CB at Hissar IA(HV) end of 220 KV Hissar IA(HV)-Narwana(HV) Ckt opened
09:28:50,412	HISAR_HS	220kV	04HISBB2	Circuit Breaker	Open	Line CB at Hissar IA(HV) end of 220 KV Hissar(BB)-Hissar IA(HV) (BBMB) Ckt-2 opened
09:28:50,417	HISAR_HS	220kV	11HISPG1	Circuit Breaker	Open	Line CB at Hissar IA(HV) end of 220 KV Hissar(PG)-Hissar IA(HV) (PG) Ckt-1 opened

Point of discussion

i. Exact reason of tripping of both the buses need to be shared. Whether bus bar protection operated in both the buses? If yes, then why? Whether there is any issue with bus coupler opening?
ii. DR of Hissar_IA(Har) are not time synced, time syncing of all the recording devices/software need to be ensured.
iii. DR/EL of all the tripped elements along with tripping report of the event need to be shared from BBMB and PGCIL end.
iv. Proper maintenance of protection equipments and their healthiness need to be ensured.
v. Reason of tripping of line from Hissar_BB end?
vi. Remedial action taken report to be shared.

Multiple trippings occurred at 220 kV S/stn., HVPNL, IA Hisar on dated 05.10.2023

Description of Disturbance

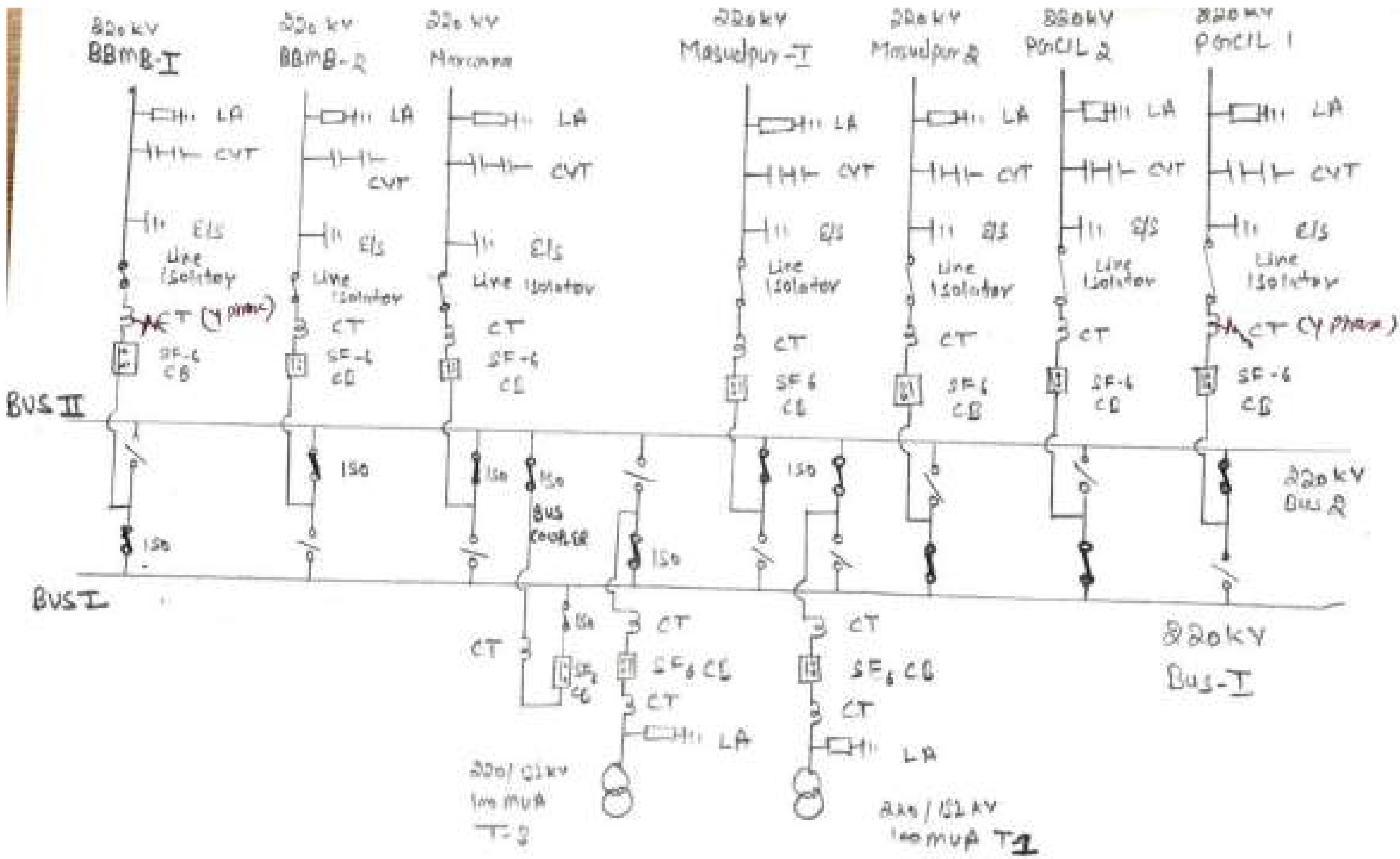
At 09:28 Hrs on dated 05.10.2023, the following transmission elements were tripped due to sparking observed on the B-phase of 220 kV Bus Isolator-2 of 220kV Hissar IA(Har)-Hissar (PG) ckt-1 at Hissar IA(Har) end.

Name of Tripped Elements:-

1.	220 kV IA Hisar-BBMB ckt 1	(IA Hisar end)
2.	220 kV IA Hisar-BBMB ckt 2	(IA Hisar end)
3.	220 KV IA Hisar –PGCIL Ckt 1	(IA Hisar end)
4.	220 KV IA Hisar –PGCIL Ckt 2	(IA Hisar end)
5.	220 KV IA Hisar –Narwana ckt	(IA Hisar end)
6.	220/132 kV 100 MVA T-1	(IA Hisar End)

Single line Diagram (Attached

Sld 220IA.pdf


220 kV
BBMB-I
220 kV
BBMB-2
220 kV
Marcona
220kV
Masudpur-I
220kV
Masudpur 2
220kV
PGCIL 2
220kV
PGCIL 1
LA
CVT
E/S
Line Isolator
CT (Y phase)
CT
SF-6 CB
SF6 CB
BUS II
BUS I
ISO
BUS COUPLER
220kV Bus 2
220kV Bus-I
220/132kV 100 MVA T-2
220/132kV 100 MVA T1

Antecedent Conditions:

1. 220 kV Bus Coupler was not in operation & already opened.
2. 220 kV IA Hisar-Masudpur Ckt 1 & 2 already opened since 15.09.2023 as per direction of SLDC to prevent overloading.
3. 220/132 kV 100 MVA TF T-3 was under shutdown for replacement of 220 kV Bus-1 isolator.
4. 220 kV Bus Bar Protection was in operation (MICOM Make P746).
5. Transmission elements connected at 220 kV IA Hisar tabulated as under:

Sr. No.	220 kV Bus -1	220 kV Bus -2
1.	Under Shut down	220 kV IA Hisar-BBMB ckt 1
2.		220 kV IA Hisar-BBMB ckt 2
3.		220 KV IA Hisar –PGCIL Ckt 1
4.		220 KV IA Hisar –PGCIL Ckt 2
5.		220 KV IA Hisar –Narwana ckt
6.		220/132 kV 100 MVA T-1

Restoration of Tripped elements

Name of Element	***Tripped from***	***Restoration***	***Relay at IA Hisar End***	***Relay Operated at Other end***
220KV IA Hisar Hisar_PG Ckt-1	09:28	13:01	Bus Bar Protection operated	Not Tripped
220KV IA Hisar Hisar_PG Ckt-2	09:28	13:05	Bus Bar Protection operated	Not Tripped
220KV IA Hisar-Hisar(BBMB) Ckt-1	09:28	12:30	Bus Bar Protection operated	Not Tripped
220KV IA Hisar-Hisar(BBMB) Ckt-2	09:28	12:30	Bus Bar Protection operated	Not Tripped
220KV IA Hisar-Narwana line	09:28	10:00	Bus Bar Protection operated	Not Tripped
220/132KV 100MVA T-1	09:28	10:05	Bus Bar Protection operated	---

Analysis of Fault:

1. A shutdown of 220 kV Bus Bar-1 at 220 kV IA Hisar was in progress for the replacement bus isolator-1 of 220/132 KV ,100 MVA T/F T-3.
2. All the elements were connected on Bus -2.
3. It was reported that heavy sparking occurred on the old/obsolete 220 kV Bus isolator of 220kV IA Hisar PGCIL ckt 1 due to which differential bus bar protection operated for Bus 2 giving tripping command to all the elements connected to Bus bar-2.

Remedial Measures:

1. Replacement of the old/ obsolete bus isolators will be carried out at the earliest.

Multiple elements tripping at 765kV Koteshwar(PG)

12th October 2023

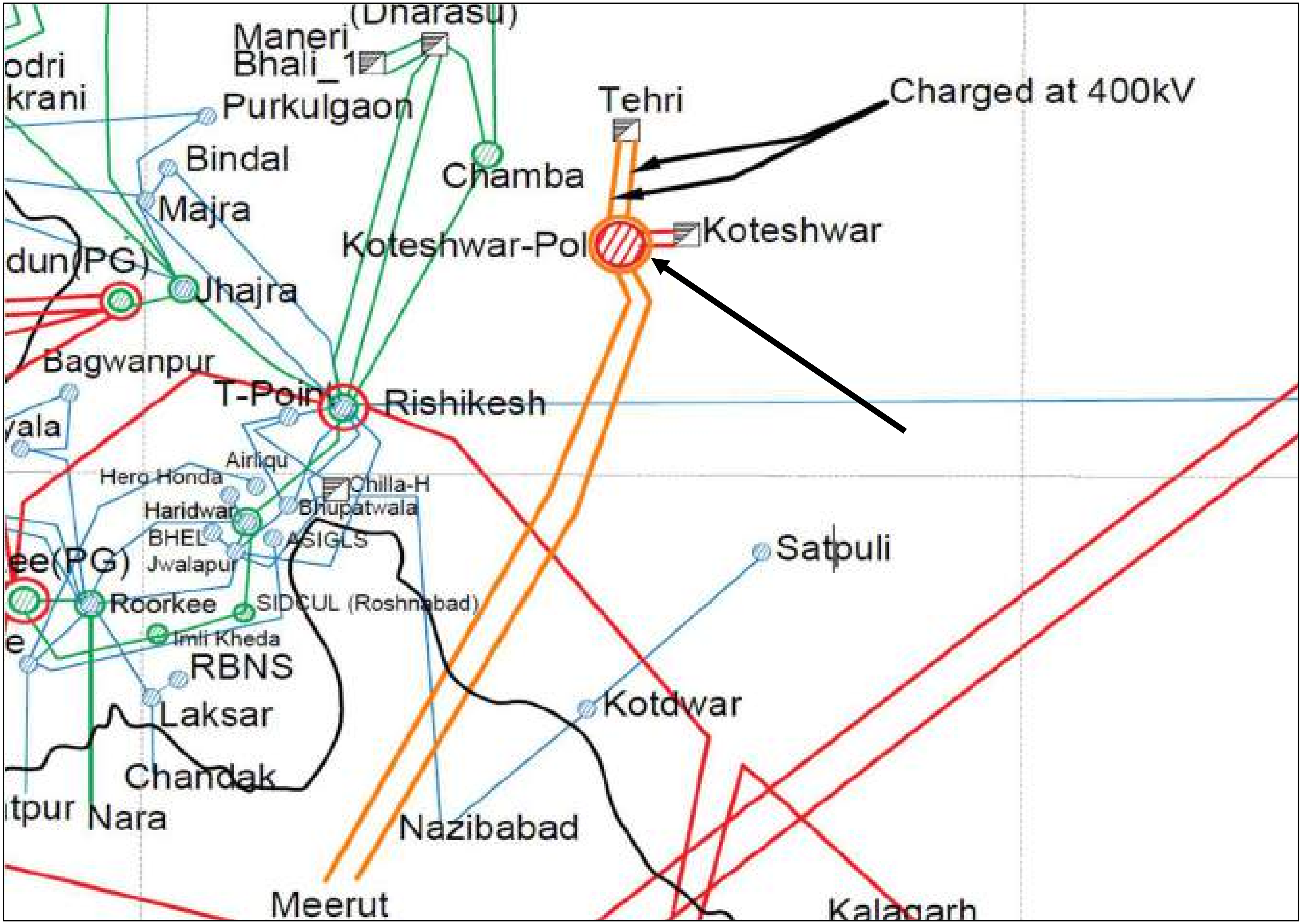
Brief of event:

- 765/400kV Koteshwar(PG) has one and half breaker scheme at 765kV level and double main bus scheme at 400kV level. During antecedent condition, only 100MW Unit-1 at Koteshwar HEP was in running condition and was generating approx. 90MW and active power loading on 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 & 2 was approx. 45MW each.
- **As reported, at 15:36hrs, "Protection operated in FSC" signal came at Meerut(PG) end which tripped group relays and sent DT to Koteshwar(PG). 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 & 2 tripped due to DT received at Koteshwar(PG) end.**
- During the same time, 100MW Unit-1 at Koteshwar(TH) tripped on over-excitation due to loss of evacuation path.
- CBs from both the ends of 400kV Koteshwar(PG)-Tehri(TH) (PG) Ckt-1 & 2 and 400kV Koteshwar(PG)- Koteshwar (TH) (PG) Ckt-1 & 2 opened due to safety purpose.
- Due to this tripping, complete blackout occurred at 765/400kV Koteshwar(PG) & 400kV Koteshwar(TH).
- Although no generation was there at Tehri(TH) during the event time, but Tehri(TH) generation was affected from 16:00hrs to 17:14hrs.
- **As per PMU Meerut(PG), no fault is observed in the system.**
- As per SCADA, change in generation of approx. 90MW is observed at Koteshwar(TH).

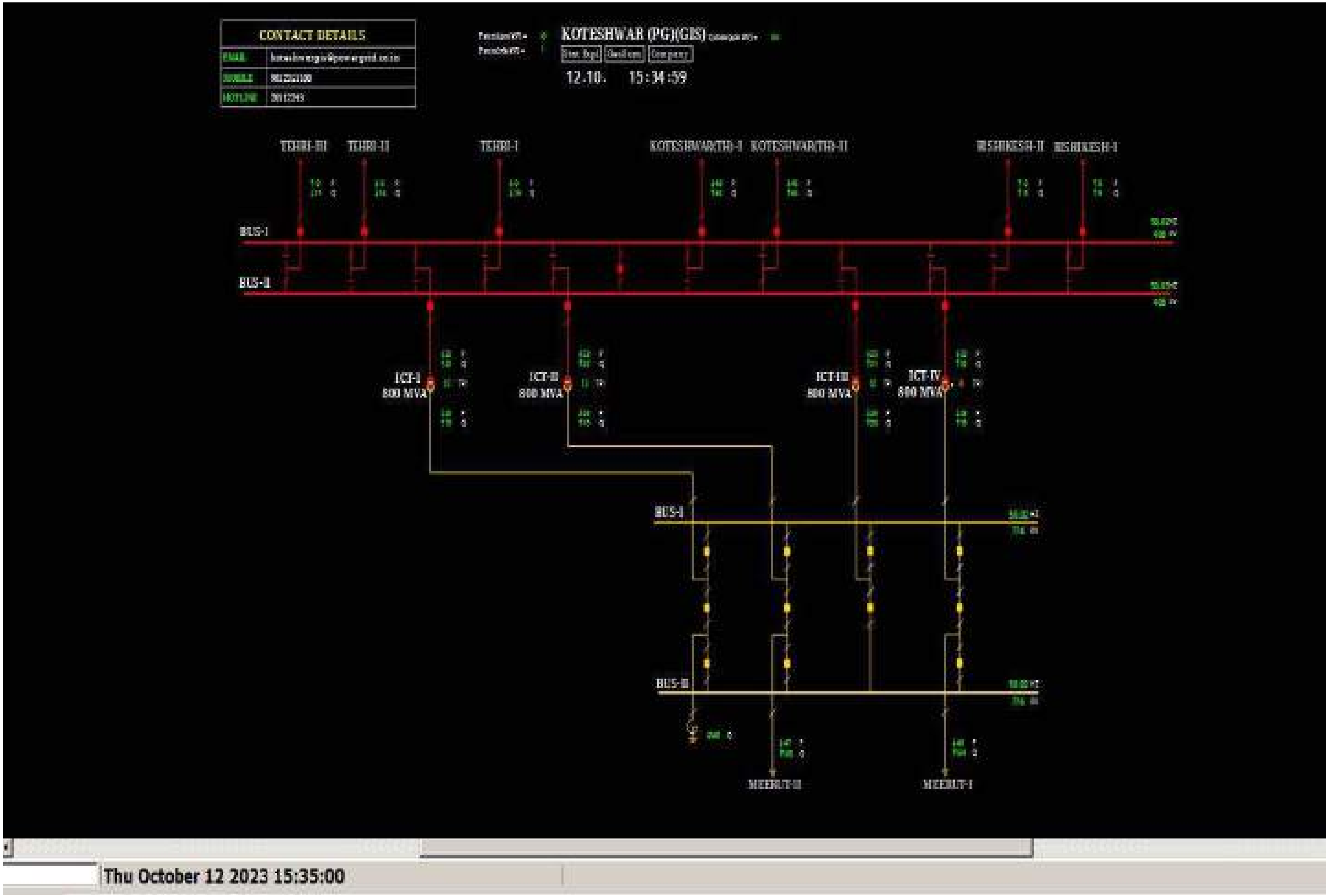
Elements tripped:

i. 765kV Koteshwar(PG)-Meerut(PG) Ckt-1
ii. 765kV Koteshwar(PG)-Meerut(PG) Ckt-2
iii. 400kV Koteshwar(PG)-Tehri(TH) (PG) Ckt-1
iv. 400kV Koteshwar(PG)-Tehri(TH) (PG) Ckt-2
v. 400kV Koteshwar(PG)- Koteshwar (TH) (PG) Ckt-1
vi. 400kV Koteshwar(PG)- Koteshwar (TH) (PG) Ckt-2
vii. 100 MW Unit-1 at Koteshwar(TH)

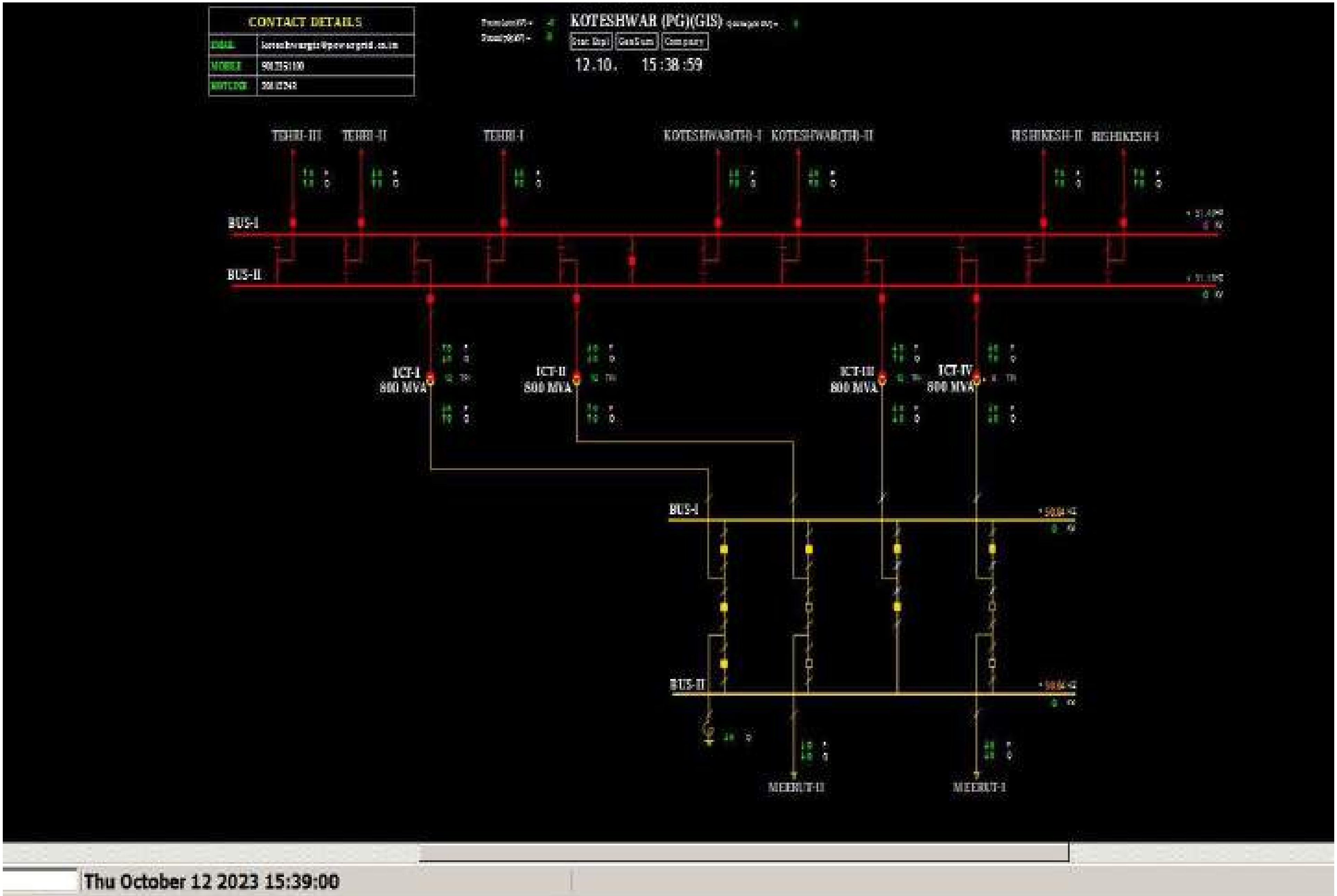
Network Diagram



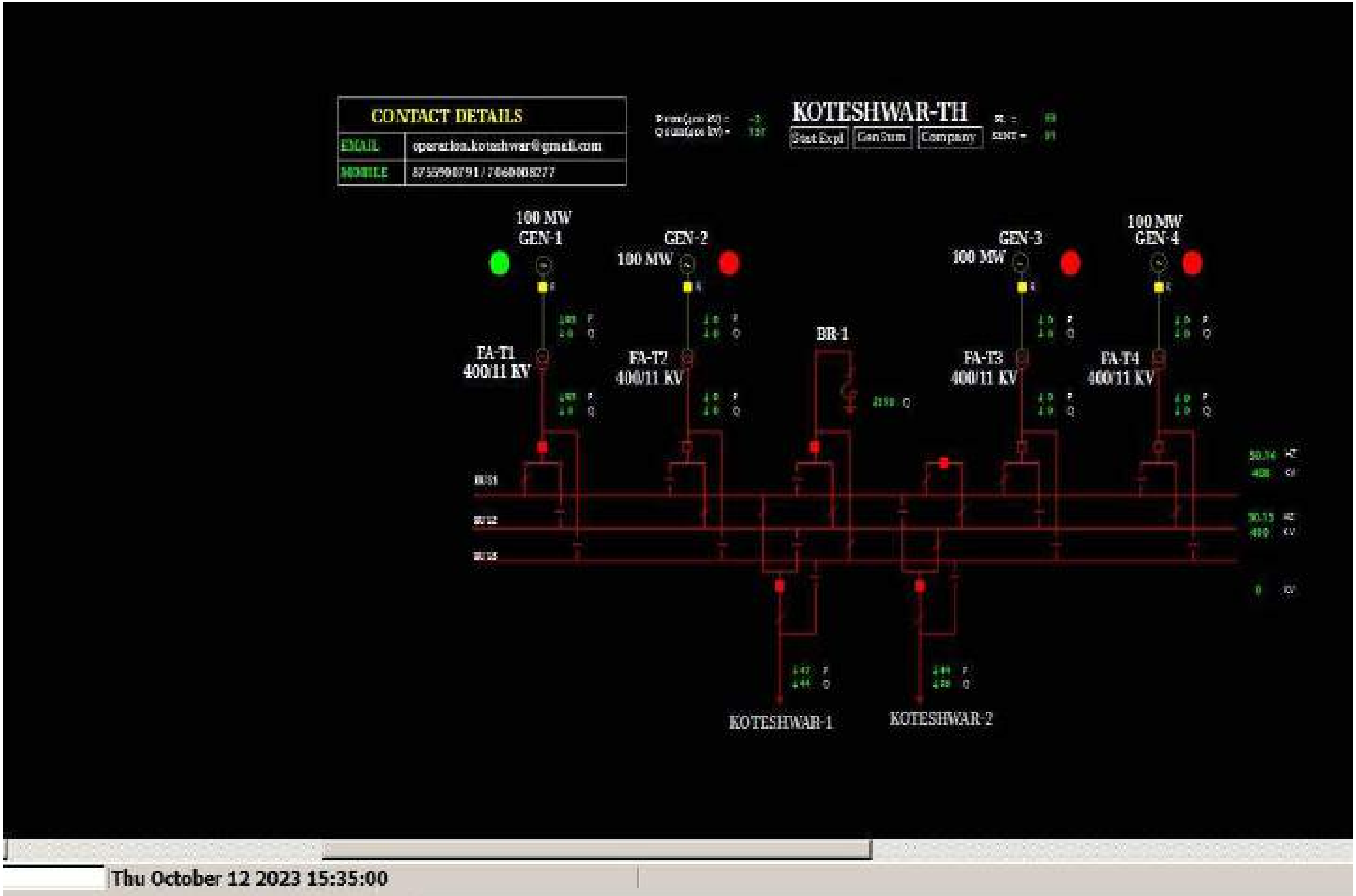
SLD of 765/400kV Koteshwar(PG) before the event



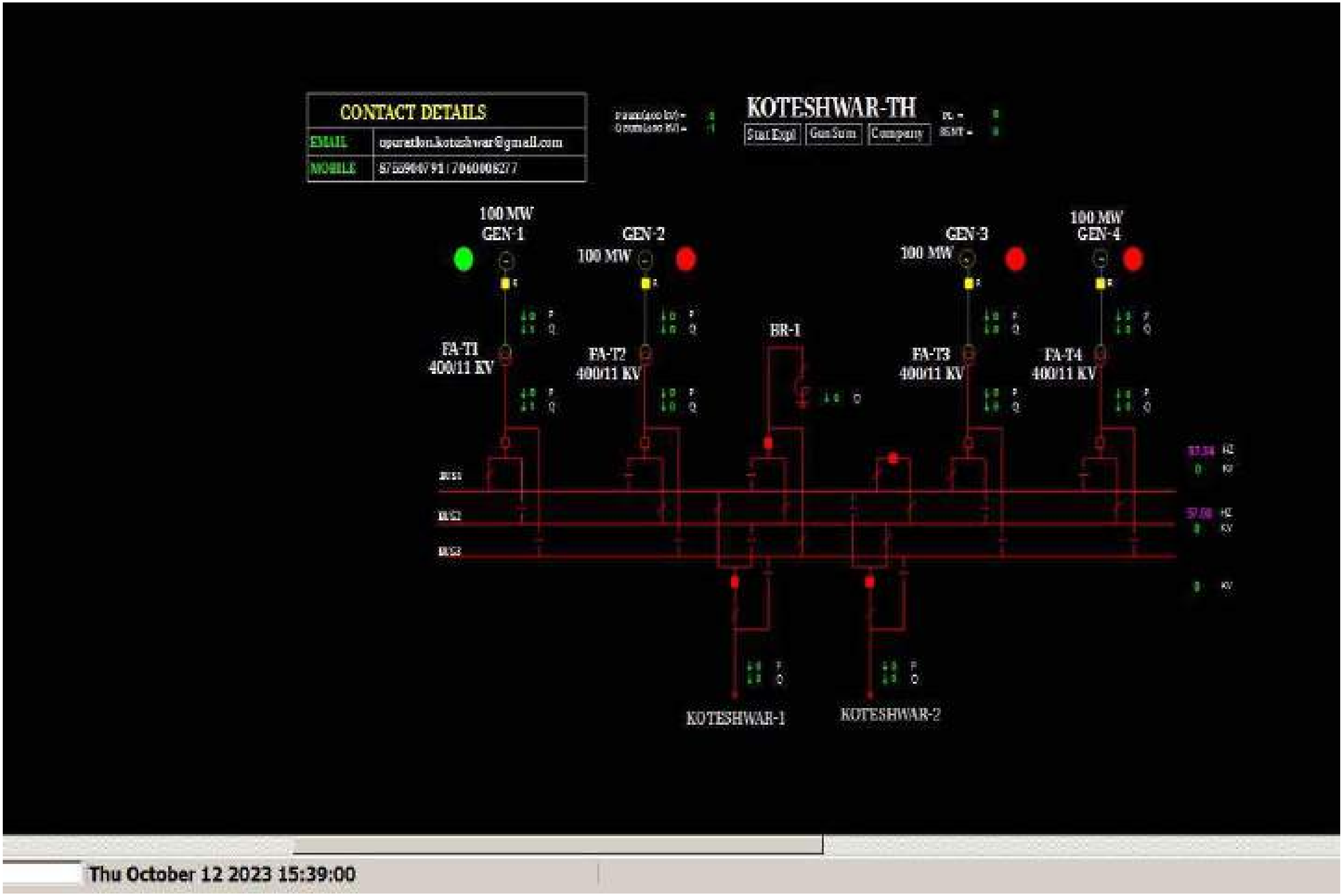
SLD of 765/400kV Koteshwar(PG) after the event



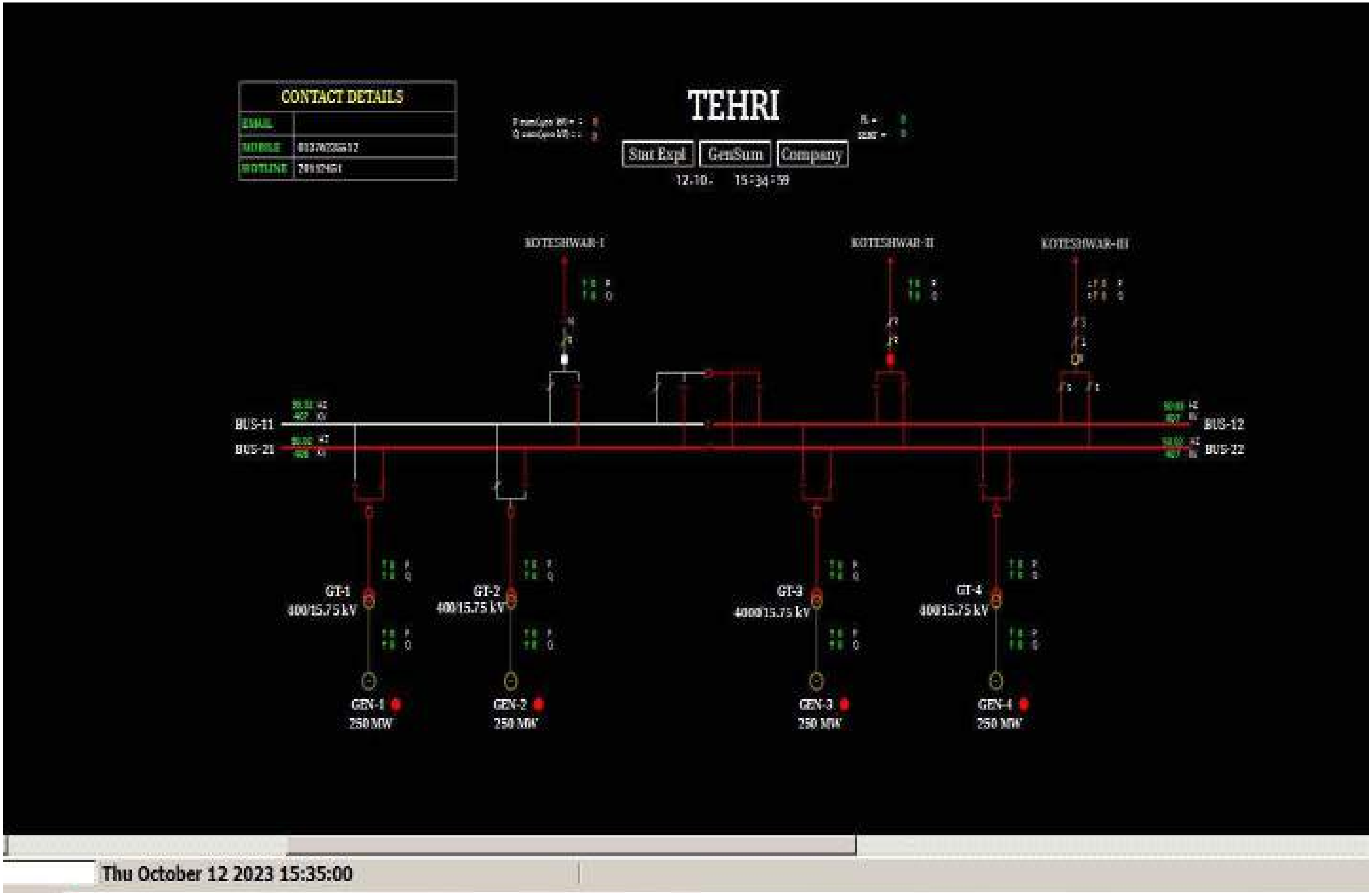
SLD of 400kV Koteshwar(THDC) before the event



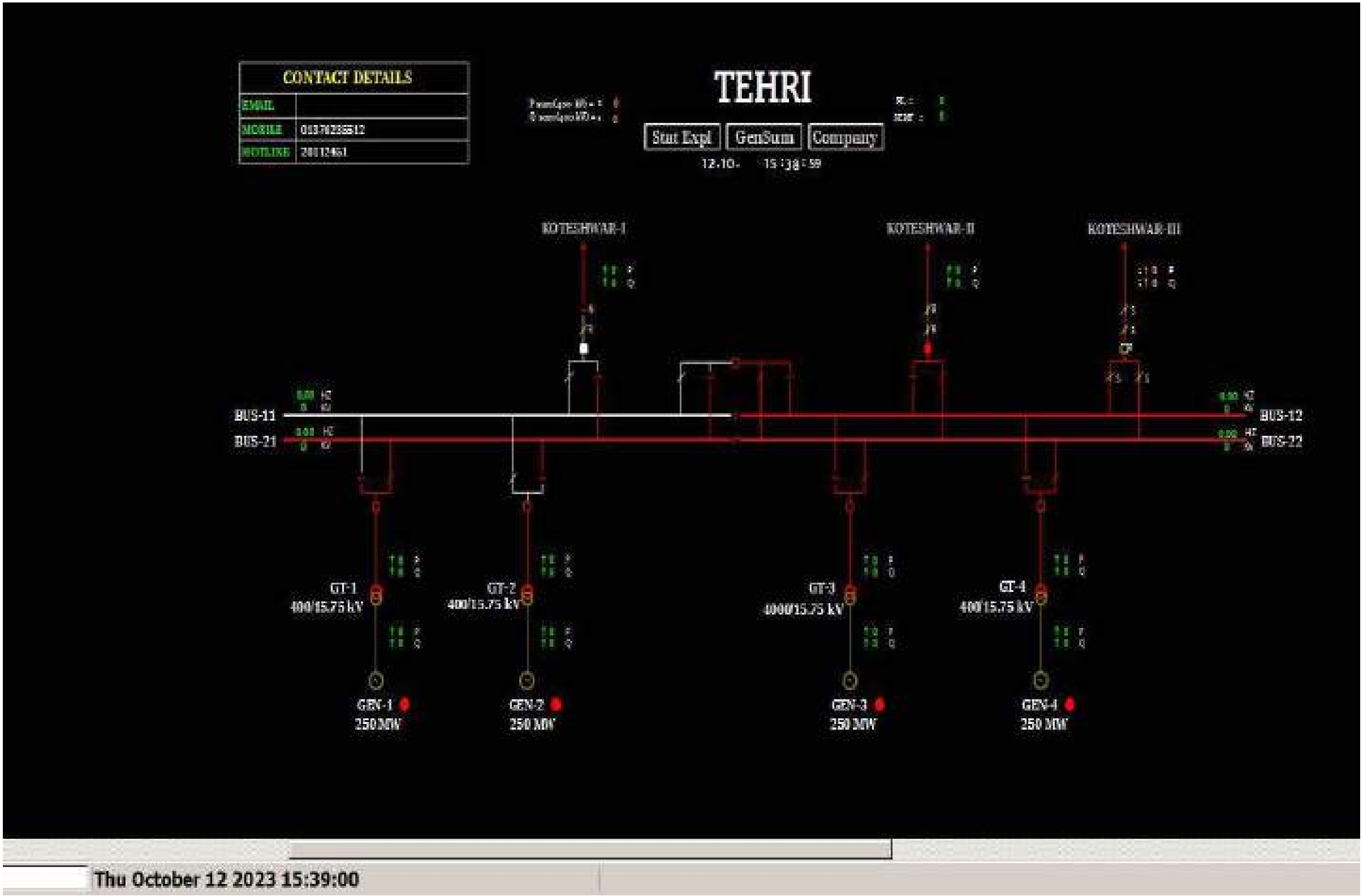
SLD of 400kV Koteshwar(THDC) after the event



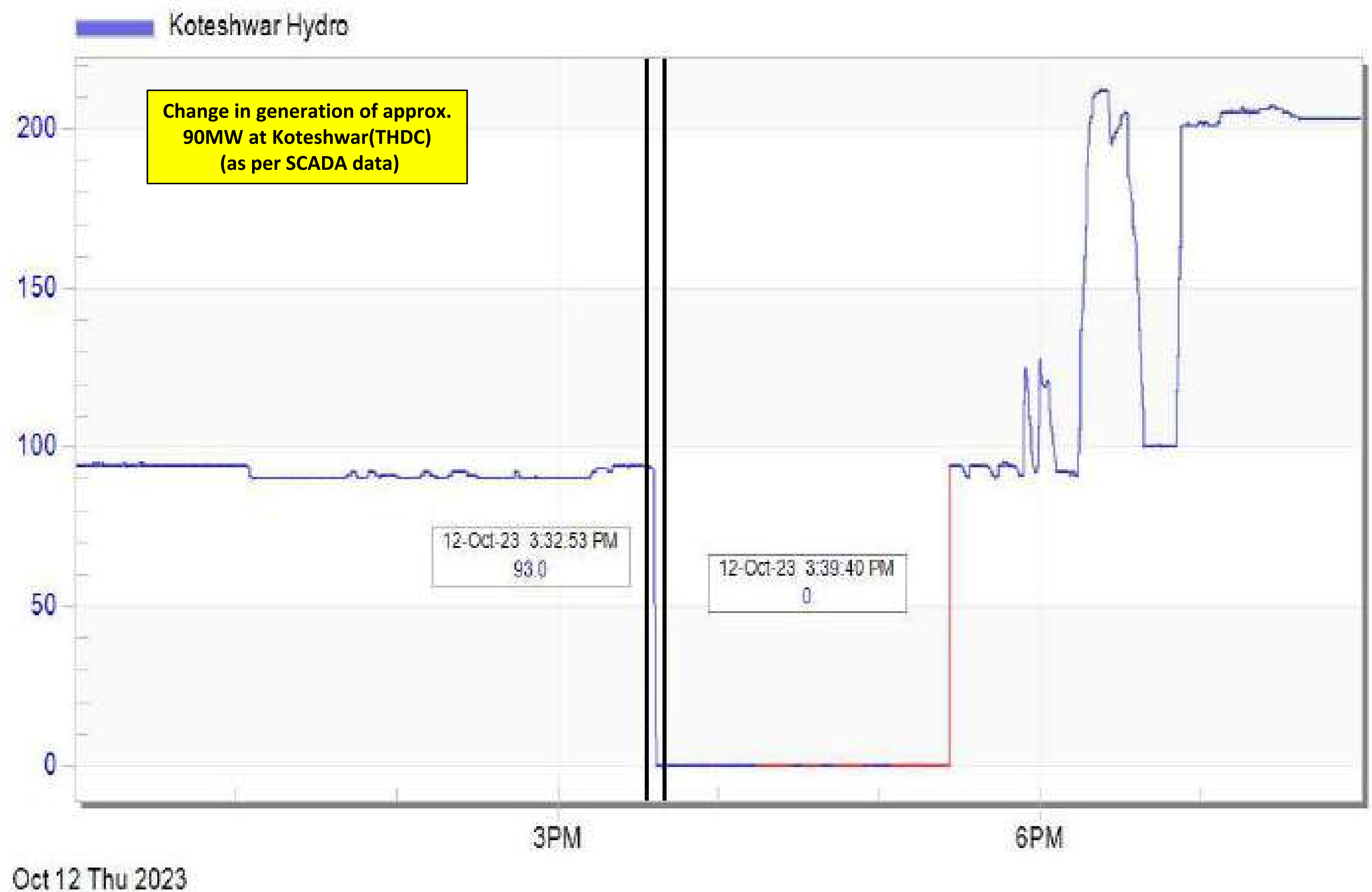
SLD of 400kV Tehri(THDC) before the event



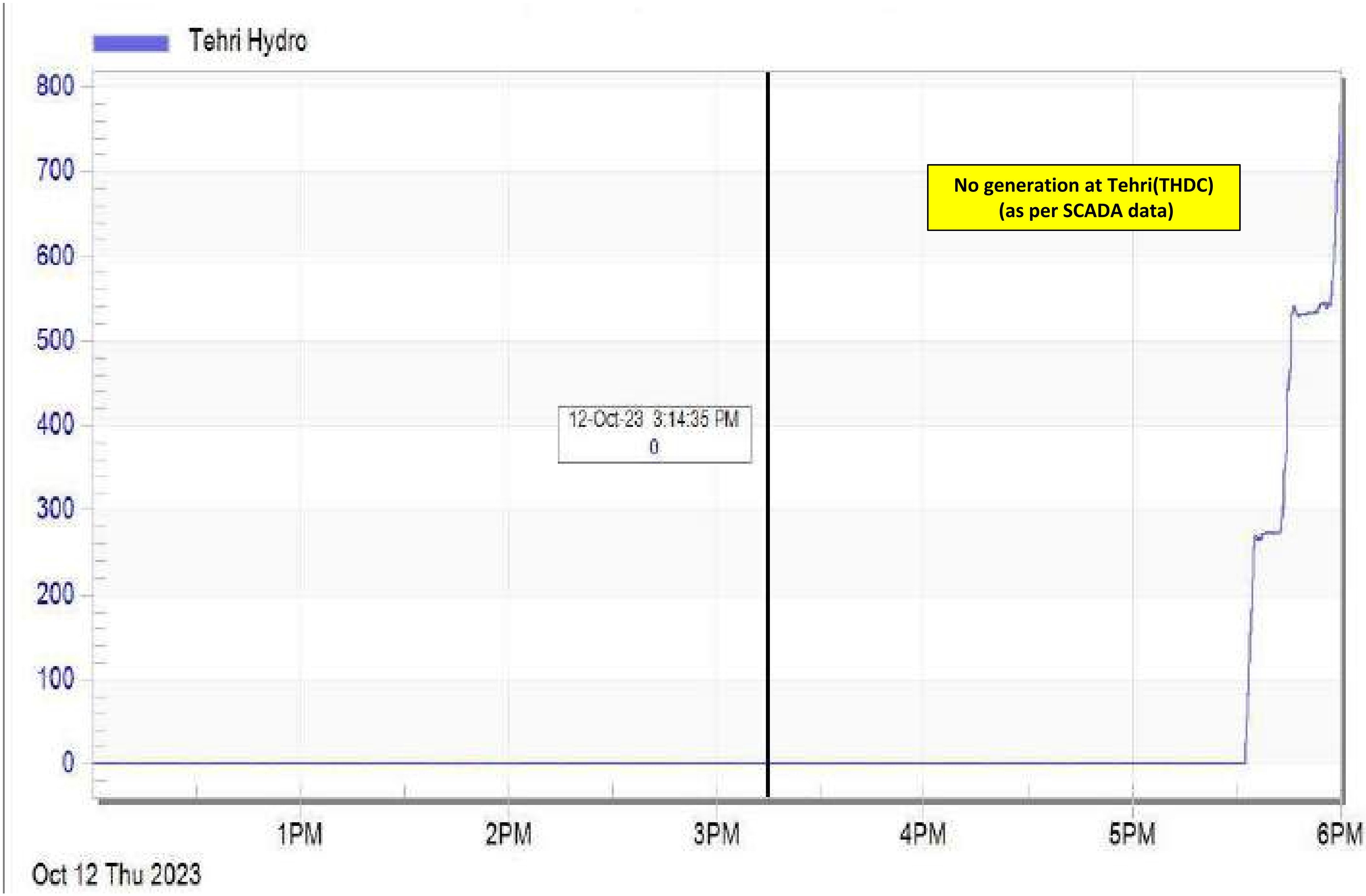
SLD of 400kV Tehri(THDC) after the event



Koteshwar(THDC) generation during the event

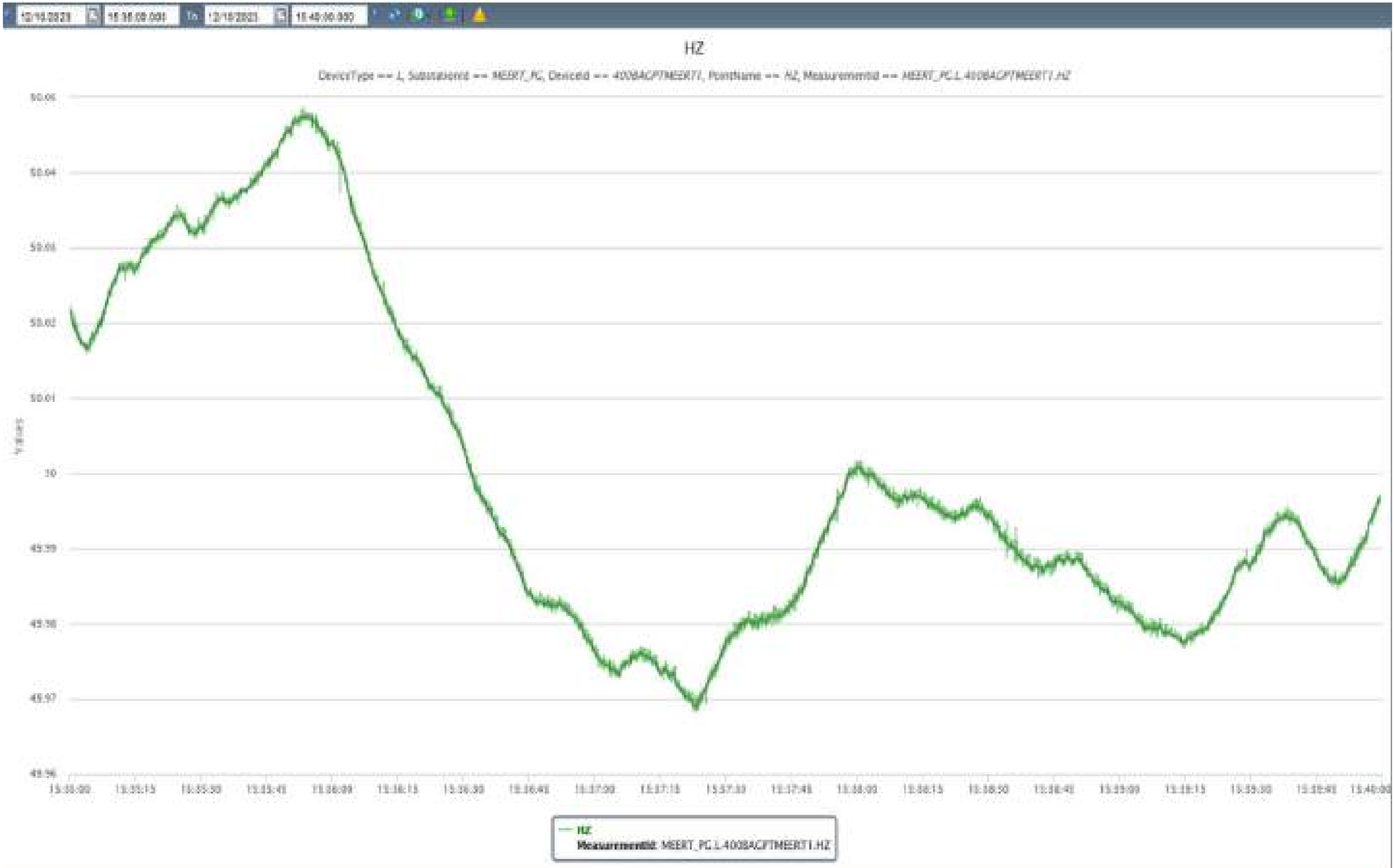


Tehri(THDC) generation during the event



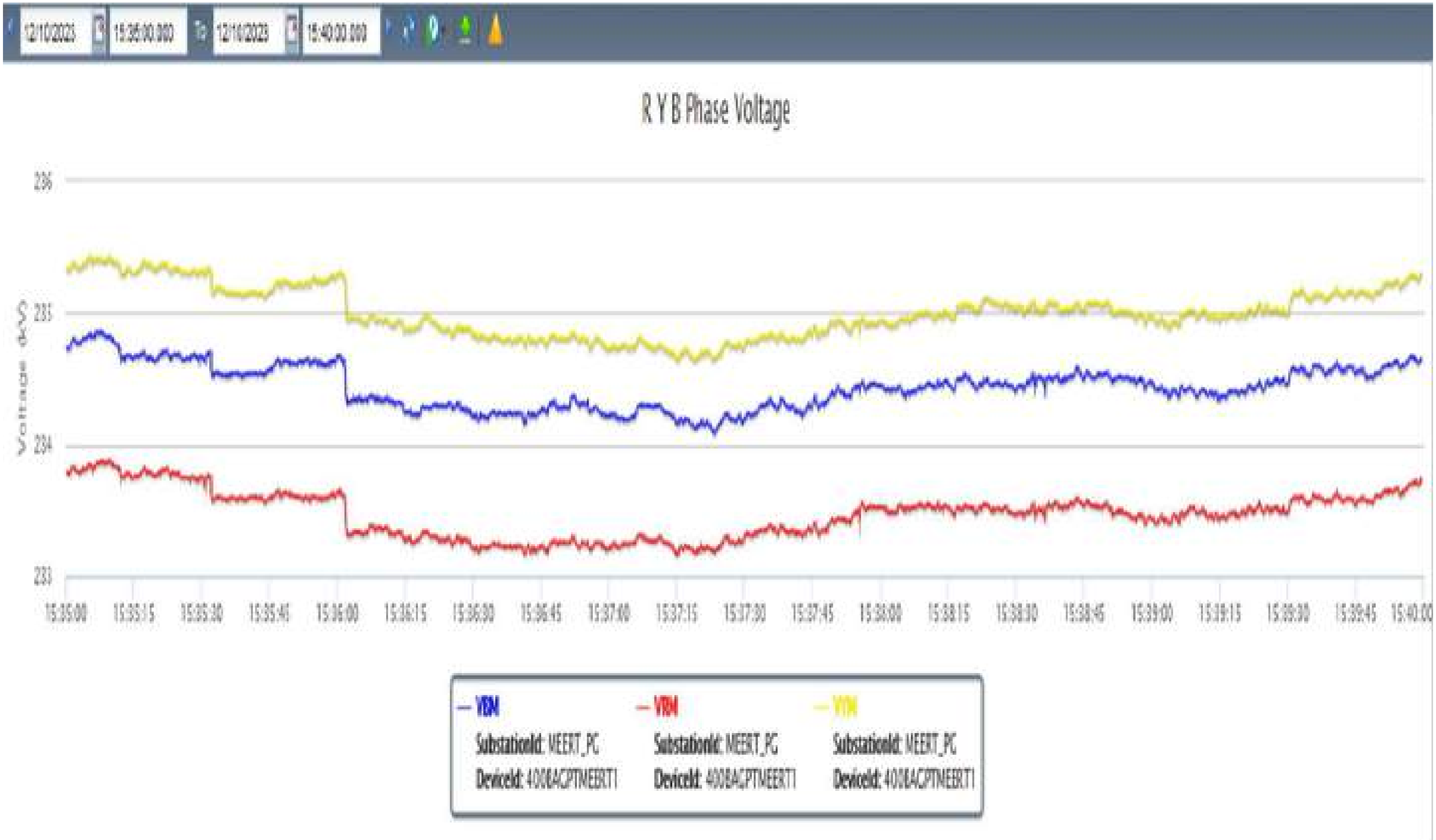
PMU Plot of frequency at Meerut(PG)

15:36hrs/12-Oct-23



PMU Plot of phase voltage magnitude at Meerut(PG)

15:36hrs/12-Oct-23



Event Logger Details (PROTECTION OPERATED IN FSC)

2023-10-12 15:36:01.841	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 706_ICT-2 / B706_BCU1	89TE-R POSITION	OPEN	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 706_ICT-2 / B706_BCU1	89RTE-R COUNTER	State 52794	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 704_BUS REACTOR-1 / B704_BCU1	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.840	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	SET	Valid
2023-10-12 15:36:01.840	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR R-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR Y-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR R-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR B-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B706BC2 / B706_BCU2	OIL FLOW ALARM ICT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.838	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	SET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	RESET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / B706BC2 / B706_BCU2	START OF FAN COOLING R/Y/B ICT	SET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.834	MEERUT / 765KV / B706BC2 / B706_BCU2	START OF FAN COOLING R/Y/B ICT	RESET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR Y-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR R-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR B-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR Y-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR R-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR B-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B706BC2 / B706_BCU2	OIL FLOW ALARM ICT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.832	MEERUT / 765KV / 714_TIE / B714RT_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.831	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	RESET	Valid
2023-10-12 15:36:01.821	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	SET	Valid
2023-10-12 15:36:01.816	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	RESET	Valid

SCADA SOE

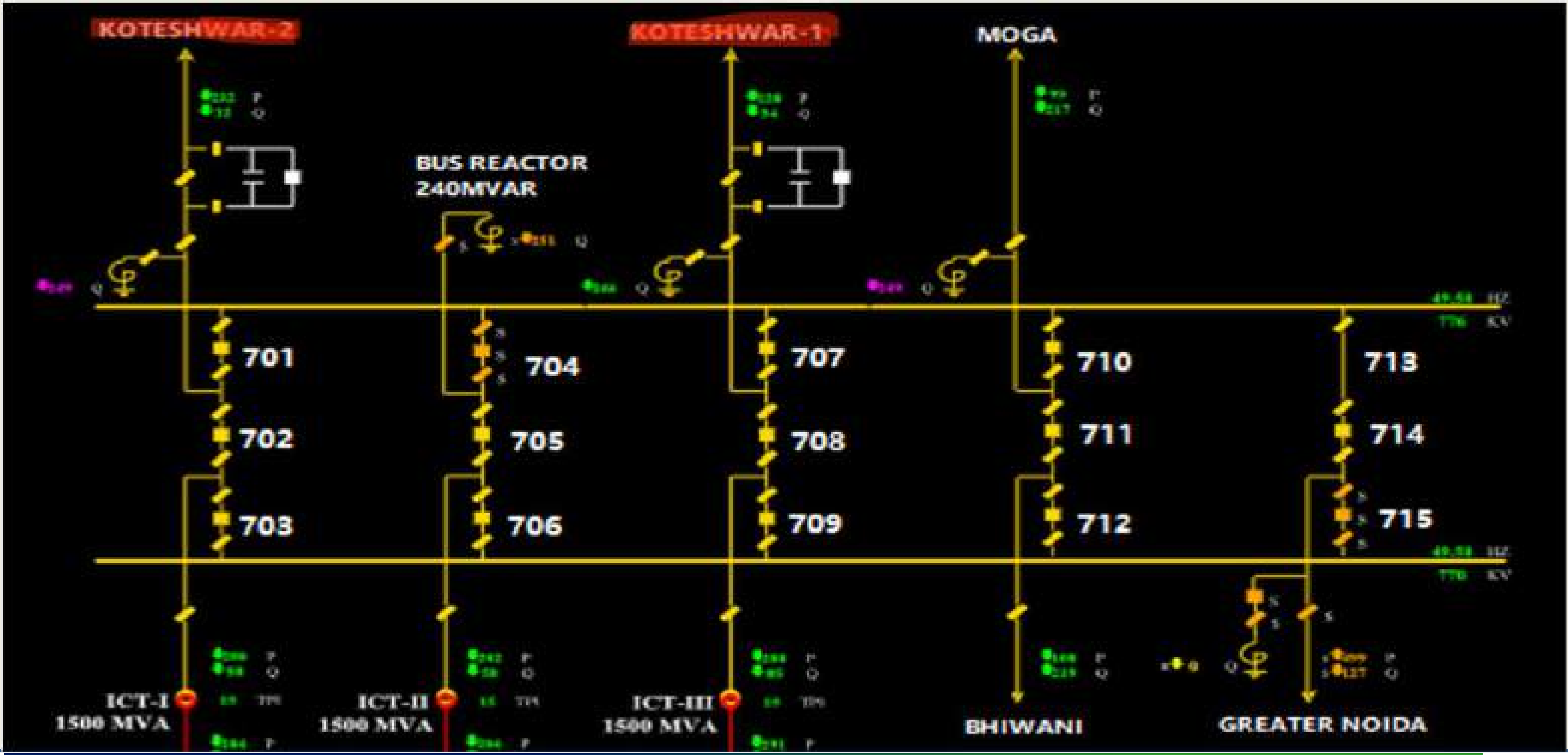
Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remark
15:36:01,947	KTSWR_PG	765kV	12MEERT1	Circuit Breaker	Open	Main CB at Koteshwar(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 opened
15:36:01,948	KTSWR_PG	765kV	11T4MRT1	Circuit Breaker	Open	Tie CB at Koteshwar(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 opened
15:36:01,972	KTSWR_PG	765kV	6MEERT2	Circuit Breaker	Open	Main CB at Koteshwar(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-2 opened
15:36:01,974	KTSWR_PG	765kV	5T2MERT2	Circuit Breaker	Open	Tie CB at Koteshwar(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-2 opened
15:36:02,206	MEERT_PG	765kV	8T3K1TIE	Circuit Breaker	Open	Tie CB at Meerut(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 opened
15:36:02,678	MEERT_PG	765kV	7KTSWR1	Circuit Breaker	Open	Main CB at Meerut(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-1 opened
15:36:03,048	MEERT_PG	765kV	4R1	Circuit Breaker	Open	Main CB of Bus reactor at 765 kV Meerut(PG) opened
15:39:38,735	MEERT_PG	765kV	2T1K2TIE	Circuit Breaker	Open	Tie CB at Meerut(PG) end of 765kV Koteshwar(PG)-Meerut(PG) Ckt-2 opened

Point of discussion

i. DR/EL of all the tripped elements, sequence of event along with tripping report of the event need to be shared.
ii. Which protection had operated in FSC?
iii. Reason of DT sent from Koteshwar(THDC) end need to be shared.
iv. Remedial action taken report to be shared.

Tripping: 765kV Meerut-Koteshwar DC line
12.10.2023 15:36 hrs

SLD: Meerut


KOTESHWAR-2
KOTESHWAR-1
MOGA
BUS REACTOR
240MVAR
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
ICT-I
1500 MVA
ICT-II
1500 MVA
ICT-III
1500 MVA
BHIWANI
GREATER NOIDA

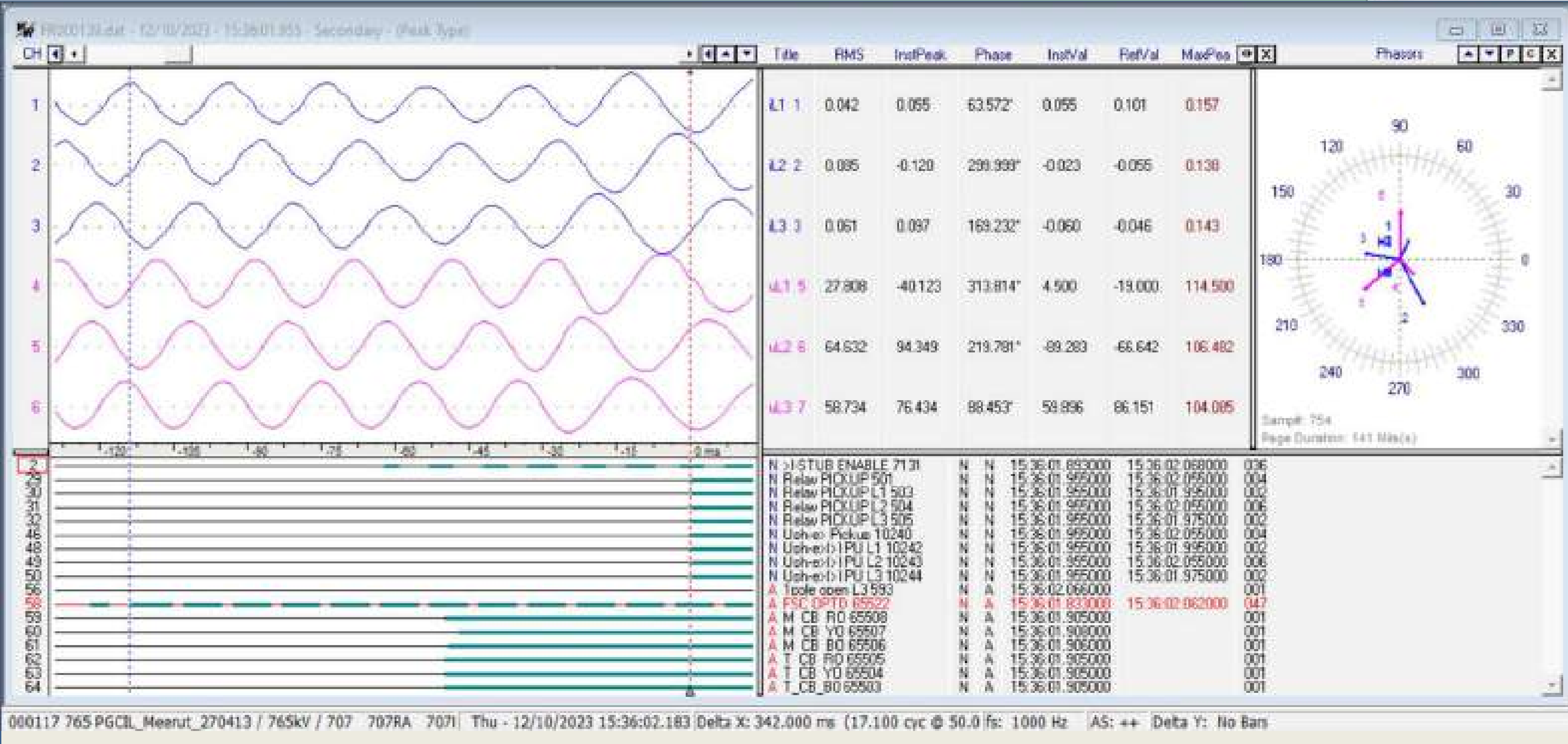
Event synopsis

Date/Timing	Event
Time & Date of Event	12.10.2023 15:36:01 hrs
Antecedent Condition	Both circuits of 765kV Koteshwar-Meerut in service Load on each circuit: ~45MW **Generation:** Koteshwar Hydro: 90MW Tehri Hydro: No scheduled (under S/D)
Elements affected	765kV Meerut-Koteshwar ckt-1 765kV Meerut-Koteshwar ckt-2 Voltage loss at Koteshwar GIS (units at KHEP tripped)
Koteshwar GIS	After loss of evacuation lines, Generating units at KHEP tripped on Over-excitation. No other CB tripped at Koteshwar GIS

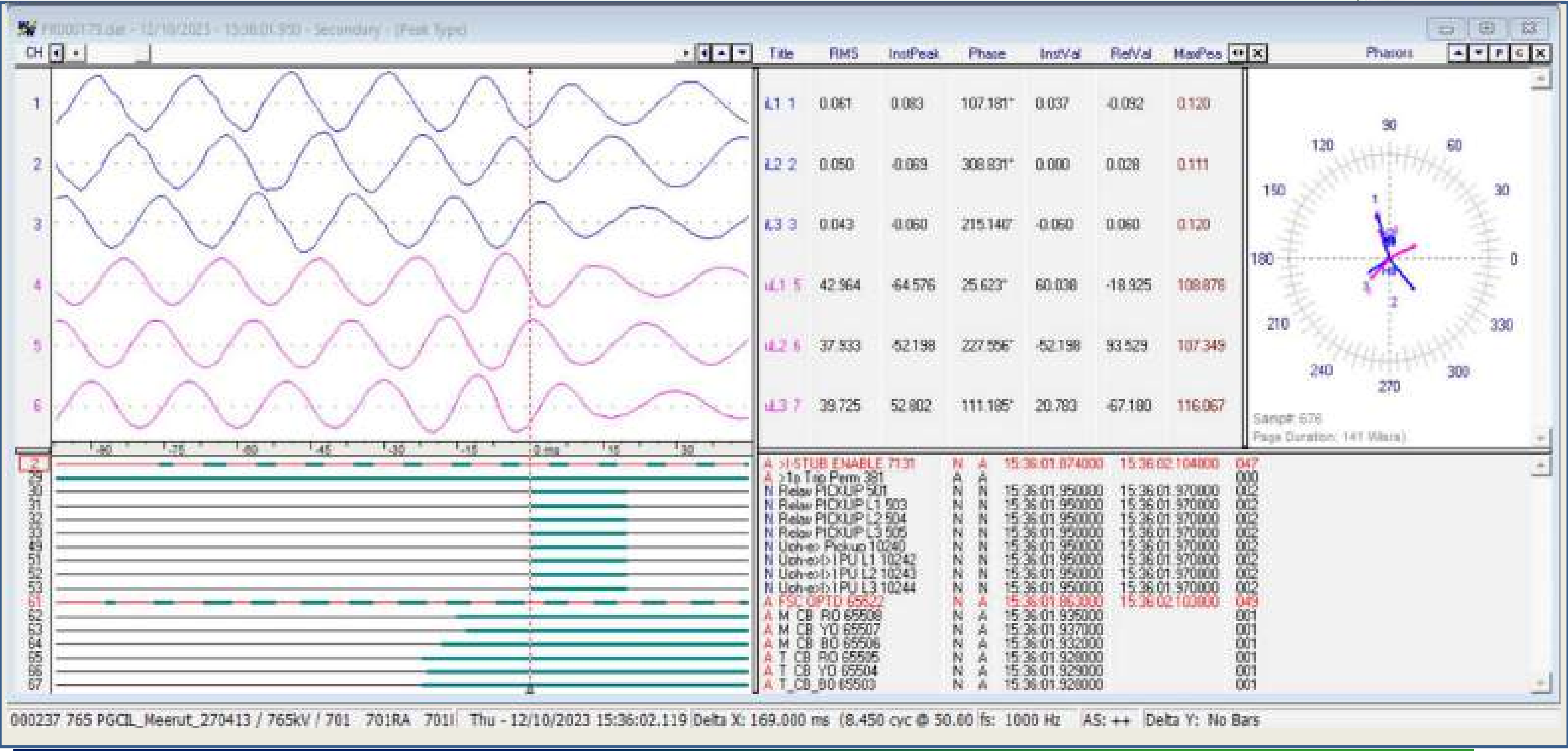
PROTECTION OPERATED IN FSC

2023-10-12 15:36:01.841	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 706_ICT-2 / B706_BCU1	89TE-R POSITION	OPEN	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 706_ICT-2 / B706_BCU1	89RTE-R COUNTER	State 52794	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 704_BUS REACTOR-1 / B704_BCU1	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.841	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.840	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	SET	Valid
2023-10-12 15:36:01.840	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR R-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR Y-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR R-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR B-PH	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / B706BC2 / B706_BCU2	OIL FLOW ALARM ICT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.839	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.838	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	SET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	RESET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / B706BC2 / B706_BCU2	START OF FAN COOLING R/Y/B ICT	SET	Valid
2023-10-12 15:36:01.836	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	RESET	Valid
2023-10-12 15:36:01.834	MEERUT / 765KV / B706BC2 / B706_BCU2	START OF FAN COOLING R/Y/B ICT	RESET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR Y-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR R-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 707 REACTOR B-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR Y-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR R-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B709RC_BCU_2 / B709RC_BCU_2	FIRE IN 701 REACTOR B-PH	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B707RA_21_1 / B707RA_21_1	PROTECTION OPERATED IN SFC	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / B706BC2 / B706_BCU2	OIL FLOW ALARM ICT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 715_ GR NOIDA / B715RB_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 711_TIE / B711_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 710_MOGA LINE REACTOR / B710_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.833	MEERUT / 765KV / 702_TIE / B702_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.832	MEERUT / 765KV / 714_TIE / B714RT_BCU	CT SF6 LOCKOUT	SET	Valid
2023-10-12 15:36:01.831	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	RESET	Valid
2023-10-12 15:36:01.821	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	SET	Valid
2023-10-12 15:36:01.815	MEERUT / AUXILLARY SYSTEM / LT_BCU3 / LTBCU3	220 DC-1 EARTH FAULT	RESET	Valid

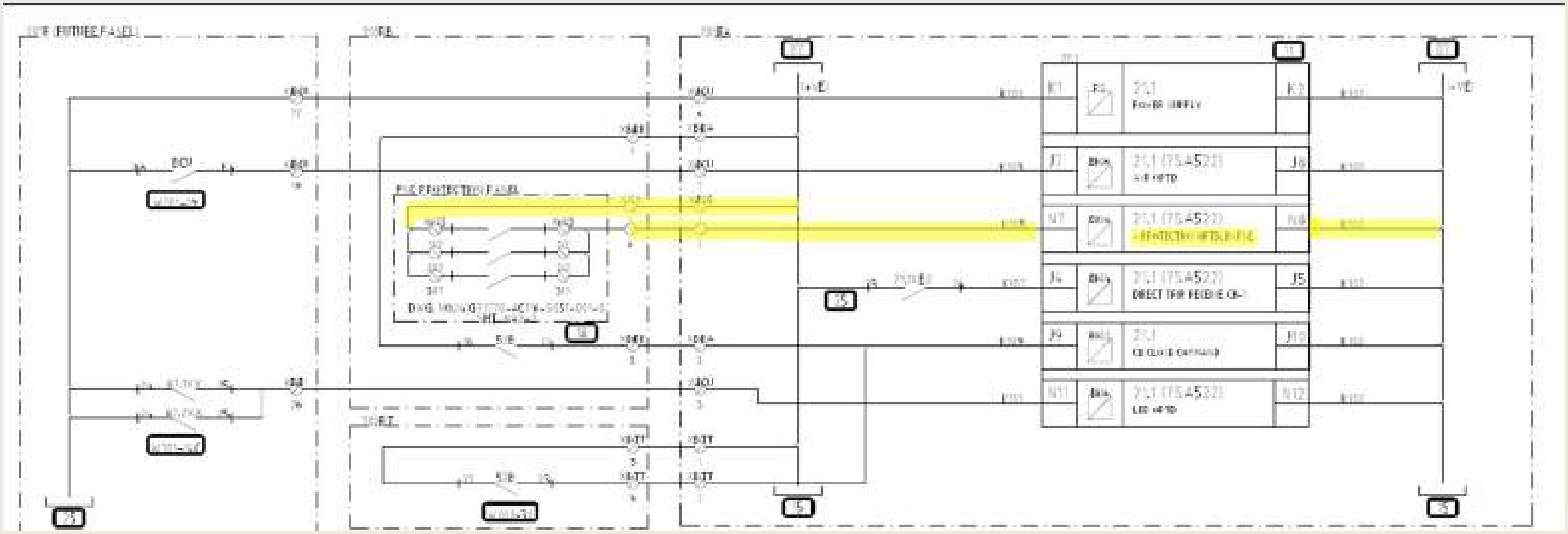
Meerut-Koteshwar-1 DR



Meerut-Koteshwar-2 DR



PROTECTION OPERATED IN FSC




THANK YOU

DC rectification work at Meerut S/s

Northern Region-I

Content

- Background
- Work Carried Out
- Challenges Faced
- Rectification Done
- Conclusions

Background

- 765/400/220kV Meerut Sub-station: commissioned in 2007
- No of bays:
  - 765 kV - 15
  - 400 kV - 32
  - 220 kV - 12
- Multiple retrofitment works
- Numerous scheme modifications to comply with different protection circulars.

Contd…

- Replacement of equipments including re-wiring and scheme modifications.
- NTAMC adaptation works caused multiple changes in scheme
- Ageing of control cables (poor quality of M/s Paramount make cables) in switchyard led to the severe mixing/earth faults in DC system
- DC mixing and Earth Fault have caused spurious trippings of the elements recently.
- Rectification of DC mixing/earth-fault critical

Work Carried Out

Task force of following members was deputed at Meerut for rectification of DC system issues:

(i) Sh. Mayank Rana, Dy Mgr (Bagpat)

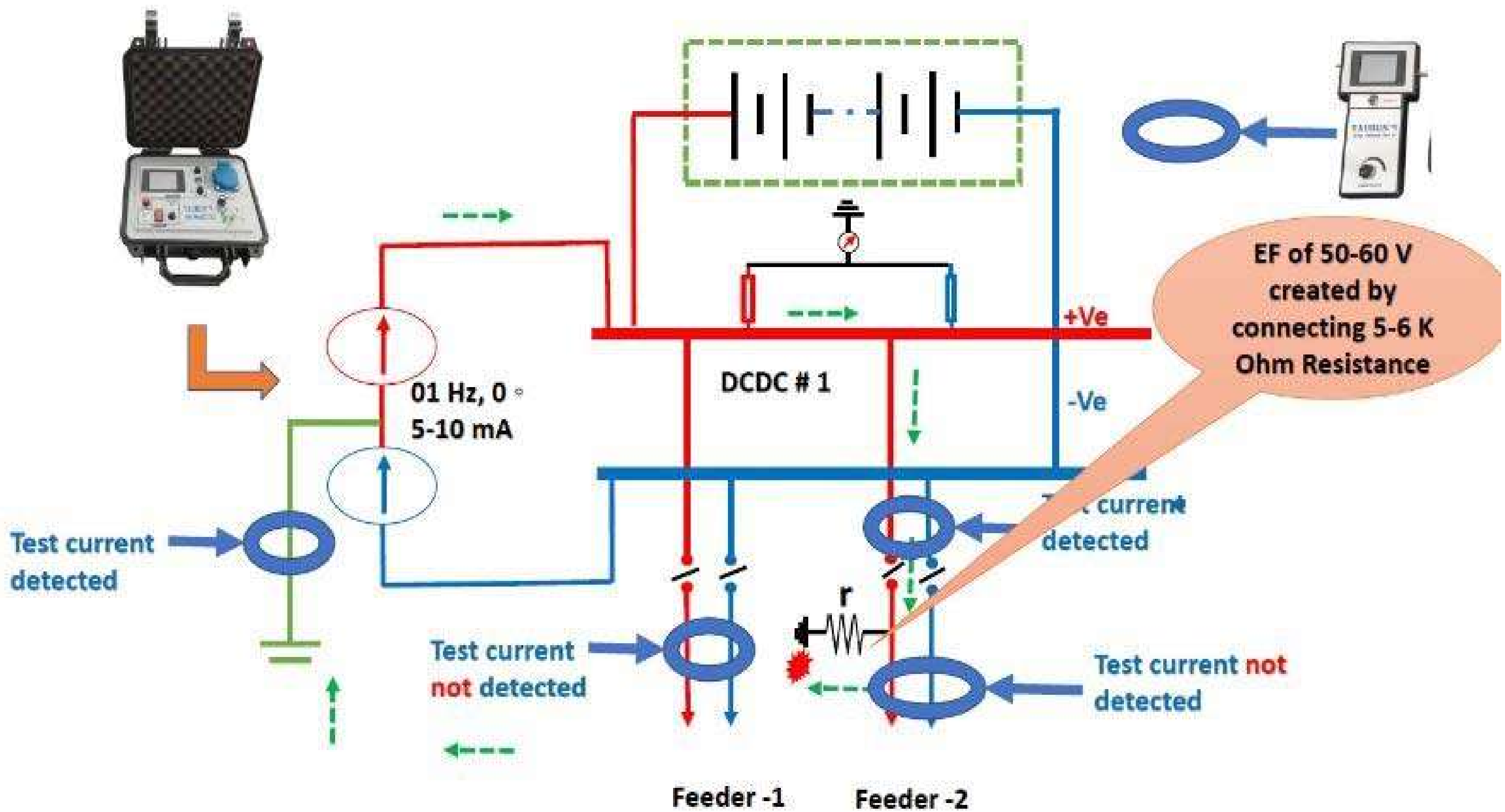
(ii) Sh. Sandeep Sheron, Dy Mgr (Saharanpur)

(iii) Sh. Ajay Rana, Technician (Ballabgarh)

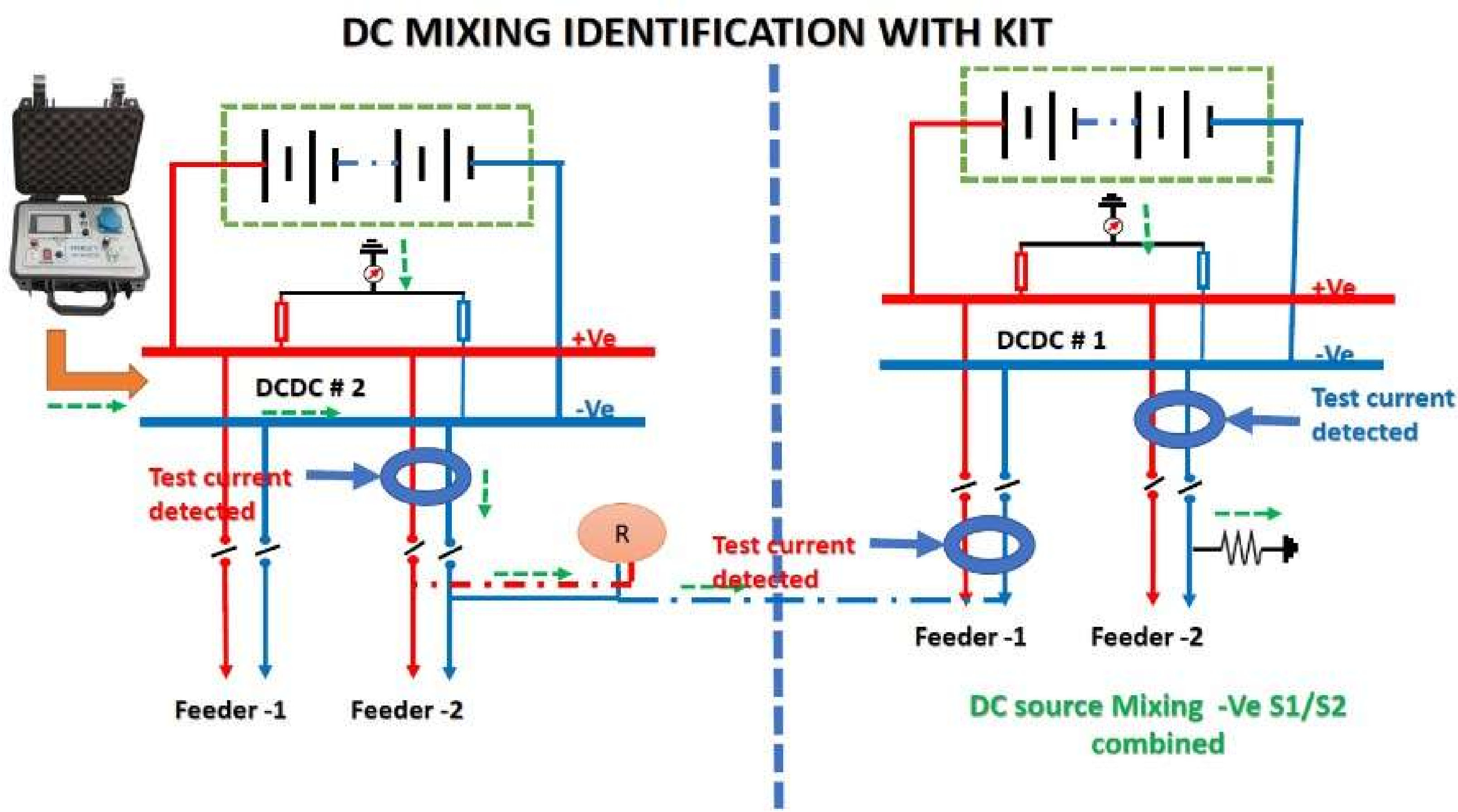
- **Objective:** Rectification of DC source mixing and elimination of earth-fault in DC sources

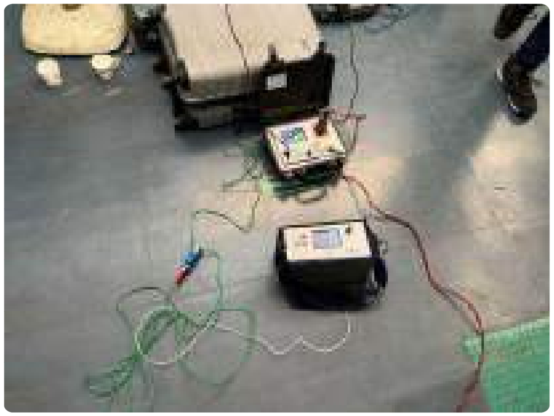
- **Method:** Detection of faulty (earthed/mixed) DC feeder using an E/F locator. Earth fault was simulated through external resistor in one DC source and DC E/f was checked in 2^{nd} DC source using E/F locator.

Fault identification using EF locator kit is shown below



DC Mixing identification using EF locator kit is shown below





EF/Mixing Detection Kit

- DC system of the 765 KV substation has been checked by simulating an earth fault in DCDB-1. The DC voltage after simulating the earth fault is tabulated below:

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		**After DC EF simulation in Source -1 [6k Ohm]**	
+Ve -E = 124 V **-Ve-E = 119 V** **+Ve/-Ve = 243.5 V**	+Ve -E =122 V -Ve-E = 119 V +Ve/-Ve = 243 V	+Ve -E = 150 V -Ve-E = 89 V +Ve/-Ve = 243.5 V	+Ve -E = 123 V -Ve-E =118 V +Ve/-Ve = 243 V

During the above simulation, all bays of 765 KV were in service with FSC isolated. From the above data, it can be concluded that there is NO DC mixing in the 765 kV DC system in that condition.

2. DC system of 400kV substation has also been checked by simulating a controlled earth fault [6 K OHM] in DCDB-1. The DC voltage after the earth fault is tabulated below

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After DC EF simulation in Source -1[6k Ohm]	
+Ve -E = 139.0 V -Ve-E = 103.5V +Ve/-Ve = 243.0V	+139.0V -104.0V 243.0 V	+153.0 V -90.0 V 243.0 V	+ 152.7 V - 89.0 V 243.0 V

During the above simulation, bay no 403, 40304, 405, 40506, 413, 41314, 415 and 41516 were in open condition. The line isolators no 40389L, 40589L, 41389L and 41589 L were in the open position and the concerned line earth switches were in a close position. The above data indicates the presence of DC mixing in the 400 KV DC system. Taurus make DC earth fault kit was connected in DCDB 2 and DC leakage current was measured in all feeders of DCDB-1 and DCDB -2. Based on the earth fault receiver`s indication, the following DC mixing has been identified and rectified.

a) **Mixing -1:** Bay no 407 Auto reclose ckt [DC mixing in DT -2 and AR ckt]. DC system voltage after removal of DC mixing was

DCDB -1	DCDB -2	DCDB -1	DCDB -2	
Initial Condition		After the removal of DC mixing		Initial Condition
+Ve -E = 153.0 V -Ve-E = 90.0 V	+152.7 V - 89.0 V	+197.4 V -45.4 V	+60.2 V -182.8 V	+152.7 V - 89.0 V +243.0 V

b) **Mixing -2:** Bay no 40708 AR Check Syn ckt [DC mixing in LBB and AR ckt]. DC system voltage after removal of DC mixing was

DCDB -1	DCDB -2	DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the removal of DC mixing		Initial Condition	
+Ve -E = 197.4 V -Ve-E = 45.4 V	+60.2 V - 182.8 V	+ 146.0 V - 97.5 V	+134.0 V - 107.0 V	+197.4 V -45.4 V	+60.2 V - 182.8 V

c) **DC Earth Fault -1:** Bay no 401-control panel [DC Earth fault in Isolator interlock ckt]. DC system voltage after isolation of DC earth fault was

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the isolation of the Interlock ckt	
+Ve -E = 146.0 V -Ve-E = 97.5 V	+134.0 V -107.0 V	+121.5 V -121.8 V	+129.4 V - 114.4 V

d) DC Earth fault was simulated in DC Source -2 [6k Ohm]. The DC voltage after the earth fault is tabulated below

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the removal of DC mixing	
+Ve -E = 121.5 V -Ve-E = 121.8 V	+129.4 V -114.4 V	+146.0 V -97.5 V	+137.2 V -106.7 V

e) **Mixing -3:** Bay no 40304 NTAMC ckt [DC mixing in AR and NTAMC ckt]. DC system voltage after removal of DC mixing was

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the removal of DC mixing	
+Ve -E = 146.0 V -Ve-E = 97.5 V	+137.2 V -106.7 V	+116.0 V -128.0 V	+131.0 V -113.0 V

f) **Mixing -4:** Bay no 40506 CB alarm ckt [DC mixing in AR and CB alarm ckt]. DC system voltage after removal of DC mixing was

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the removal of DC mixing	
+Ve -E = 116.0 V -Ve-E = 128.0 V	+131.0 V -113.0 V	+119.0 V -124.0 V	+125.0 V -119.0 V

g) **Mixing -5:** Bay no 40910 AR ckt [DC mixing in AR and NTAMC ckt]. DC system voltage after removal of DC mixing was

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After the removal of DC mixing	
+Ve -E = 119.0 V -Ve-E = 124.0 V	+ 125.0 V - 119.0 V	+ 115.0 V - 128.0 V	+ 134.0 V - 109.0 V

After the removal of the above DC mixing, Kit indicates NIL DC mixing in system. To confirm the same an Earth fault of 3 K Ohm was simulated in DC source -2. DC system voltage in this condition was tabulated below:

DCDB -1	DCDB -2	DCDB -1	DCDB -2
Initial Condition		After DC EF simulation in Source -1 [3k Ohm]	
+Ve -E = 115.0 V -Ve-E = 128.0 V	+134.0 V -109.0 V	+118.0 V -125.0 V	+176.0 V -66.0 V

The above data shows that there is very little [2-3 V] drift in DC-1 voltage on simulating an earth fault in DC-2. The difference in +Ve /-Ve to E Voltage is due to the existence of High resistive earth faults. The final voltages of the DC system on dated 21 Oct 2023 were:

DCDB -1	DCDB -2	DCDB -1	DCDB -2
With DC simulation		**Final voltage**	
+Ve -E = 118.0 V **-Ve-E = 125.0 V**	+176.0 V - 66.0 V	+115.0 V -128.0 V	+134.0 V -109.0 V

- An earth fault with 6.58 k Ohm resistor was created in DCDB 2 and voltages were measured as shown below:

	DCDB 1		DCDB 2		Remarks
	+ve	-ve	+ve	-ve	
	+ 119.5	-123.8	+ 134.0	- 109.5	Nominal Voltages
After creating Earth fault	+124.1	-119.0	+160.5	-83.2	High resistive DC mixing suspected which is causing change in voltage of DCDB1.

Interpretation from simulated earth-fault

- With nominal voltages:
  - Minor DC Earth Fault is suspected in DCDB 2.
  - No DC Earth Fault in DCDB 1.

- With artificial Earth Fault in DCDB 2 :
  - Minor DC mixing in DC sources is suspected as voltages of healthy DCDB also changed by 4 Volts in both positive and negative.

Contd…

- The earth fault kit was connected to the DCDB-1 and all the feeders of DCDB-2 were checked thoroughly for identifying the feeder which is causing DC mixing, but no clear signal was received in any feeder.
- However, full injected current was detected in the common earthing point of voltage divider resisters, indicating a very high resistive mixing/EF.
- This common earthing point was removed, so as to provide only a single path to the injected current, so that kit may be able to identify the fault.

Contd…

- All the feeders were again checked by the receiver unit and no signal was received in any feeder.
- As no signals were received in the receiver unit, a fault in the Battery Battery charger cable was also suspected.
- All the feeders were then shifted to a single source and the charger and batteries were isolated, and a balanced voltage were recorder. (+ 124.1 V, -118 V)

Conclusion

01

Either there is no mixing in the DC system as it cannot be detected by the kit.

02

Or the kit is not able to detect this high resistive fault.

03

The cables of Battery and Charger system were healthy and all the DC relay and monitoring system was also healthy.

Contd…

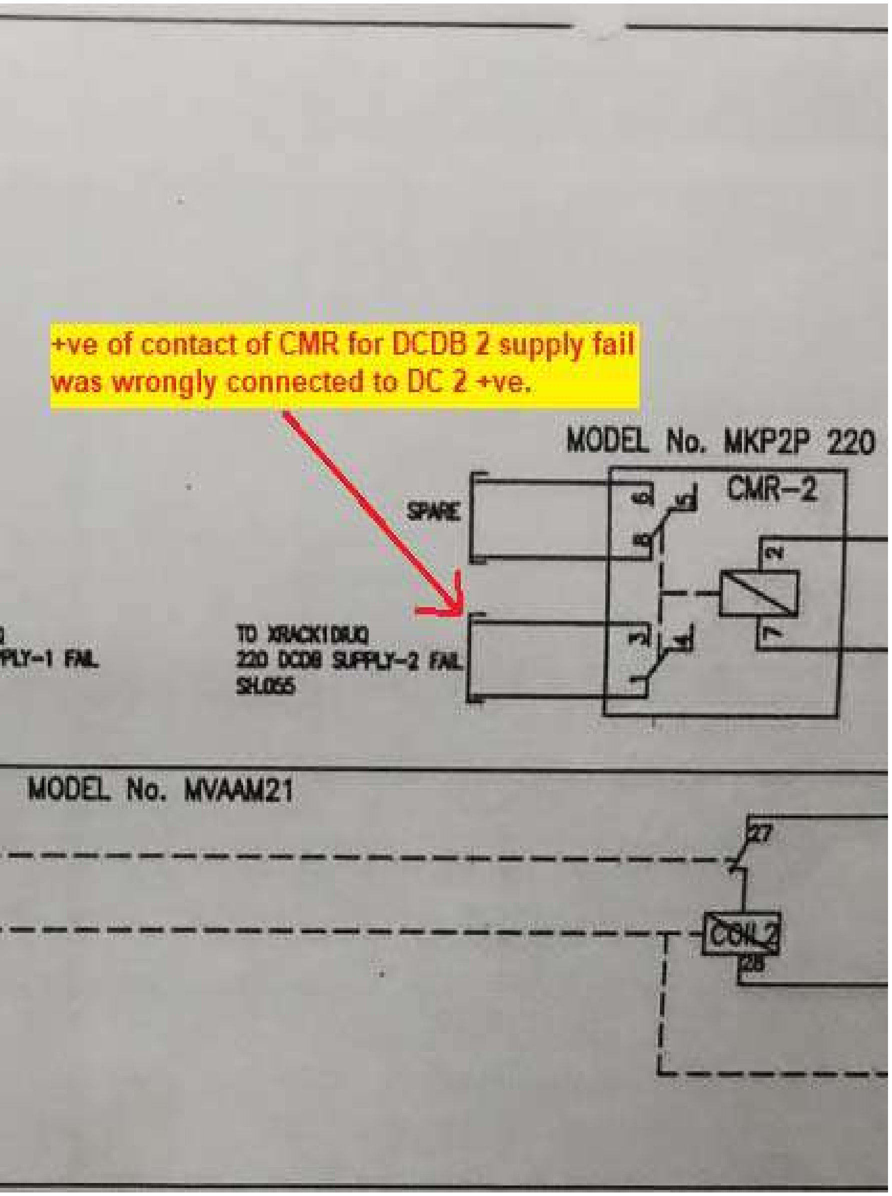
- When no conclusive evidence and feeders were identified, committee decided to go ahead with the conventional method of DC fault detection.

- The MCBs of DC feeders were put down one by one and DCDB voltage and voltage at output of MCBs were recorded for all the feeders of DCDB 2.

Contd…

- Following results were obtained by switching off each MCBs :

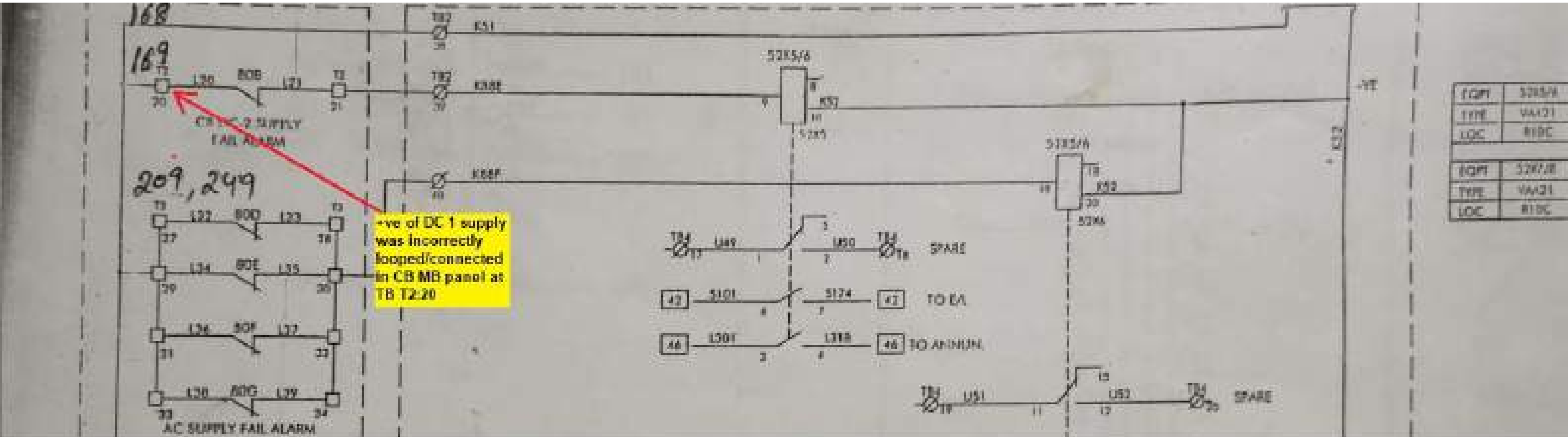
Feeder Name	DCDB 2 Voltage		Voltage at O/P terminal of MCB		DCDB 1 Voltage		Remarks
NTAMC BCU	+ 137.1	-106.4	-122.0	-121.9	+ 117.8	-124.6	DC mixing: –ve voltage of DC 1 is appearing
Muzaffarnagar	+ 136.9	-106.3	+117.3	+117.3	+117.9	-125.1	DC mixing: +ve voltage of DC 1 is appearing
220 kV Nehtaur CP	+ 125.1	-118.2	+120.0	+120.0	+129.7	-113.5	DC mixing: +ve voltage of DC 1 is appearing
220 kV Nehtaur CRP	+137.3	-106.0	+116.0	+116.0	+ 117.6	-125.5	DC of same source is appearing.
Remaining	+137.0	-106.3	0	0	+117.6	-125.4	No DC mixing/EF



Rectification in NTAMC BCU Panel

- **Conditional DC mixing** was found as follows:

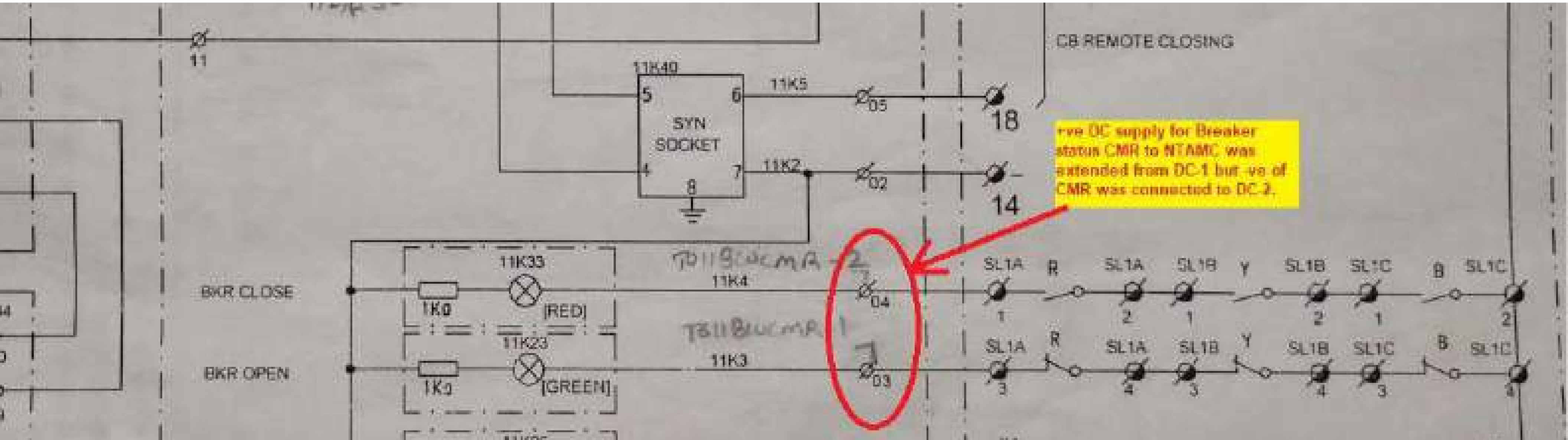
- The +ve supply to contacts of CMR for DC supply 2 fail was wrongly taken from DC 2 supply source, however the –ve supply was correctly taken from DC 1 supply, and therefore during supply failure of DCDB 2, the –ve from DC 1 was extended to +ve terminal of DC 2.



Rectification in Muzaffarnagar Bay Panel

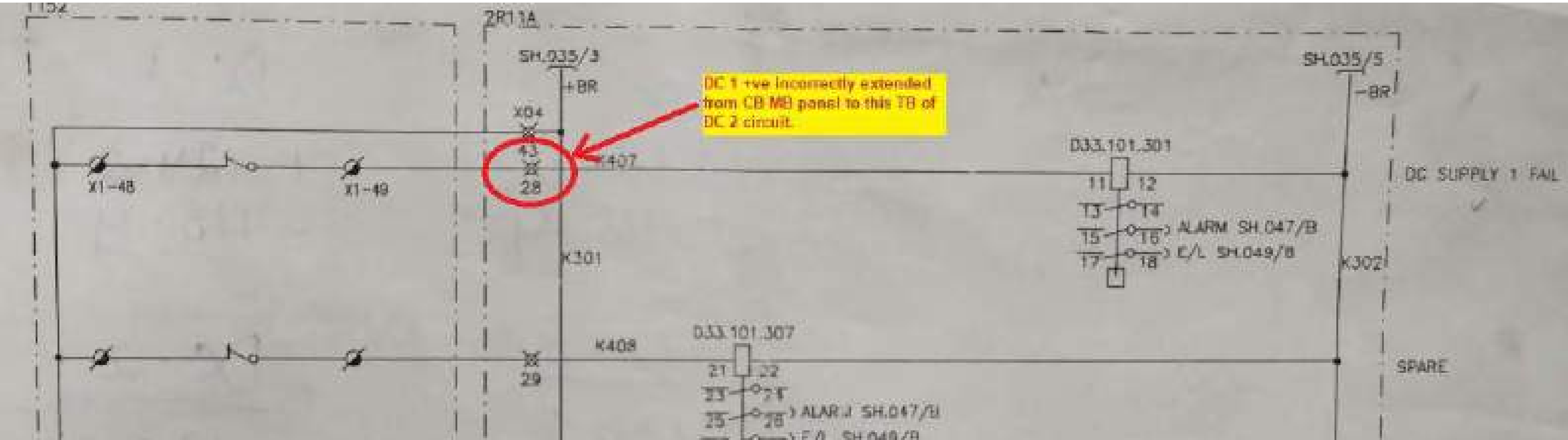
- **Conditional DC mixing** was found as follows:

- The +ve supply to T2:20 contact in CB MB panel was incorrectly taken from DC 1 source and upon failure of DC 2 supply, this +ve is extended to –ve of DC 2 source. Causing mixing….



Rectification in 220 kV Nehtaur Control Panel Bay

- **Permanent DC mixing** was found as follows:
- The +ve supply for CB status CMR (for NTAMC signal) was taken correctly taken from DC1 source, but –ve supply of the CMR was taken from DC source 2. The DCs were connected together through 21 Kilo-Ohms resistance of CMR.
- **Corrective action:**
- -ve supply was changed to DC source 1.



Rectification in 220 kV Nehtaur Relay Panel

- **Permanent DC mixing** was found as follows:

- The +ve supply for DC supply 1 fail was incorrectly taken from DC1 source in CB MB and causing DC mixing with DC 2 supply, as DC 1 fail alarm is to be reported by DC 2 supply as per scheme.

- **Corrective action:**
- +ve supply was changed to DC source 2.

DC Source Voltages after rectification work

- An earth fault with 6.58 k Ohm resistor was again created in DCDB 2 and voltages were measured as shown below:

	DCDB 1		DCDB 2		Remarks
	+ve	-ve	+ve	-ve	
	+ 129.6	-113.2	+ 123.4	- 120.1	Nominal Voltages (DC EF/Mixing rectified in DCDB 2) but DC EF persisting in DCDB 1
After creating EF	+ 129.6	-113.2	+154.0	-89.4	No change observed in voltages of DCDB 1, implies DC mixing fully rectified.

Note: At this point, all the bays of 400 kV and 220 kV were in service. DC mixing again come into picture depending of the status of different elements in different bays, accordingly, DC mixing needs to be checked in each shutdown to completely rectify the issue.

DC E/F rectification work in DCDB-1

- After recification of DC mixing in DCDB 2, the nominal DC voltages recorded shows that there is an EF fault persisting in DCDB 1, which needs to be rectified.

- Kit was used but again as the EF was minor. (Not detected by DC EF relay), conventional method of switching off the MCBs was followed.

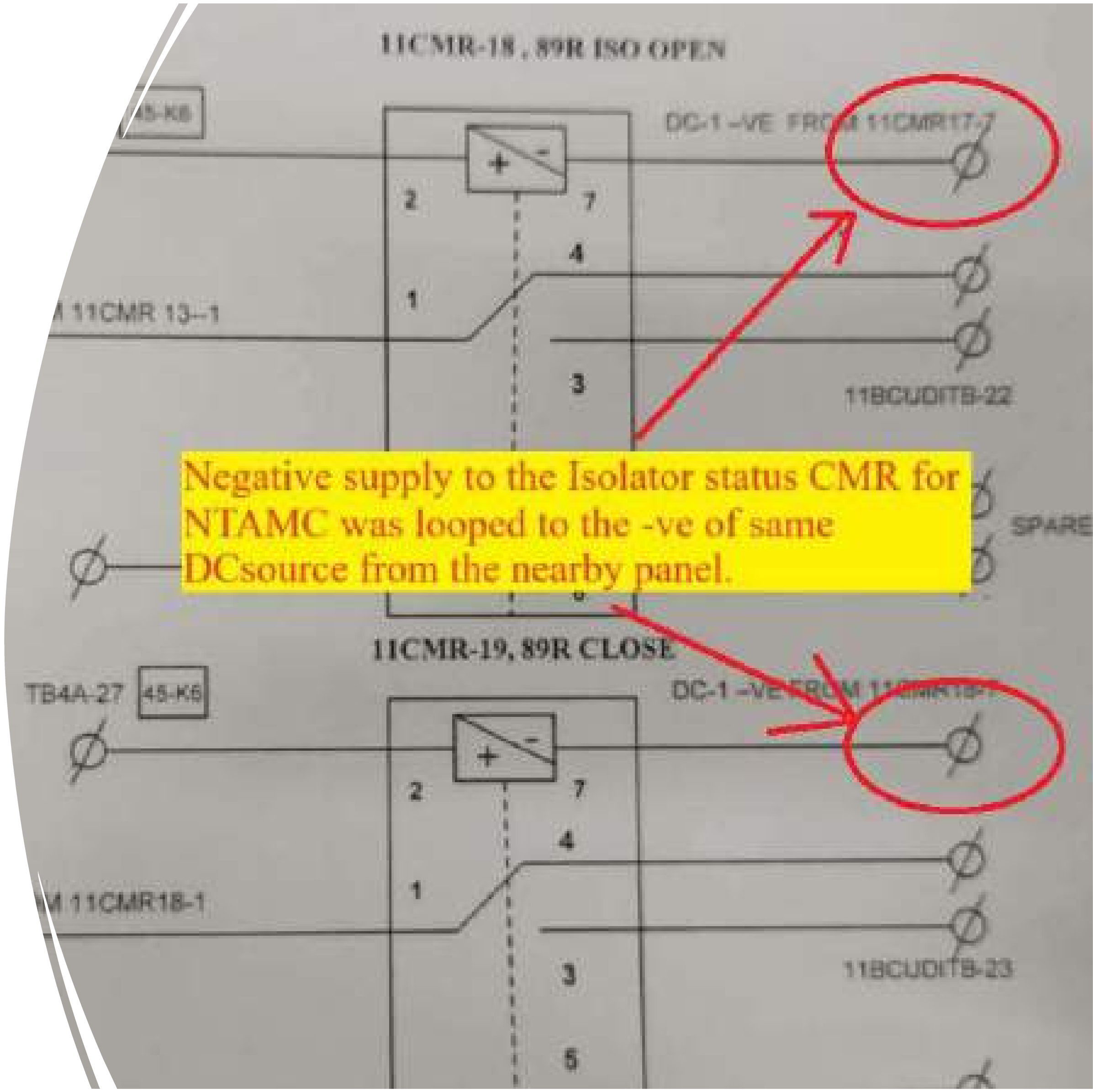
Feeder Name	DCDB 1 Voltage		Voltage at O/P terminal of MCB		DCDB 2 Voltage		Remarks
Remaining Feeders	**+ 131.0**	**-112.3**	**0**	**0**	**+ 123.7**	**-120.4**	No DC E/F and mixing in the feeder
409 (R-409)	**+ 124.7**	**-118.7**	**-118.0**	**-118.0**	**+ 123.7**	**-120.4**	- ve voltage of the same source is extending also DCDB voltage became normal, i.e. EF is persisting in this Bay.

Contd..

Rectification of same source DC mixing

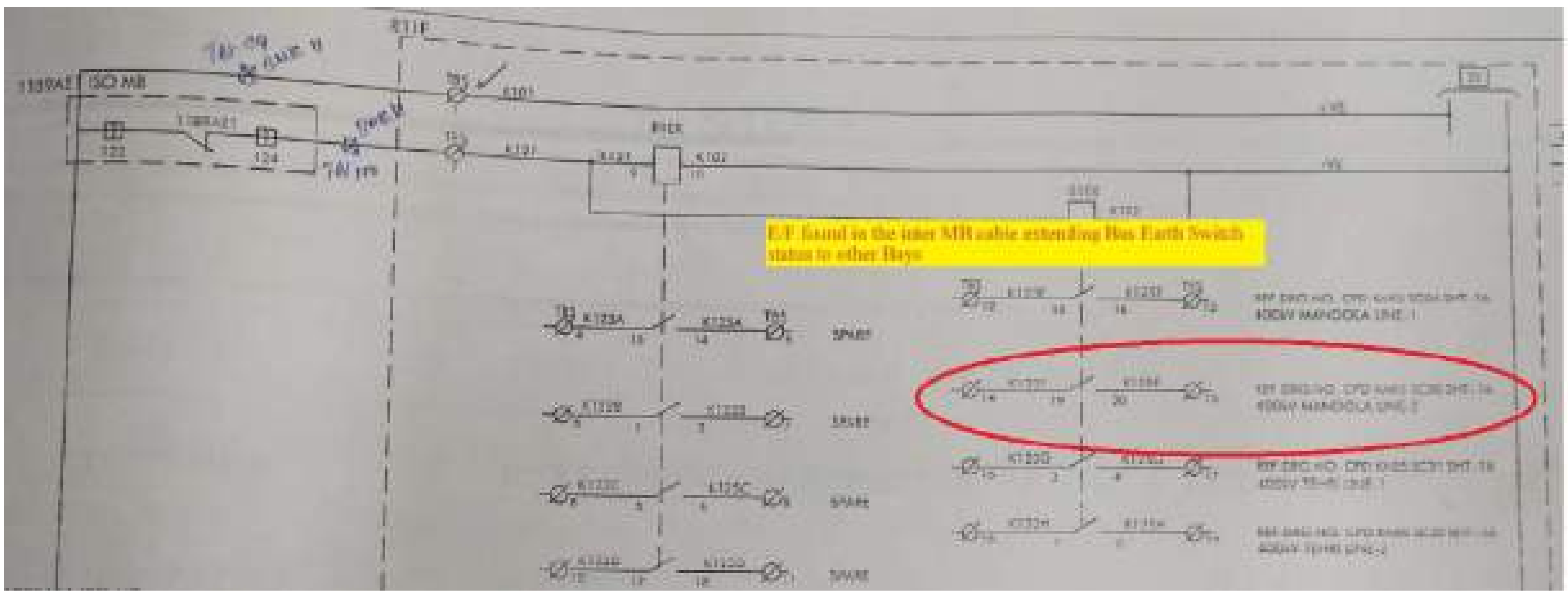
- The -ve supply to Isolator status CMR, which are extending isolator status to NTAMC, was given from the nearby bay panel from the same DC source. This causes the extension of same source DC to this feeder's MCB.

- Same was rectified and –ve of DC 1 was given from same feeder's supply.



Rectification of DC E/F in DCDB 1 Bay 409

- Earth Fault found in the Inter MB cable extending the status of Bus Earth Switch present in Bay 409 to other Bays. Same was replaced and DC EF was rectified.



Final DCDB voltages

- After rectification of DC earth fault and mixing, following voltages were recorded:

	DCDB 1		DCDB 2		Remarks
	+ve	-ve	+ve	-ve	
Voltages w.r.t ground	+ 124.4	-118.6	+ 123.4	- 120.1	No EF and Mixing in Both the DCDBs.

Thank You.. !!!

Multiple elements tripping at 400kV Uri-2(NH)

14th October 2023

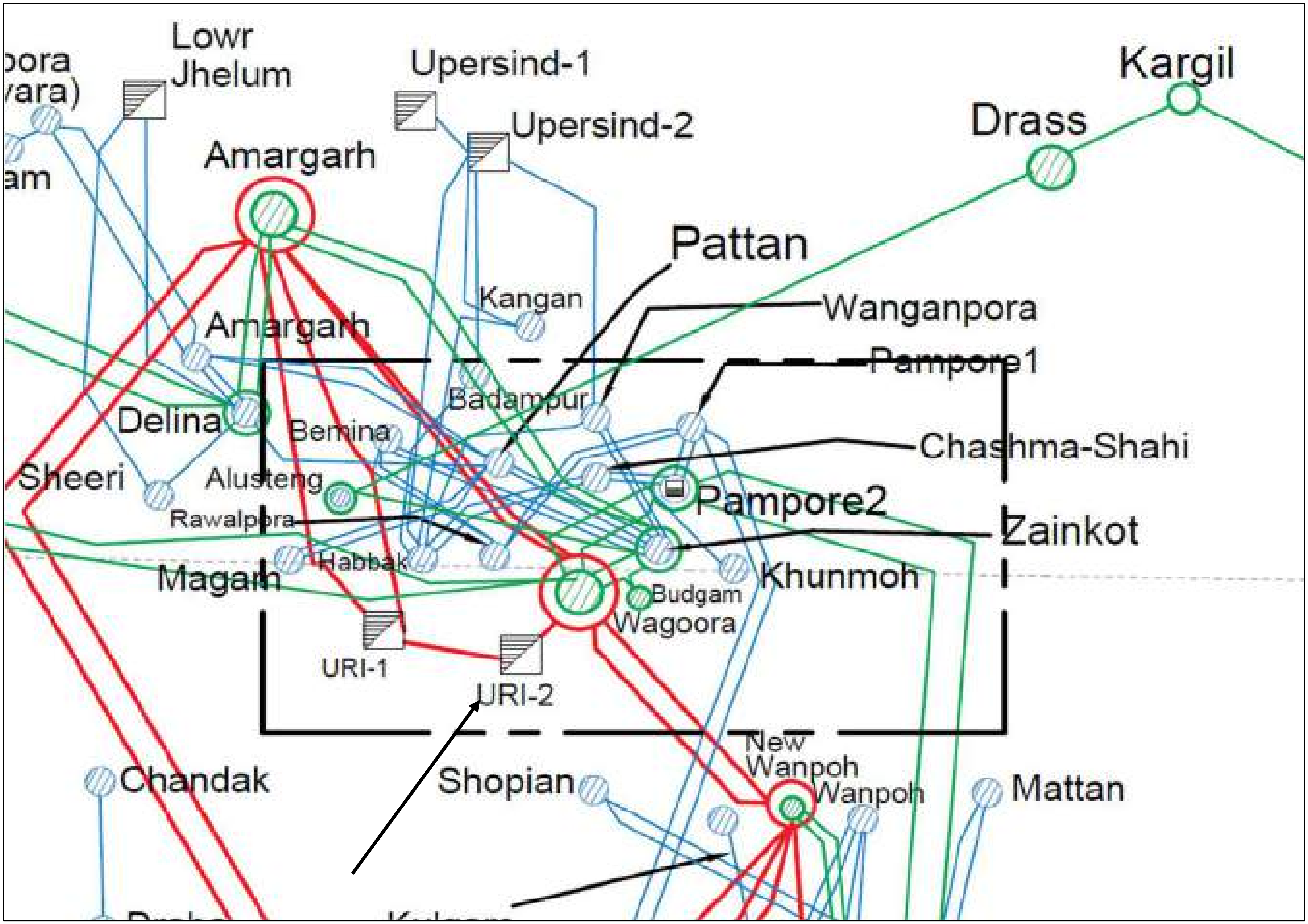
Brief of event:

- During antecedent condition, 60 MW Unit-2 & 3 at Uri-2(NH) were running and generating approx. 36MW each and total MW generation of 72MW was evacuating through 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt and 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt.
- As reported, at 04:23hrs, **400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt tripped on B-N phase to ground fault** with fault current of approx. 1.89kA and fault distance of 11.87km from Wagoora(PG) end due to heavy wind and storm in the area.
- As per DR, **400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt also tripped on B-N phase to ground fault at the same time with delayed fault clearance time of approx. 690ms** and fault current of approx. 2.53kA from Uri-2(NH) end. Over-current protection operated at both Uri-1(NH) and Uri-2(NH) end as per DR.
- Due to tripping of both the lines, 60 MW Unit-2 & 3 at Uri-2(NH) tripped on over-excitation due to loss of evacuation path.
- On this, complete blackout occurred at 400kV Uri-2(NH).
- As per PMU at Wanpoh(PG), two consecutive B-N phase to ground fault is observed in the system with delayed fault clearance time of 720ms and 440ms respectively.
- As per SCADA, generation loss of approx. 72MW is observed at Uri-2(NH).

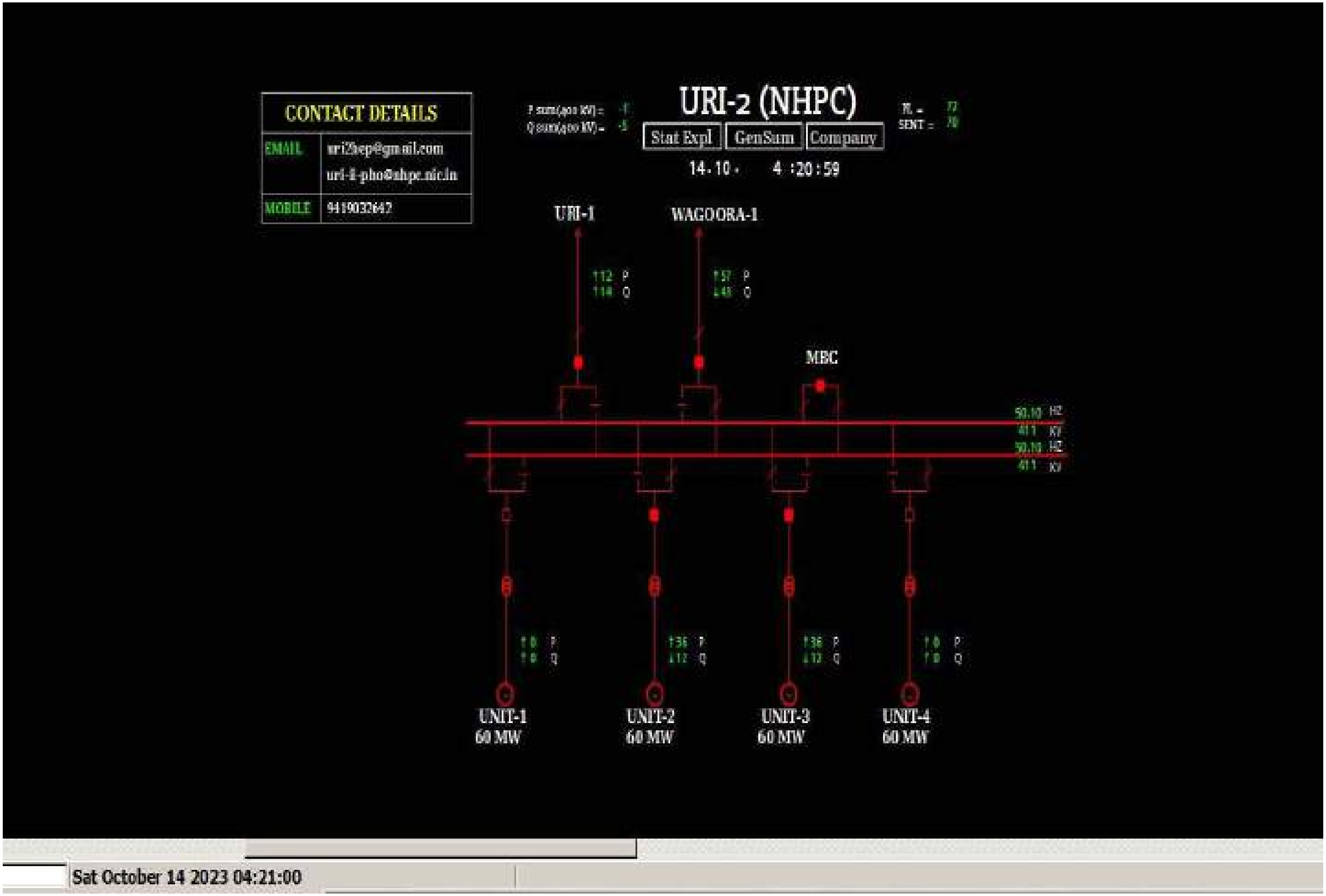
Elements tripped:

i. 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt
ii. 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt
iii. 60 MW Unit-2 at Uri-2(NH)
iv. 60 MW Unit-2 at Uri-3(NH)

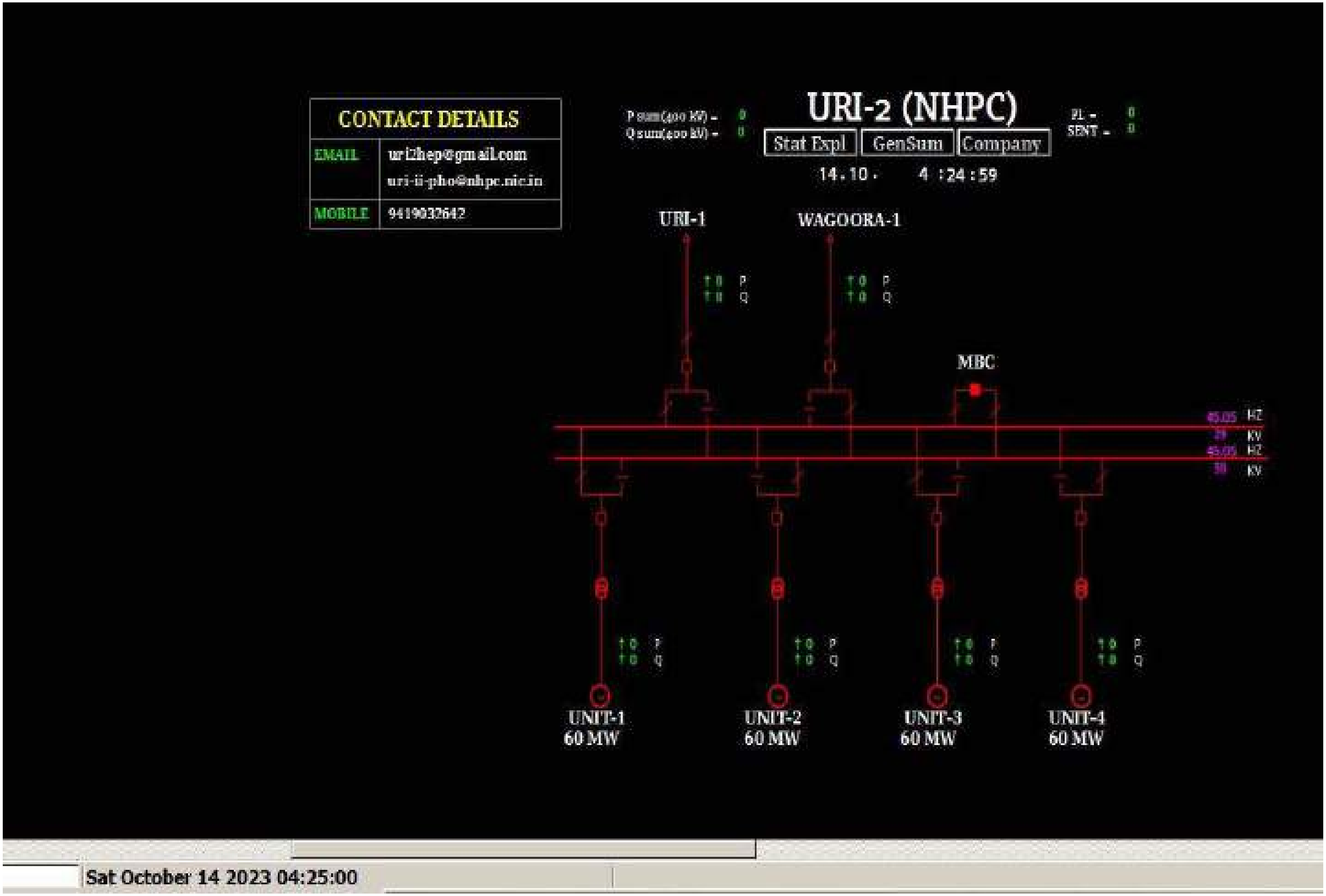
Network Diagram



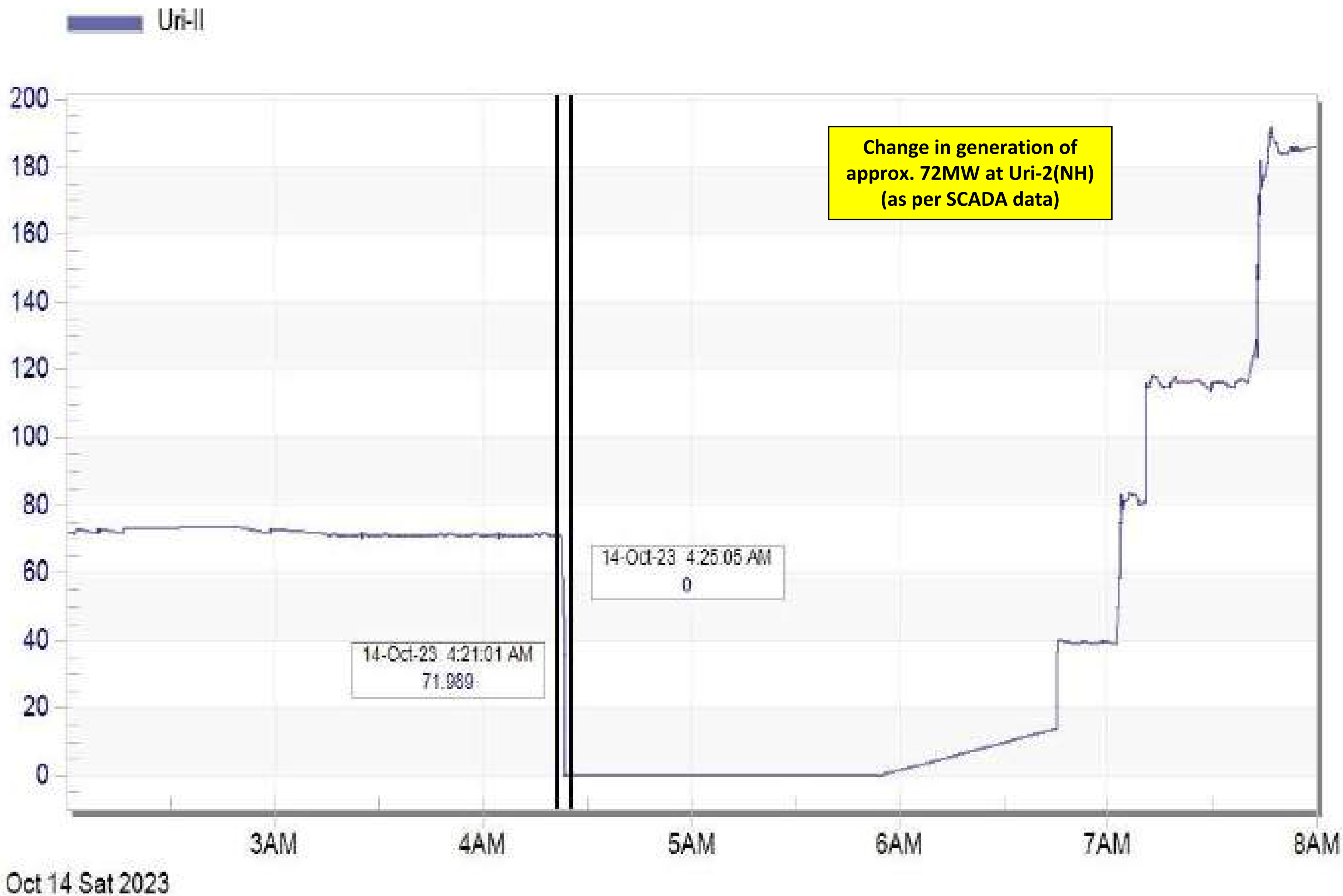
SLD of 400kV Uri-2(NH) before the event



SLD of 400kV Uri-2(NH) after the event



Uri-2(NH) generation during the event



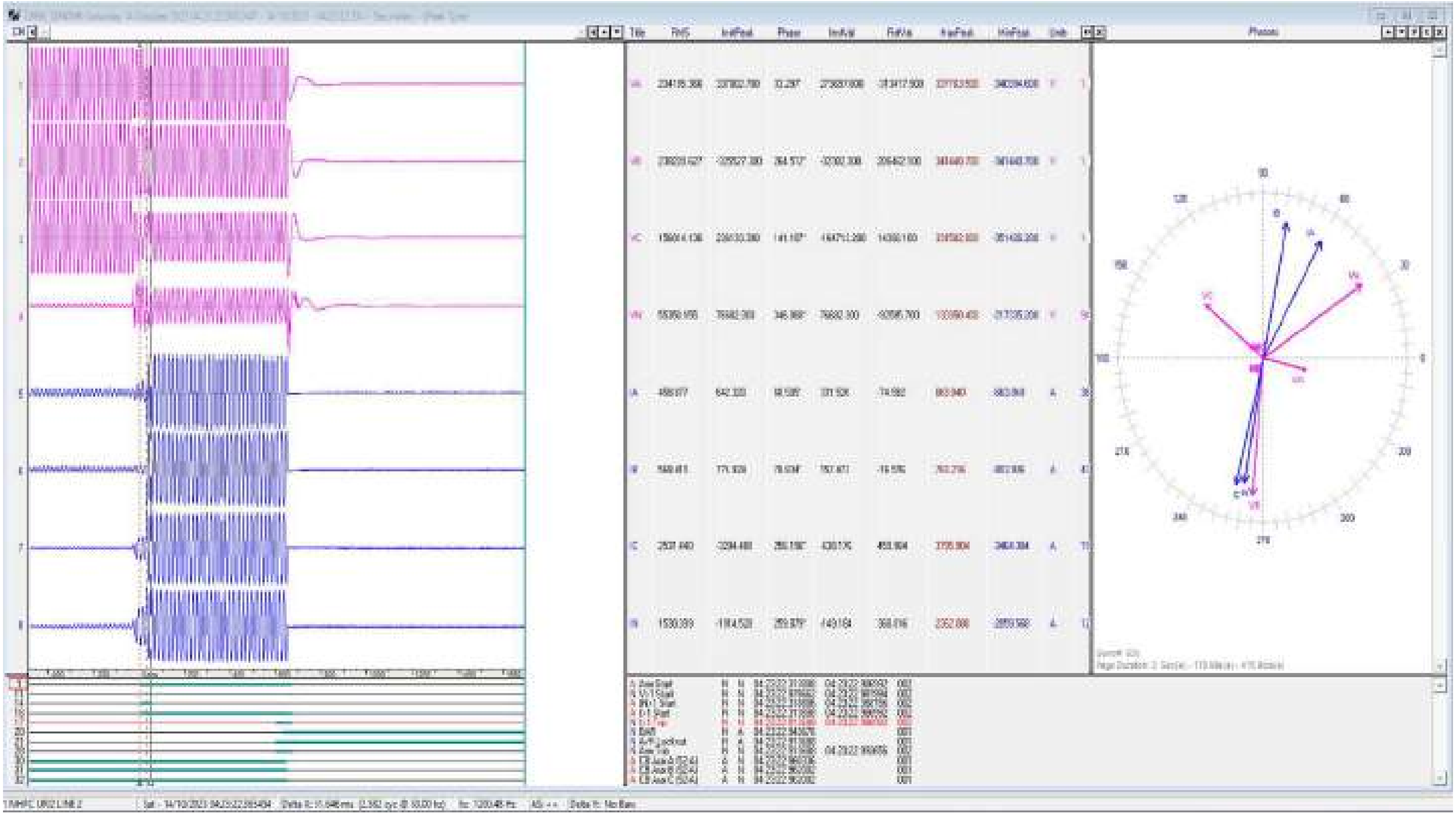
PMU Plot of frequency at Wanpoh(PG)

04:23hrs/14-Oct-23

PMU Plot of phase voltage magnitude at Wanpoh (PG)

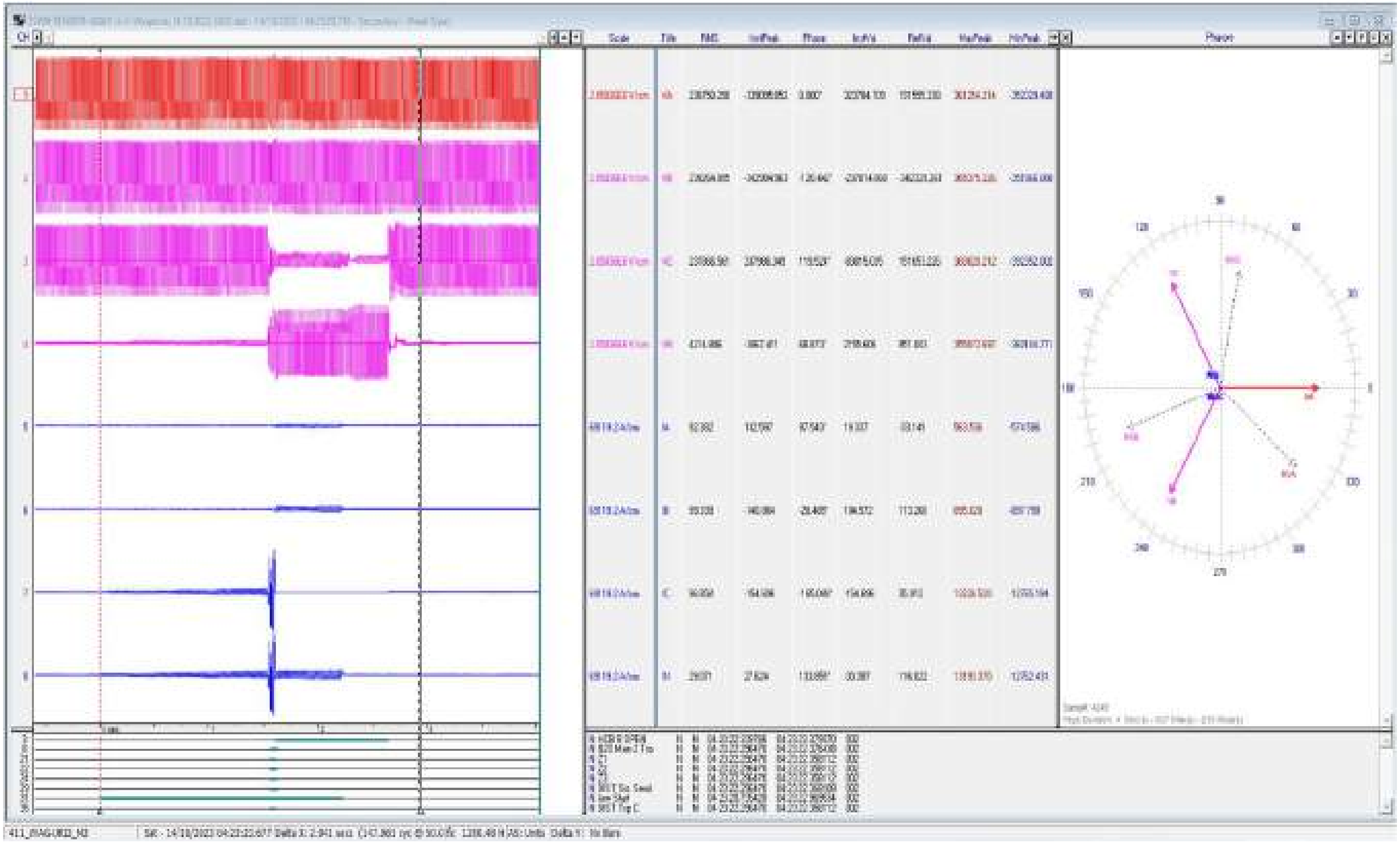
04:23hrs/14-Oct-23

DR of 400 KV Uri_2(NH) (end)-Uri_1(NH) (PG) Ckt



- ✓ B-N phase to earth fault; fault current=~2.53kA from Uri-2(NH) end
- ✓ Fault clearing time=~690ms
- ✓ Over-current protection operated

DR of 400 KV Uri_2(NH)-Wagoora(PG)(end) (PG) Ckt Ckt



- ✓ B-N phase to earth fault, Z-1, A/R started, delayed closing after A/R is observed,
- ✓ Tripped from Uri_2 end

SCADA SOE

Time	Station Name	Voltage(kV)	Element Name	Element Type	Element Status	Remark
04:23:26,856	URI2_NH	400kV	12URI1	Circuit Breaker	Open	Line CB at Uri-2(NH) end of 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt opened
04:23:26,907	URI2_NH	400kV	11SRING1	Circuit Breaker	Open	Line CB at Uri-2(NH) end of 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt opened
04:23:27,690	URI2_NH	400kV	02G2	Circuit Breaker	Open	CB at 400kV side of 60MW Unit-2 at Uri-2(NH) opened
04:23:27,710	URI2_NH	400kV	03G3	Circuit Breaker	Open	CB at 400kV side of 60MW Unit-3 at Uri-2(NH) opened

Point of discussion

i. According to Protection Philosophy of Northern region, no over-current protection should be applied on 400kV lines. Then why 400 KV Uri_2(NH)-Uri_1(NH) (PG) Ckt tripped on over-current protection operation?
ii. On which protection 400 KV Uri_2(NH)-Wagoora(PG) (PG) Ckt tripped from Uri_2 end?
iii. Reason of delayed clearance of fault need to be shared.
iv. DR/EL of all the tripped elements along with tripping report of the event need to be shared for both the ends for proper analysis of the event.
v. Remedial action taken report to be shared.

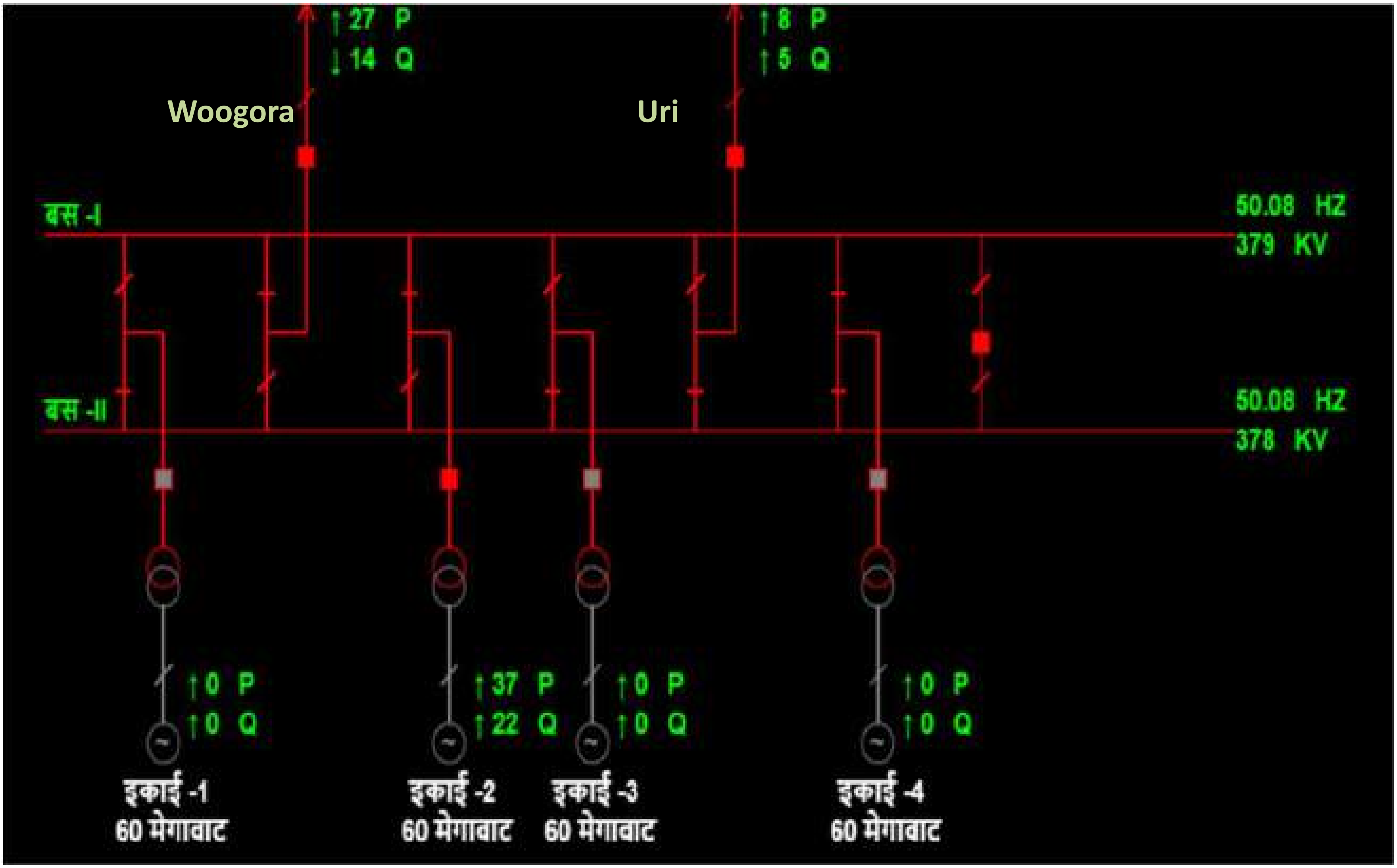
49th
PCC meeting of NRPC

NHPC Limited

Tripping at Point No.-11

Tripping of Two Lines & two running units of **Uri2 Power Station(NHPC)** at 04:23 hrs on 14-Oct-2023

SLD of Uri2 PS



Elements Tripped on 14/10/2023

क्रम सं	यूनिट / लाइन नाम	से		तक		कुल आउटेज समय	आउटेज के कारण	ऊर्जा नुकसान (मेगावाट)
		तारीख	समय	तारीख	समय			
1	400 KV Uri2-Woogora Line#1	14-Oct-23	4:23	14-Oct-23	6:37	2:14	Distance protection operated in Z2	0
2	400 KV Uri2-Uri Line#2	14-Oct-23	4:23	14-Oct-23	6:36	2:13	Over Current Protection operated	0
3	Unit#2	14-Oct-23	4:23	14-Oct-23	7:10	2:47	Over Speed Protection operated	35
4	Unit#3	14-Oct-23	4:23	14-Oct-23	15:27	11:04	Over Speed Protection operated	30

Detail Analysis

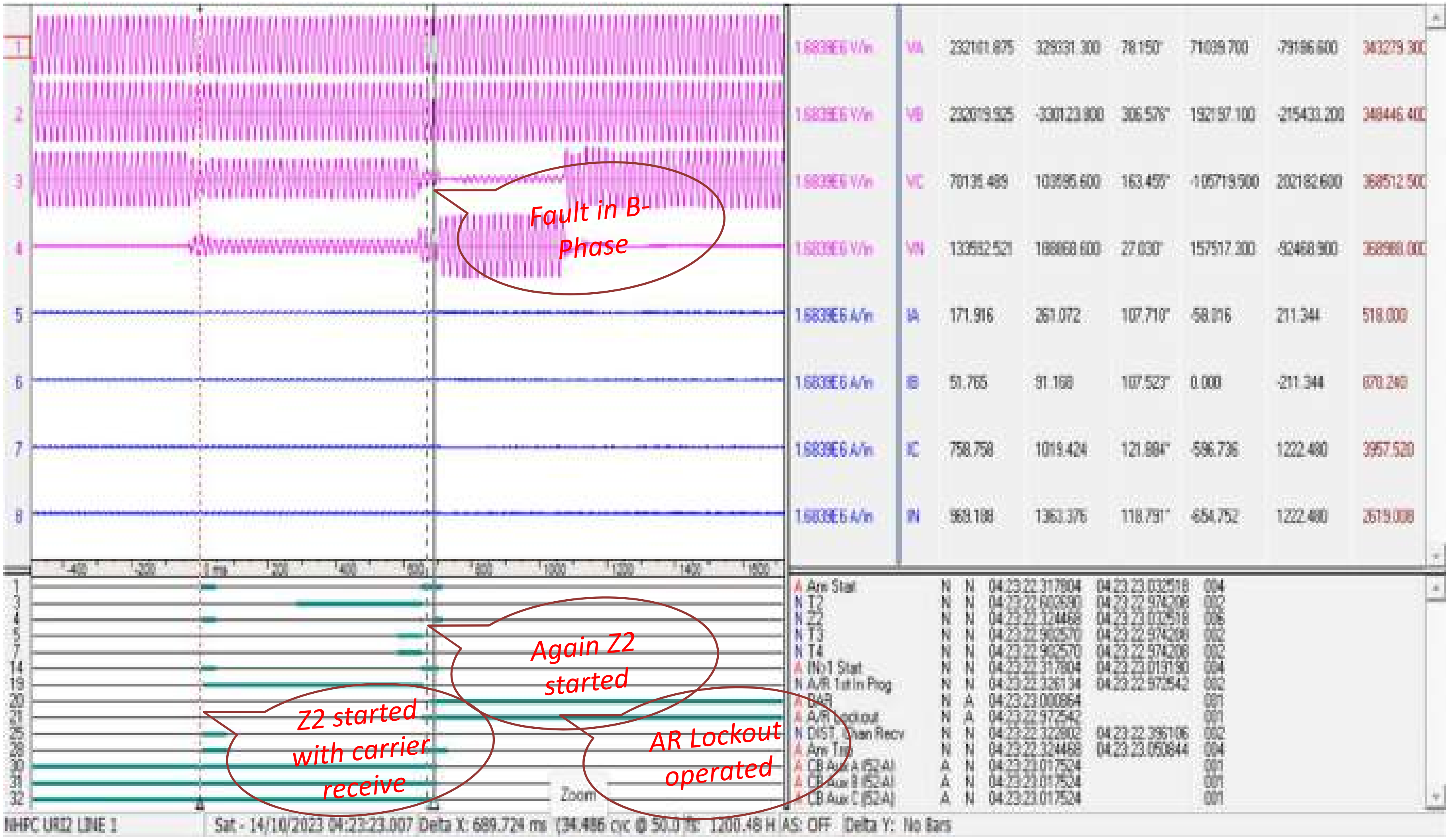
Uri2-Woogora Line#1:

1. Prior to event occurred at 04:23 Hrs, unbalanced current was observed in DR among all phases as transient fault was occurring since 04:11.09.785 Hrs.

2. Similarly at 04:23:22.320 Hrs Z2 protection started in B-Phase & carrier was received. It is evident from the DR of distance protection relay of Uri-Woogora ine#1 installed at Uri-2 end that B-Phase voltage reduced to 145 KV and B-phase current increased to 1176 A. Accordingly auto reclose operation was started from Main-1 relay, However B-Phase did not open from Uri2 end due to improper carrier aided protection implemented in PSL.

3. Subsequently, Z2 got resetted at 04:23:22.364 Hrs. Again Z2 started at 04:23:22.967 Hrs. As the auto reclose function was in progress, Z2 activation cause the blocking of auto reclose operation & three Phase tripping occurred at Uri2 end.

DR of Uri2-Woogora Line



EL of Uri2-Woogora Line

Saturday 14 October 2023 04:11:09.790	Logic Inputs 1
Saturday 14 October 2023 04:11:09.788	IN>1 Start OFF
Saturday 14 October 2023 04:11:09.788	Any Start OFF
Saturday 14 October 2023 04:11:09.785	Z3 OFF
Saturday 14 October 2023 04:11:09.785	Dist Start N OFF
Saturday 14 October 2023 04:11:09.785	DIST Start B OFF
Saturday 14 October 2023 04:11:09.785	DIST Fwd OFF
Saturday 14 October 2023 04:11:09.784	Z3 ON
Saturday 14 October 2023 04:11:09.784	Z2 OFF
Saturday 14 October 2023 04:11:09.735	Z2 ON
Saturday 14 October 2023 04:11:09.734	Logic Inputs 1
Saturday 14 October 2023 04:11:09.732	Logic Inputs 1
Saturday 14 October 2023 04:11:09.729	IN>1 Start ON
Saturday 14 October 2023 04:11:09.729	Dist Start N ON
Saturday 14 October 2023 04:11:09.729	DIST Start B ON
Saturday 14 October 2023 04:11:09.729	DIST Fwd ON
Saturday 14 October 2023 04:11:09.729	Any Start ON
Saturday 14 October 2023 04:11:08.887	Check Synch. OK ON
Saturday 14 October 2023 04:11:08.775	Fault Recorded
Saturday 14 October 2023 04:11:08.491	Check Synch. OK OFF
Saturday 14 October 2023 04:11:08.452	Logic Inputs 1
Saturday 14 October 2023 04:11:08.451	Logic Inputs 1
Saturday 14 October 2023 04:11:08.449	IN>1 Start OFF
Saturday 14 October 2023 04:11:08.449	Any Start OFF
Saturday 14 October 2023 04:11:08.446	DIST Fwd OFF
Saturday 14 October 2023 04:11:08.446	DIST Start B OFF
Saturday 14 October 2023 04:11:08.446	Dist Start N OFF
Saturday 14 October 2023 04:11:08.446	Z3 OFF
Saturday 14 October 2023 04:11:08.443	Z3 ON
Saturday 14 October 2023 04:11:08.443	Z2 OFF

Prior to Event Disturbance occurred on 04:11 Hrs

EL of Uri2-Woogora Line

Saturday 14 October 2023 04:23:22.967	Any Trip A ON
Saturday 14 October 2023 04:23:22.967	Any Trip B ON
Saturday 14 October 2023 04:23:22.967	3P Trip ON
Saturday 14 October 2023 04:23:22.967	Output Contacts1
Saturday 14 October 2023 04:23:22.967	IN>1 Start ON
Saturday 14 October 2023 04:23:22.767	Fault Recorded
Saturday 14 October 2023 04:23:22.407	Logic Inputs 1
Saturday 14 October 2023 04:23:22.405	Logic Inputs 1
Saturday 14 October 2023 04:23:22.402	A/R Trip 3P ON
Saturday 14 October 2023 04:23:22.400	1P Trip OFF
Saturday 14 October 2023 04:23:22.400	Any Trip C OFF
Saturday 14 October 2023 04:23:22.400	Any Int. Trip C OFF
Saturday 14 October 2023 04:23:22.400	Any Trip OFF
Saturday 14 October 2023 04:23:22.400	Any Int. Trip OFF
Saturday 14 October 2023 04:23:22.392	DIST UNB CR OFF
Saturday 14 October 2023 04:23:22.387	Logic Inputs 1
Saturday 14 October 2023 04:23:22.364	Any Start OFF
Saturday 14 October 2023 04:23:22.364	DIST Fwd OFF
Saturday 14 October 2023 04:23:22.364	DIST Trip C OFF
Saturday 14 October 2023 04:23:22.364	IN>1 Start OFF
Saturday 14 October 2023 04:23:22.364	Dist Start N OFF
Saturday 14 October 2023 04:23:22.364	Z2 OFF
Saturday 14 October 2023 04:23:22.364	DIST Start C OFF
Saturday 14 October 2023 04:23:22.322	AR Discrim. ON
Saturday 14 October 2023 04:23:22.322	A/R 1P In Prog ON
Saturday 14 October 2023 04:23:22.320	Any Int. Trip ON
Saturday 14 October 2023 04:23:22.320	DIST Trip C ON
Saturday 14 October 2023 04:23:22.320	Z2 ON
Saturday 14 October 2023 04:23:22.320	Any Trip ON
Saturday 14 October 2023 04:23:22.320	Any Trip C ON
Saturday 14 October 2023 04:23:22.320	1P Trip ON
Saturday 14 October 2023 04:23:22.320	Any Int. Trip C ON
Saturday 14 October 2023 04:23:22.319	Logic Inputs 1
Saturday 14 October 2023 04:23:22.319	DIST UNB CR ON
Saturday 14 October 2023 04:23:22.317	Logic Inputs 1
Saturday 14 October 2023 04:23:22.314	DIST Fwd ON

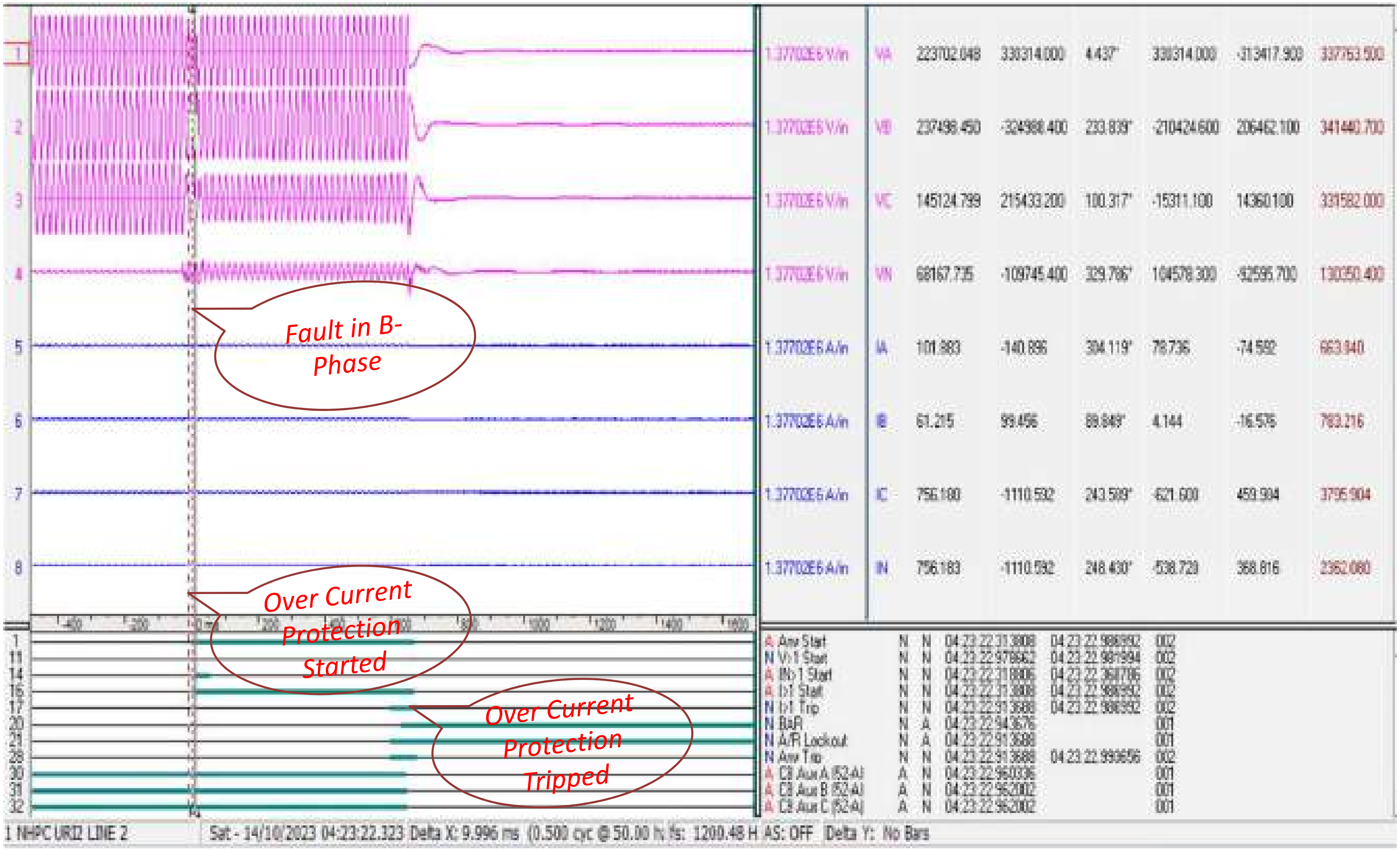
During event occurred on 04:23 Hrs

Detail Analysis

Uri2-Uri Line#2:

1. The Fault occurred in Uri2-Woogora Line#1 cause the voltage dip to 147 KV and increse in current to 701 Amp in B-Phase of Uri2-Uri Line#2. Accordingly as per existing scheme, over current protection started at 04:23:22.318 Hrs and tripped after time delay of 600 msec.
2. Present over current setting is:- Non directional, 510 Amp, 600 msec.

DR of Uri2- Uri Line



EL of Uri2-Uri Line

Saturday 14 October 2023 04:23:22.969	I> Start Any B OFF
Saturday 14 October 2023 04:23:22.959	All Pole Dead ON
Saturday 14 October 2023 04:23:22.958	Any Pole Dead ON
Saturday 14 October 2023 04:23:22.958	CB Aux C ON
Saturday 14 October 2023 04:23:22.958	CB Aux B ON
Saturday 14 October 2023 04:23:22.956	CB Aux A ON
Saturday 14 October 2023 04:23:22.953	Logic Inputs 1
Saturday 14 October 2023 04:23:22.951	Logic Inputs 1
Saturday 14 October 2023 04:23:22.934	Logic Inputs 1
Saturday 14 October 2023 04:23:22.909	General Alarm ON
Saturday 14 October 2023 04:23:22.909	Any Int. Trip ON
Saturday 14 October 2023 04:23:22.909	A/R Trip 3P ON
Saturday 14 October 2023 04:23:22.909	A/R Lockout ON
Saturday 14 October 2023 04:23:22.909	I>1 Trip ON
Saturday 14 October 2023 04:23:22.909	Any Trip ON
Saturday 14 October 2023 04:23:22.909	Any Int. Trip A ON
Saturday 14 October 2023 04:23:22.909	AR Lockout Shot> ON
Saturday 14 October 2023 04:23:22.909	Any Int. Trip C ON
Saturday 14 October 2023 04:23:22.909	Any Trip A ON
Saturday 14 October 2023 04:23:22.909	Any Trip B ON
Saturday 14 October 2023 04:23:22.909	Any Trip C ON
Saturday 14 October 2023 04:23:22.909	3P Trip ON
Saturday 14 October 2023 04:23:22.909	Output Contacts1
Saturday 14 October 2023 04:23:22.909	Any Int. Trip B ON
Saturday 14 October 2023 04:23:22.365	IN>1 Start OFF
Saturday 14 October 2023 04:23:22.363	I> Start Any B ON
Saturday 14 October 2023 04:23:22.315	IN>1 Start ON
Saturday 14 October 2023 04:23:22.310	I>1 Start ON
Saturday 14 October 2023 04:23:22.310	I> Start Any C ON
Saturday 14 October 2023 04:23:22.310	Any Start ON
Saturday 14 October 2023 04:11:10.230	Check Synch. OK ON

Over Current Protection Tripped

Over Current Protection Started

Prior to Event Disturbance occurred on 04:23 Hrs

Detail Analysis

<u>Units:-.</u>

Due to unviability of power evacuation path, the two running units i.e. Unit#2 & Unit#3 got tripped on operation of over speed protection. Present over current setting is:- Non directional, 510 Amp, 600 msec.

Detail Analysis

<u>Units:-.</u>

Due to unviability of power evacuation path, the two running units i.e. Unit#2 & Unit#3 got tripped on operation of over speed protection. Present over current setting is:- Non directional, 510 Amp, 600 msec.

Remedial Action Taken

- After analysis of the event, it was observed was not properly configured for carrier aided Z2 scheme. The PSL has been modified and being implemented during ongoing maintenance.

Thanks

Multiple elements tripping at 220kV Sikandra(Agra2)(UP)

22nd October 2023

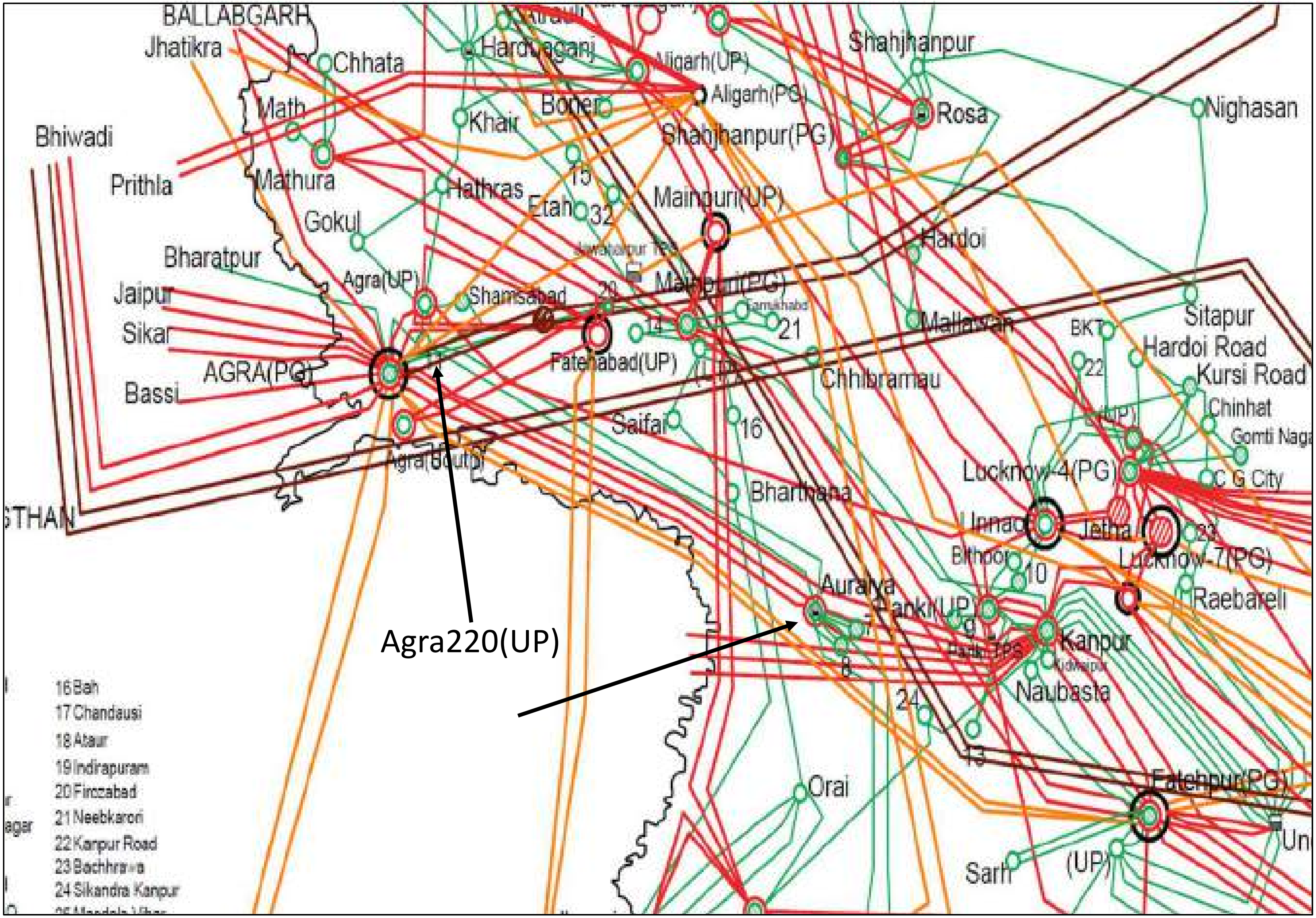
Brief of event:

- 220/132kV Sikandra (Agra2) (UP) S/s has double main transfer bus scheme at 220kV level. However, during antecedent condition, all the elements were connected to 220kV Bus-1 only. 220kV Bus-2 and transfer were not in service consition.
- As reported, at 06:00 hrs, 220 KV Auraiya(NT)-Agra2(UP) (PG) Ckt-1&2 tripped. At the same time, bus bar protection of 220kV Bus-1 at 220kV Agra2(UP) operated and as all eleemnts at Agra2(UP) were connected to 220kV Bus-1 only, all 220kV element at Agra2(UP) tripped. Details related to exact location and nature of fault yet to be received from UP.
- As per PMU at Agra(PG), B-N phase to earth fault with unsuccessful A/R operation is observed. As per SCADA SOE at NRLDC, it seems that A/R operation occurred in 220kV Agra1(UP)-Agra2(UP) ckt-1. UP has been communicated to share the DR/EL to ascertain the exact sequence of the event.
- Due to tripping of 220kV Bus-1, supply to 132kV side of Sikandra (Agra2) (UP) also lost which resulted into total blackout of 220/132kV Sikandra (Agra2) (UP) S/s.
- As per SCADA, change in demand of approx. 100MW is observed in UP control area.

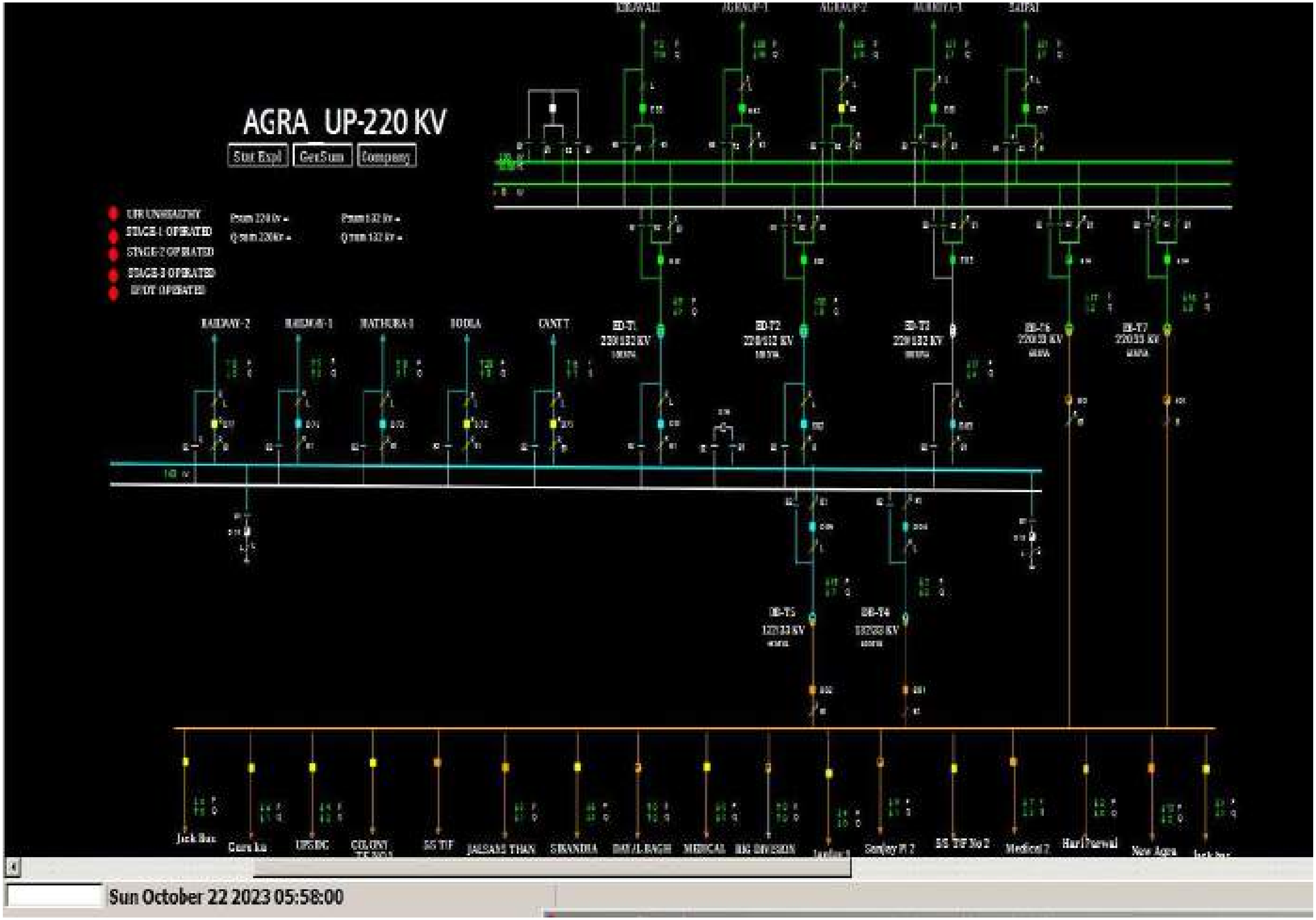
Elements tripped:

i. 220 KV Auraiya(NT)-Agra2(UP) (PG) Ckt-1
ii. 220 KV Auraiya(NT)-Agra2(UP) (PG) Ckt-2
iii. 220kV Agra1(UP)-Agra2(UP) Ckt-1
iv. 220kV Agra1(UP)-Agra2(UP) Ckt-2
v. 220kV Agra2(UP)-Kirawali Ckt
vi. 220/132kV 160MVA ICT-1 at Agra2(UP)
vii. 220/132kV 160MVA ICT-2 at Agra2(UP)
viii. 220/132kV 100MVA ICT-3 at Agra2(UP)
ix. 220/33kV 60MVA ICT-6 at Agra2(UP)

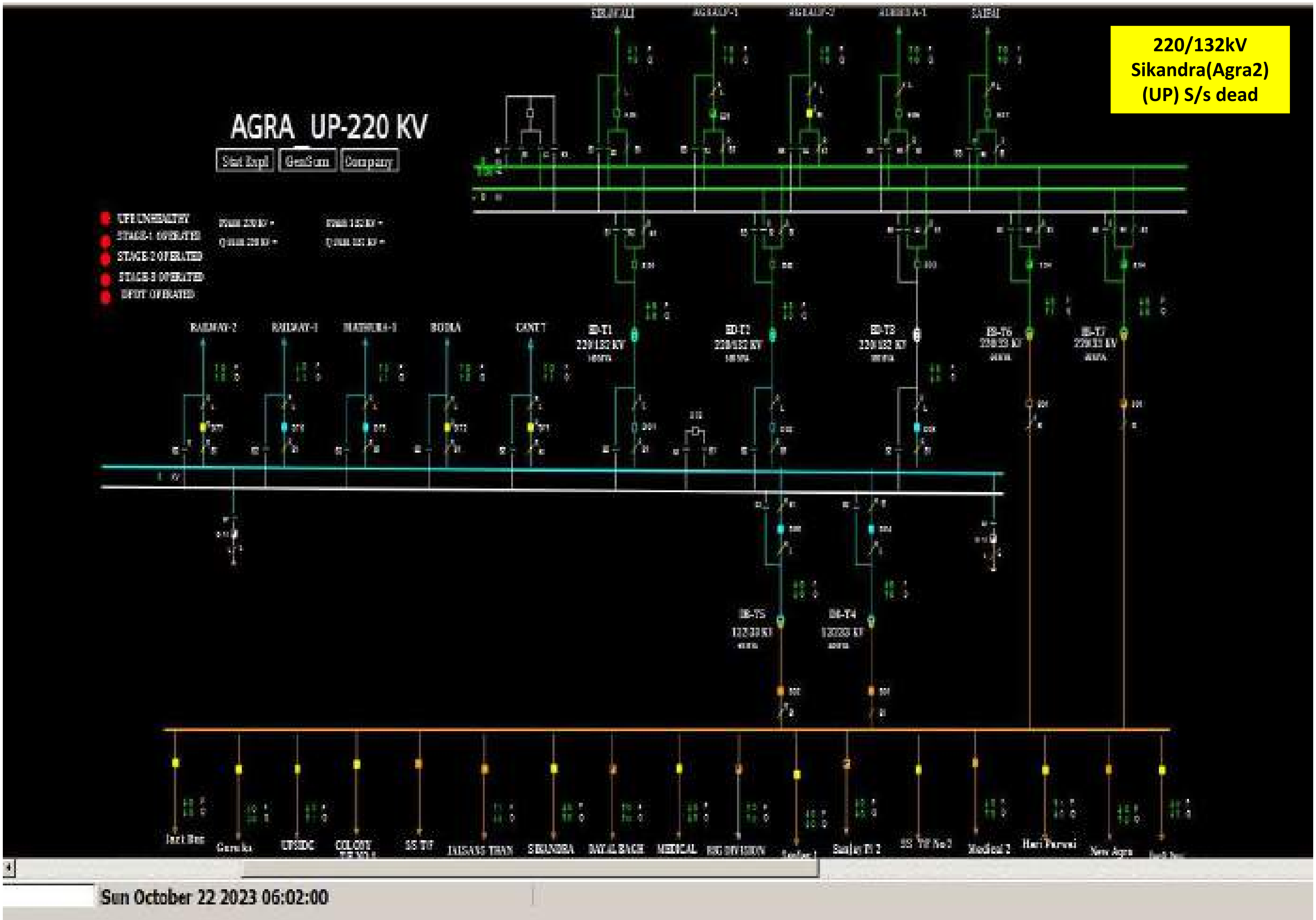
Network Diagram



SLD of 220/132kV Sikandra(Agra2)(UP) before the event

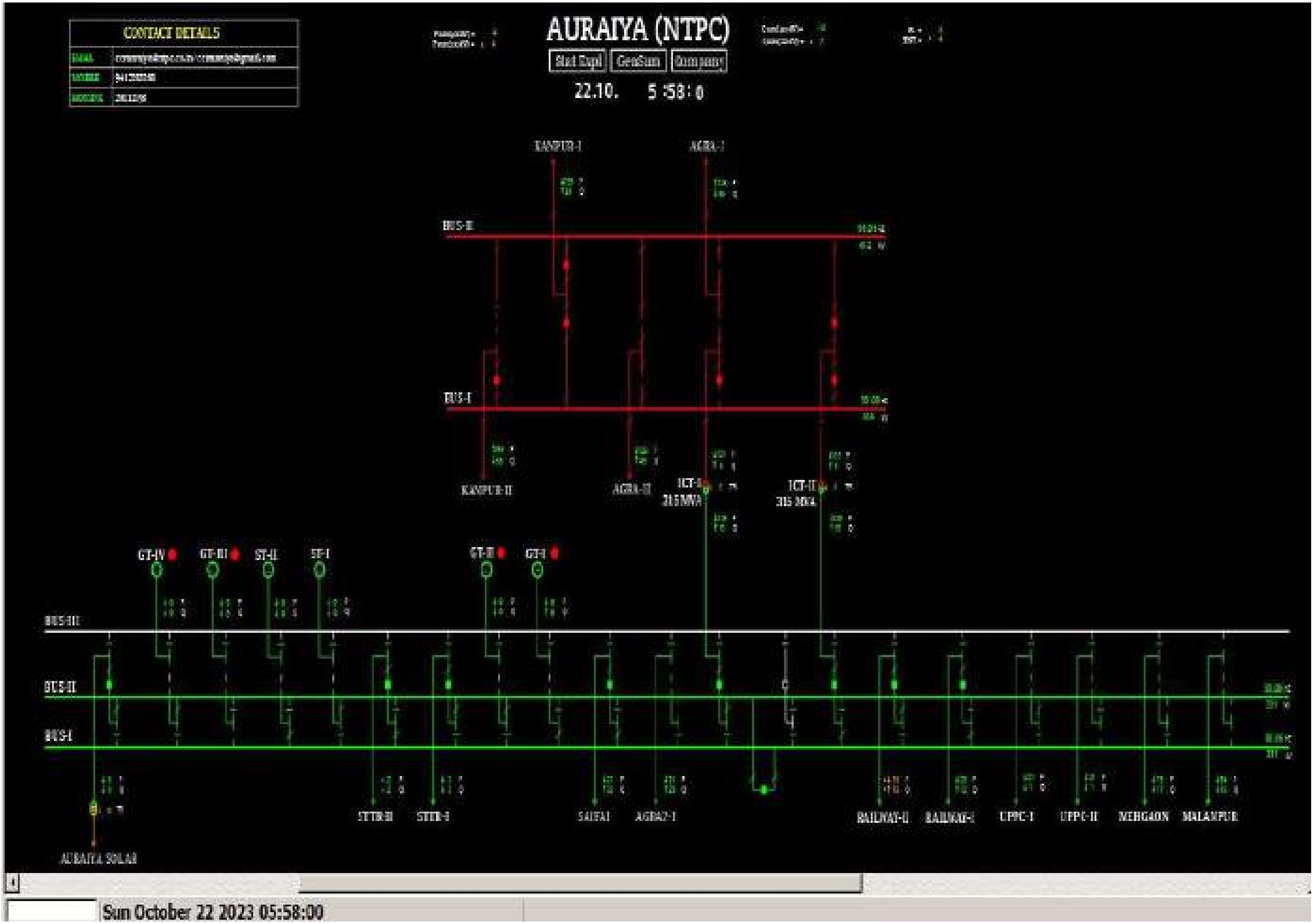


SLD of 220/132kV Sikandra(Agra2)(UP) after the event

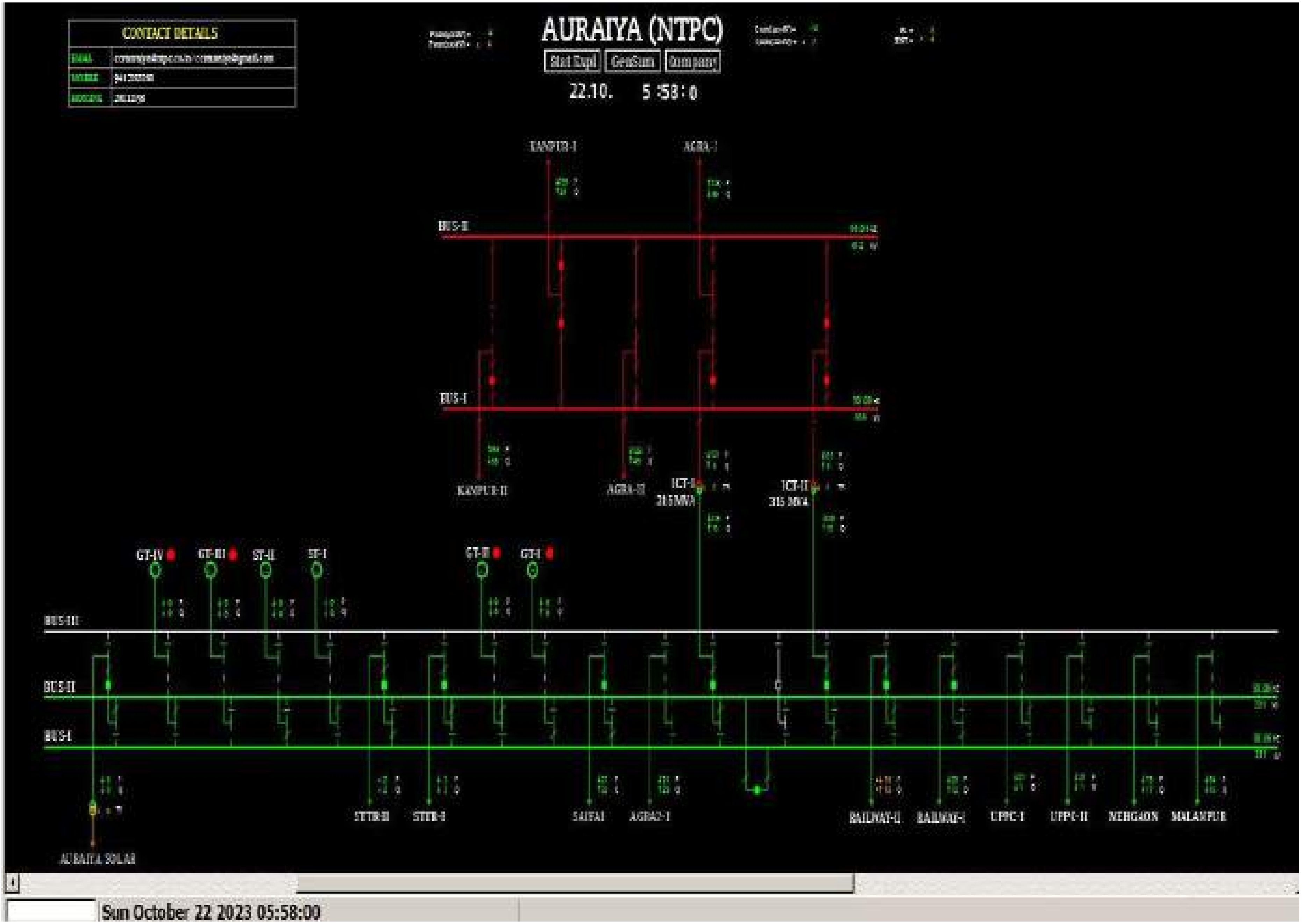


220/132kV Sikandra(Agra2) (UP) S/s dead

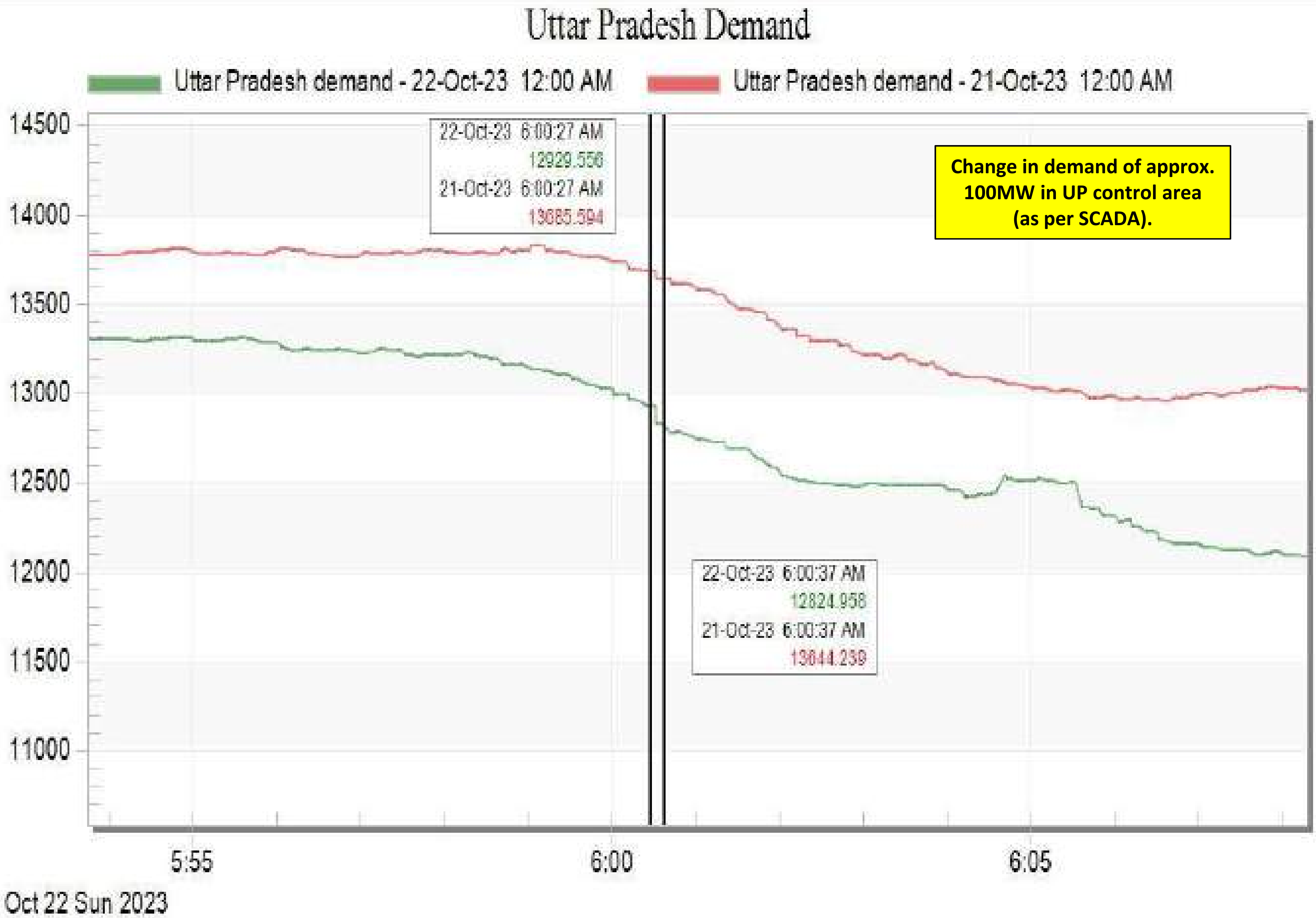
SLD of 400/220kV Auraiya(NTPC) before the event



SLD of 400/220kV Auraiya(NTPC) after the event



Uttar Pradesh demand during the event



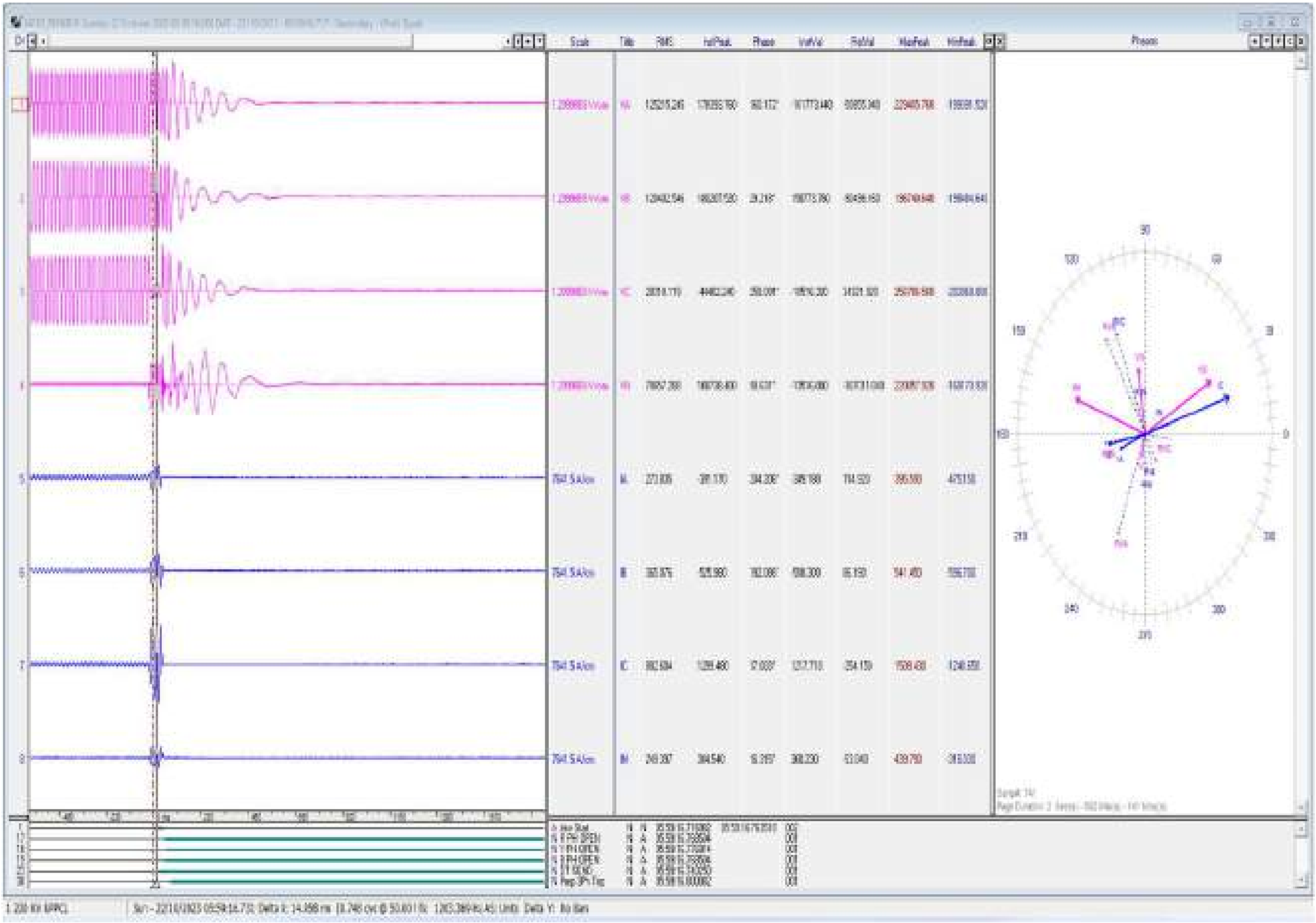
PMU Plot of frequency at Agra(PG)

06:00 hrs/22-Oct-23

PMU Plot of phase voltage magnitude at Agra(PG)

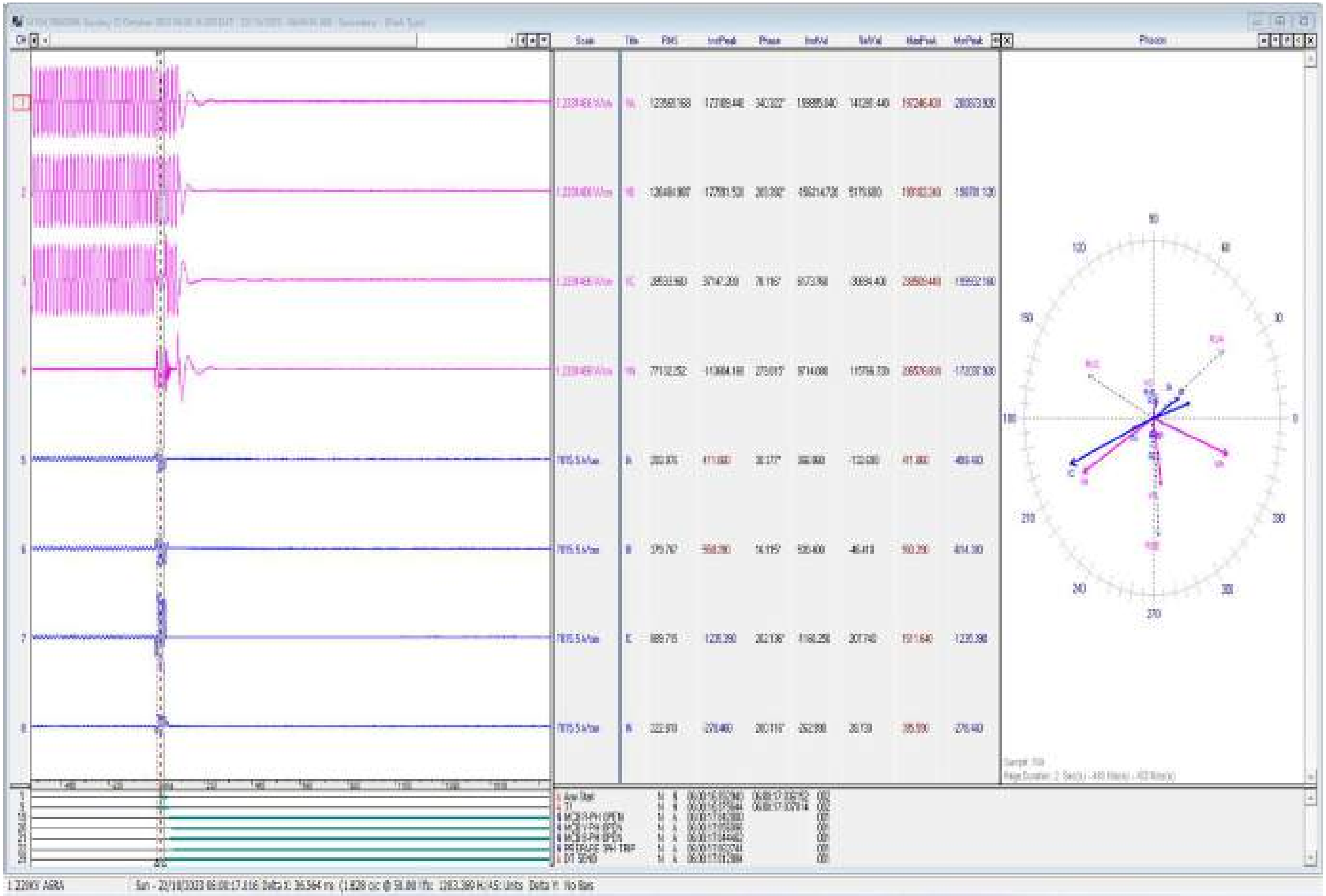
06:00 hrs/22-Oct-23

DR of 220 KV Auraiya(NT)-Agra2(UP)(end) (PG) Ckt-1



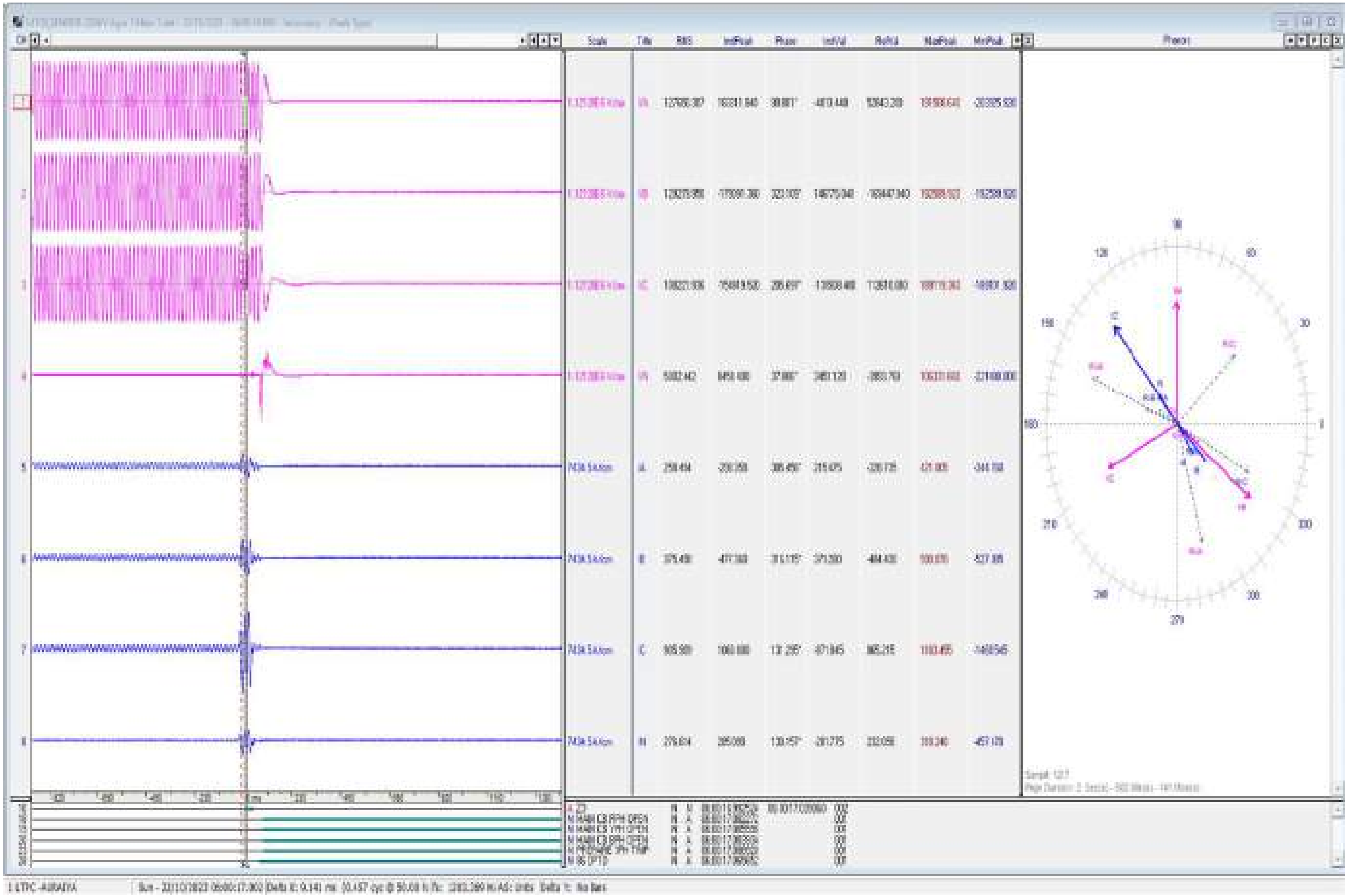
B-N fault, DT send is observed

DR of 220 KV Auraiya(NT)-Agra2(UP)(end) (PG) Ckt-2



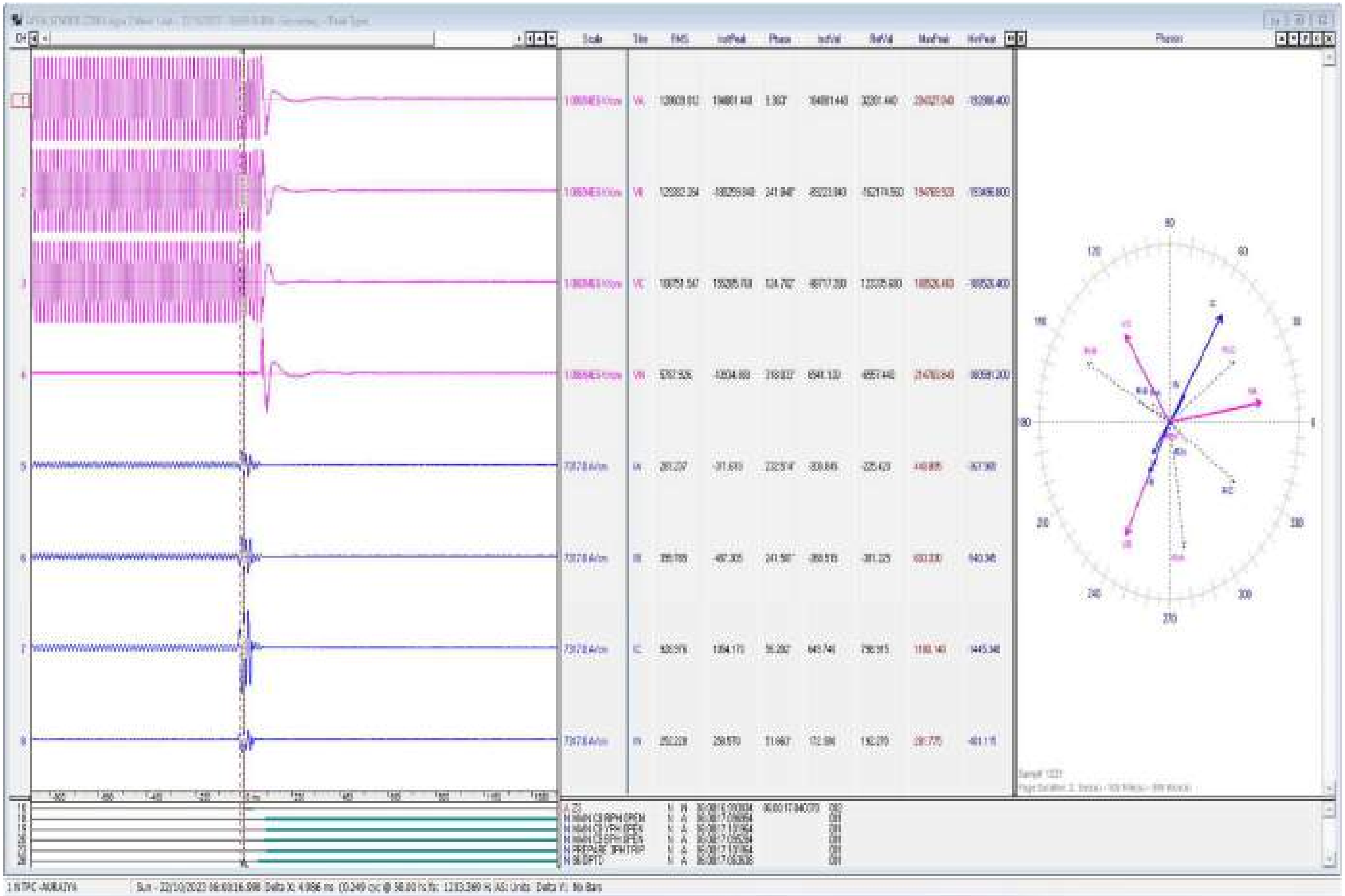
B-N fault, DT send is observed

DR of 220 KV Auraiya(NT)(end)-Agra2(UP) (PG) Ckt-1



B-N fault, Z-3, three phase trip

DR of 220 KV Auraiya(NT)(end)-Agra2(UP) (PG) Ckt-2



B-N fault, Z-3, three phase trip

SCADA SOE

Time	Station Name	Voltage	Element Name	Element Type	Element Status	Remarks
06:00:16,854	AURAIYA	220kV	14AGRA21	Circuit Breaker	Open	Line CB at Auraiya end of 220kV Agra2(Sikandra)-Auraiya ckt-1 opened
06:00:16,868	AURAIYA	220kV	13AGRA22	Circuit Breaker	Open	Line CB at Auraiya end of 220kV Agra2(Sikandra)-Auraiya ckt-2 opened
06:00:16,976	AGRA2_UP	220kV	85BC	Circuit Breaker	Open	Bus coupler breaker at Agra2(Sikandra) opened
06:00:16,981	AGRA2_UP	220kV	02T2	Circuit Breaker	Open	CB at 220kV side of 220/132kV 160MVA ICT-2 at Agra2(Sikandra) opened
06:00:16,984	AGRA2_UP	220kV	03T3	Circuit Breaker	Open	CB at 220kV side of 220/132kV 100MVA ICT-3 at Agra2(Sikandra) opened
06:00:16,998	AGRA2_UP	220kV	86AURIY1	Circuit Breaker	Open	Line CB at Agra2(Sikandra) end of 220kV Agra2(Sikandra)-Auraiya ckt-1 opened
06:00:17,004	AGRA2_UP	220kV	83KIRAW	Circuit Breaker	Open	Line CB at Agra2(Sikandra) end of 220kV Agra2(Sikandra)-Kirawali ckt opened
06:00:17,005	AGRA2_UP	220kV	87AURIY2	Circuit Breaker	Open	Line CB at Agra2(Sikandra) end of 220kV Agra2(Sikandra)-Auraiya ckt-2 opened
06:00:17,012	AGRA2_UP	220kV	01T1	Circuit Breaker	Open	CB at 220kV side of 220/132kV 160MVA ICT-1 at Agra2(Sikandra) opened
06:00:17,407	AGRA1_UP	220kV	09AGRA21	Circuit Breaker	Open	Line CB at Agra400(UP) end of 220kV Agra2(Sikandra)-Agra400(UP) ckt-1 opened
06:00:17,524	AGRA2_UP	220kV	81AGRA11	Circuit Breaker	disturbe	Line CB at Agra2(Sikandra) end of 220kV Agra2(Sikandra)-Agra400(UP) ckt-1 opened
06:00:17,524	AGRA2_UP	220kV	88T7	Circuit Breaker	disturbe	
06:00:17,911	AGRA1_UP	220kV	09AGRA21	Circuit Breaker	Close	Line CB at Agra400(UP) end of 220kV Agra2(Sikandra)-Agra400(UP) ckt-1 closed
06:00:17,963	AGRA1_UP	220kV	09AGRA21	Circuit Breaker	Open	Line CB at Agra400(UP) end of 220kV Agra2(Sikandra)-Agra400(UP) ckt-1 opened

Point of discussion

i. Exact location and nature of fault?
ii. Why did bus bar protection operate at 220kV Agra2(UP)?
iii. Why did 220kV Bus-2 and transfer bus at Agra-2(Sikandra) were not in service?
iv. DR/EL of all the elements need to be shared for both the ends.
v. Exact sequence of the event need to be shared.
vi. Remedial action taken report need to be shared.

Multiple elements tripping at 400kV Dadri TPS & Dadri HVDC

On 04th November, 2023

at 04:03:05hrs

Tripped Elements

<table>
<tr><th>S. No</th><th>Name of Elements</th><th>Outage Time</th><th>Revival Time</th><th>Reason of tripping</th></tr>
<tr><td>1.</td><td>400 KV Dadri(NT)-Mandola(PG) (PG) Ckt-1</td><td colspan="2">Not tripped</td><td>B-N fault, successful A/R</td></tr>
<tr><td>2.</td><td>400 KV Dadri(NT)-Mandola(PG) (PG) Ckt-2</td><td rowspan="5">04:03 hrs</td><td>06:33 hrs</td><td>Tripped on over voltage</td></tr>
<tr><td>3.</td><td>400 KV Dadri(NT)-Loni Harsh Vihar(DV) (NT) Ckt-2</td><td>07:40 hrs</td><td>DT received at Dadri end</td></tr>
<tr><td>4.</td><td>490 MW Dadri-II TPS - UNIT 2</td><td>10:44 hrs</td><td>Turbine vibration protection</td></tr>
<tr><td>5.</td><td>500 kV HVDC Rihand-Dadri (PG) Ckt-1</td><td>05:48 hrs</td><td rowspan="2">Pole blocked due to tripping of filter banks on over voltage</td></tr>
<tr><td>6.</td><td>500 kV HVDC Rihand-Dadri (PG) Ckt-2</td><td>05:50 hrs</td></tr>
</table>

Antecedent Condition

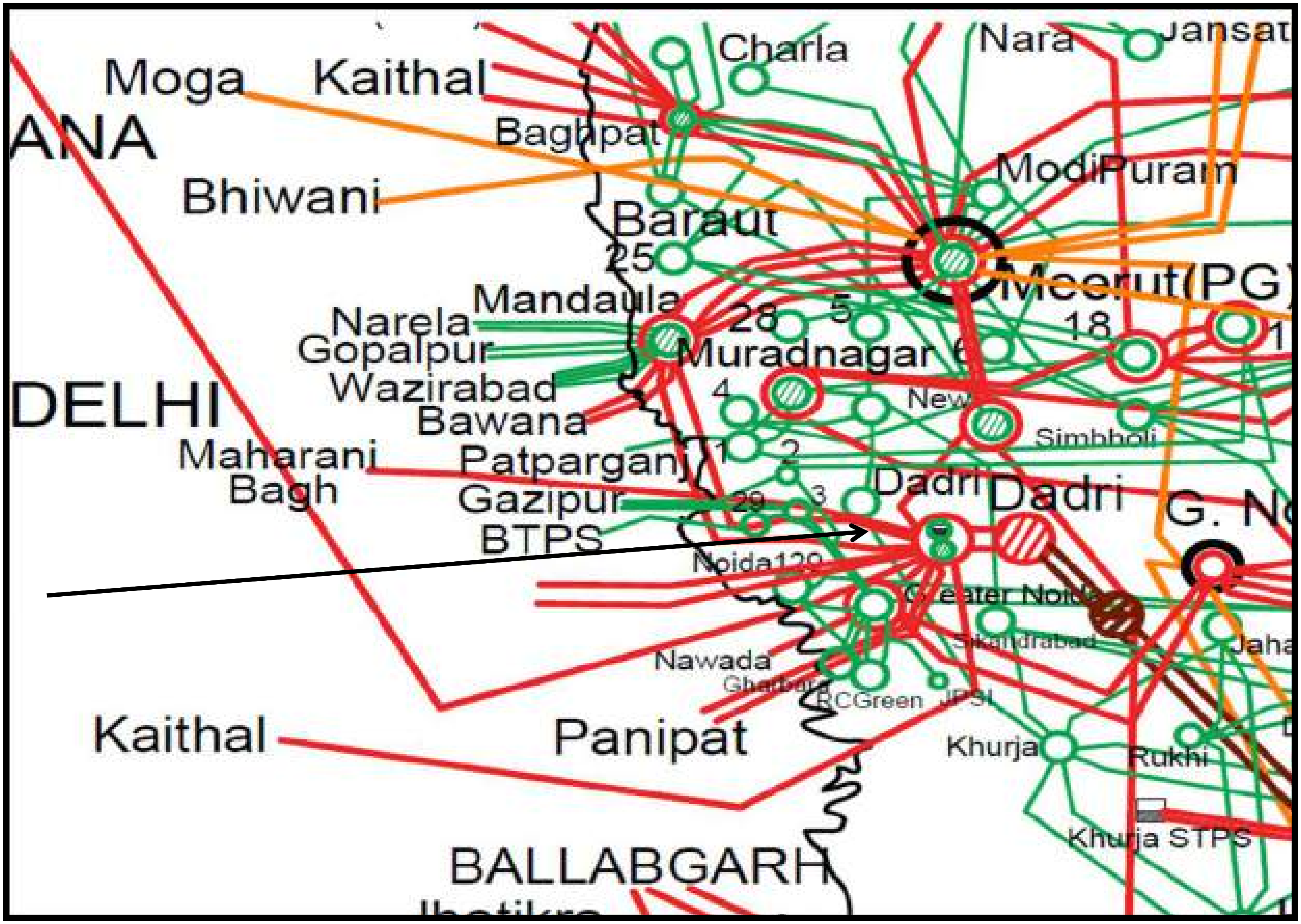
- NR Load : 39273 MW
- Affected state load(UP) : 13123 MW
- Frequency : 50.10 Hz
- Weather condition : Normal
- IR exchange : 8786 MW

- 400kV Dadri TPS(NTPC) has one and half breaker bus scheme. There are 04 buses at 400kV side. Bus-I, II and Bus III, IV are separated via interconnector. 490MW Unit-5&6 are connected at Bus-III, IV side.
- During antecedent condition, interconnectors were in opened condition. 490MW Unit-5 was not running and 490MW Unit-6 was generating approx. 455MW. HVDC Rihand-Dadri Bipole was carrying total ~600MW.

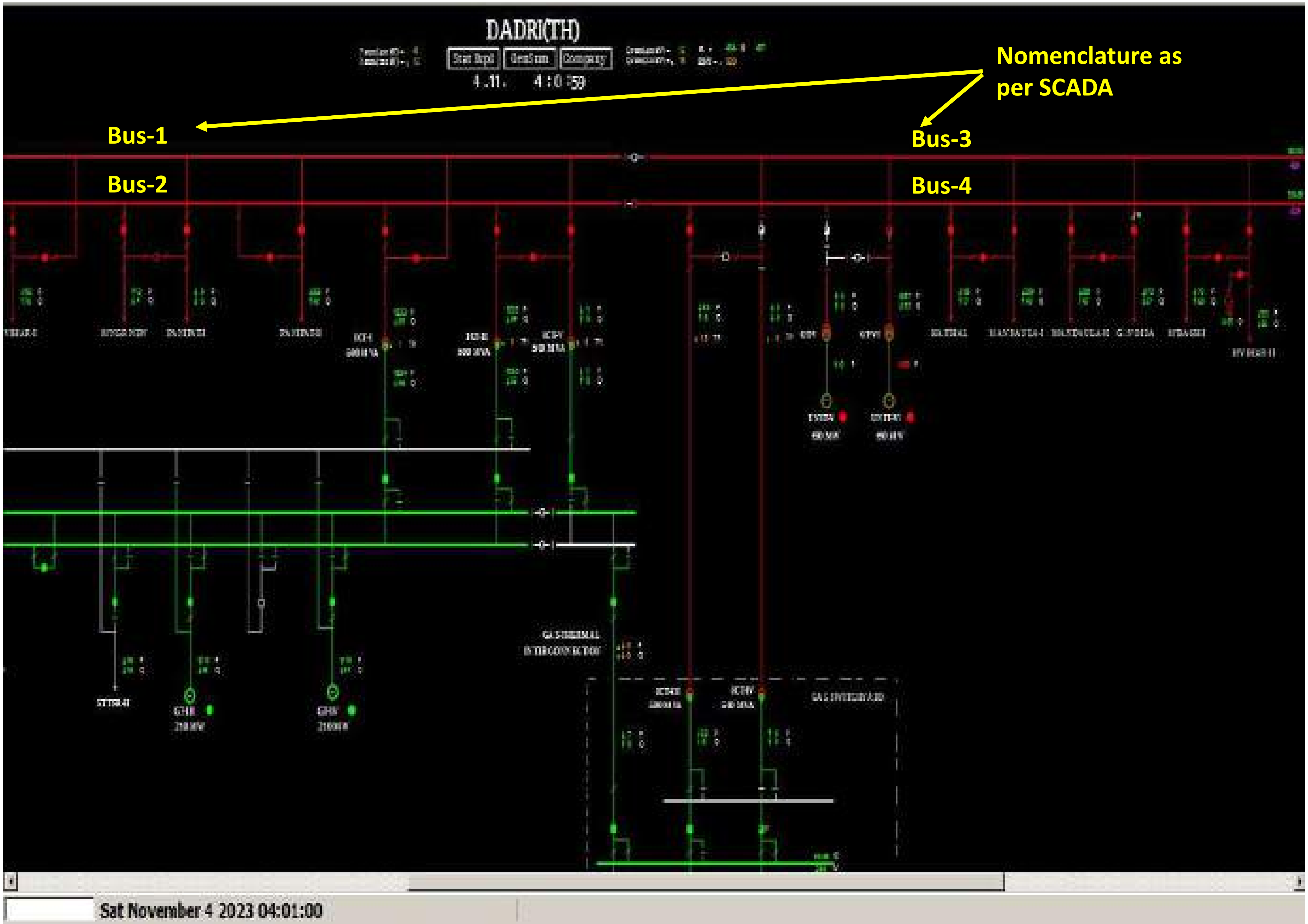
Sequence of event(as per SCADA SOE, DR, PMU and details received)

- **At 04:03:05:240hrs:** B-N phase to earth fault occurred on 400kV Dadri-Mandola ckt-1. Fault distance was approx. 100meter from Dadri TPS end. This fault was sensed by both the ends in Z-1. After ~160msec (08 cycles) of fault, B-ph pole of CB at both then ends opened and A/R started. Further after ~1sec (dead time), line successfully autoreclosed due to transient nature of fault.
- As per PMU & DR of 400kV Dadri-Mandola ckt-1, B-N phase to earth fault with successful A/R operation is observed. Steady state fault current was approx. 35kA, during transient fault current magnitude was ~52kA.
- **At 04:03:05:292hrs:** commutation failure at HVDC Rihand-Dadri occurred and power order dropped to zero (0).
- **At 04:03:05:300hrs:** Distance protection relay at Harshvihar end of 400kV Dadri-Harshvihar ckt-2 sensed the fault on 400kV Dadri-Mandola ckt in Z-1 and successful autoreclosed from Harshvihar end. Dadri end relay sensed fault in Z-4 as fault was in reverse direction however as informed by Dadri, instant three phase tripping occurred on DT received from Harshvihar end.
- **At 04:03:05:320hrs:** All three filter banks at Dadri HVDC tripped on overvoltage protection. As reported by POWERGRID, setting of over voltage protection of filter banks is 489.89kV with 20msec pickup time delay.
- **At 04:03:05:327hrs:** Rihand-Dadri HVDC Bipole blocked due to filter tripping.
- **At 04:03:05:440hrs:** 400kV Dadri-Mandola ckt-2 tripped on over voltage stage-2 protection operation at Dadri end.
- **After approx. 1sec of fault:** 490MW Unit-6 at Dadri TPS tripped on turbine high vibration protection (spikes were observed in all Turbine Shaft & pedestal vibration points; **protection setting:** Turbine protection acts on high vibration if any two out of 14 points goes above 300 microns for more than 01 sec)

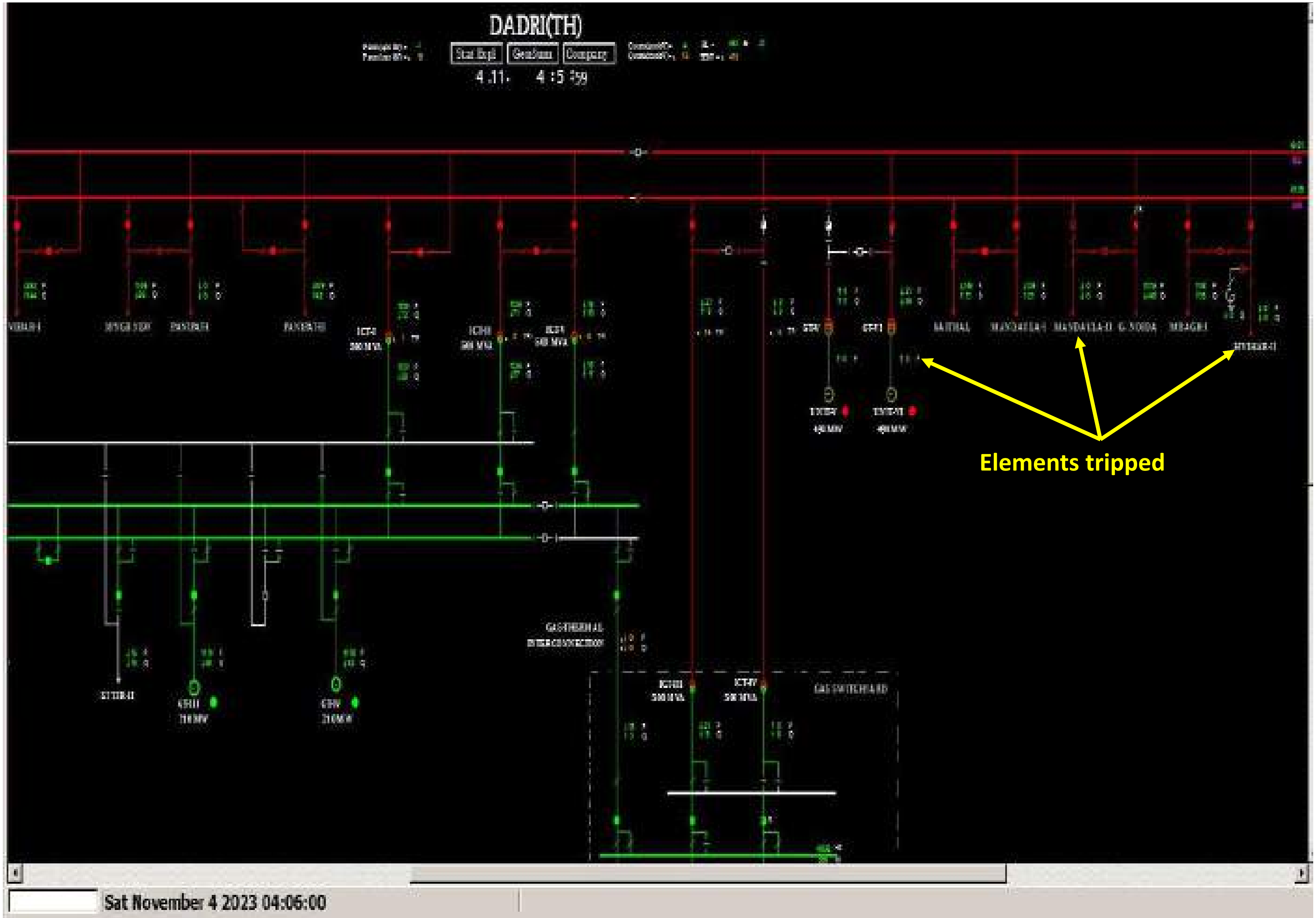
Network Diagram



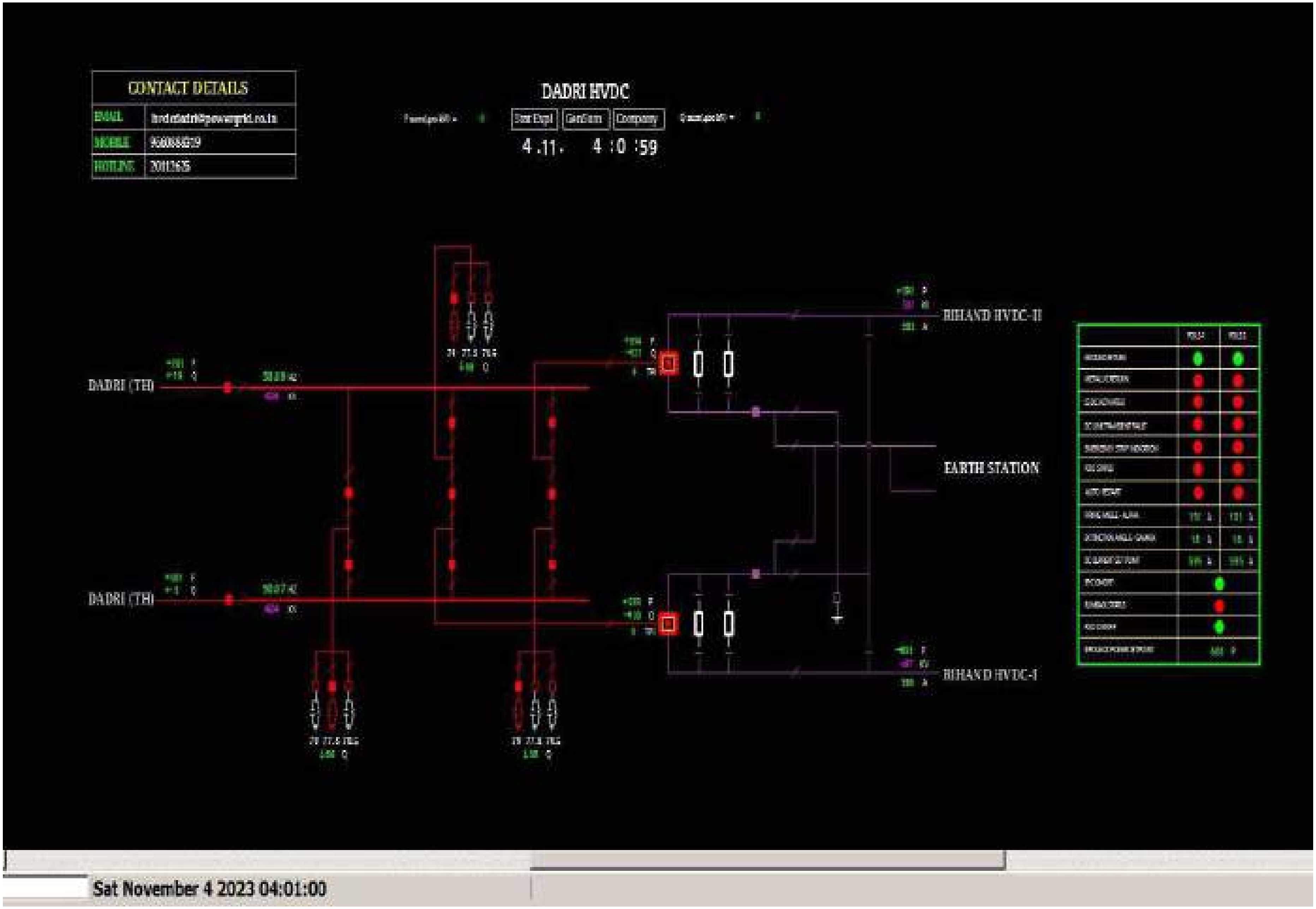
SLD of 400/220kV Dadri TPS(NTPC) before the event



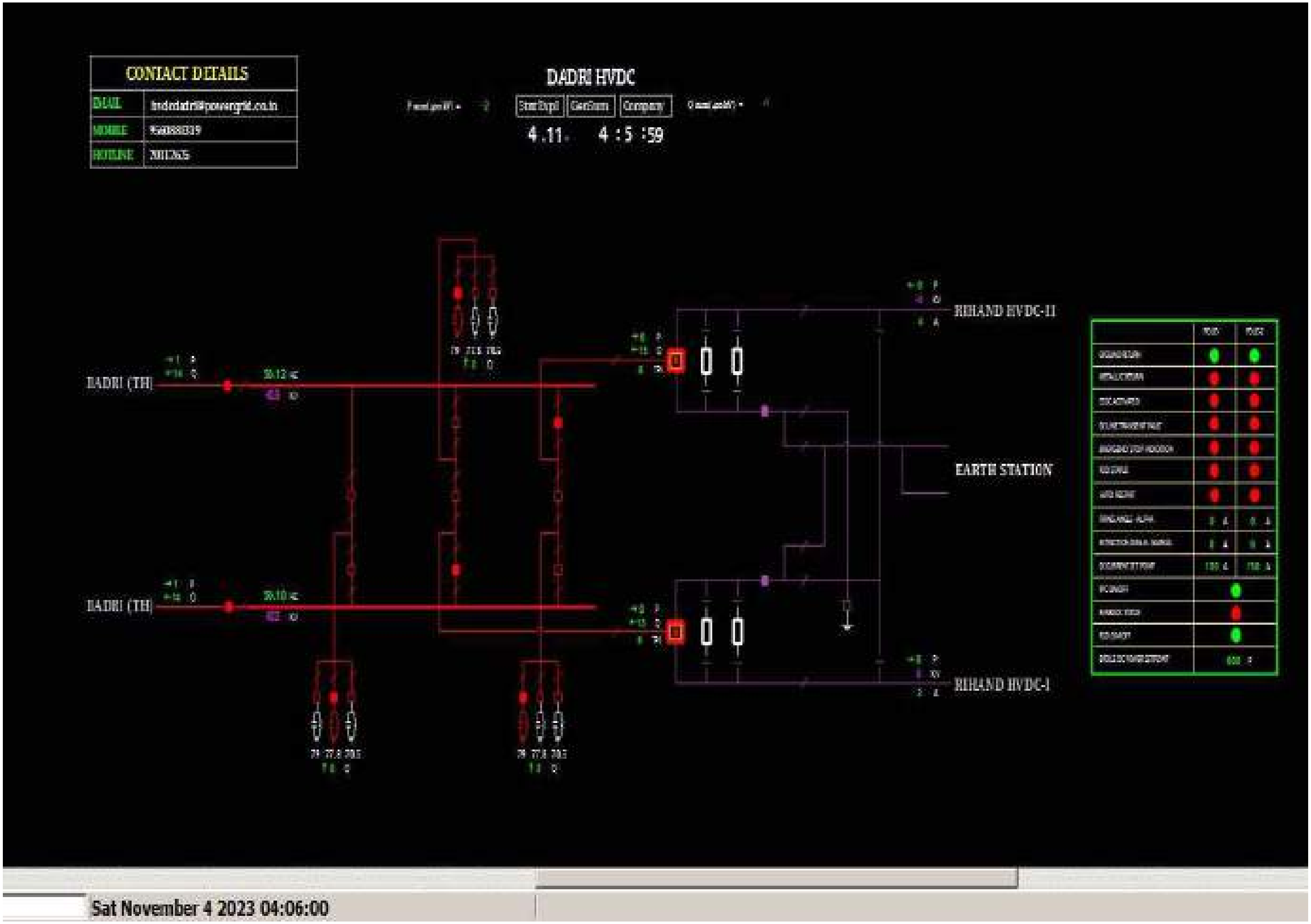
SLD of 400/220kV Dadri TPS(NTPC) after the event



SLD of Dadri HVDC before the event



SLD of Dadri HVDC after the event

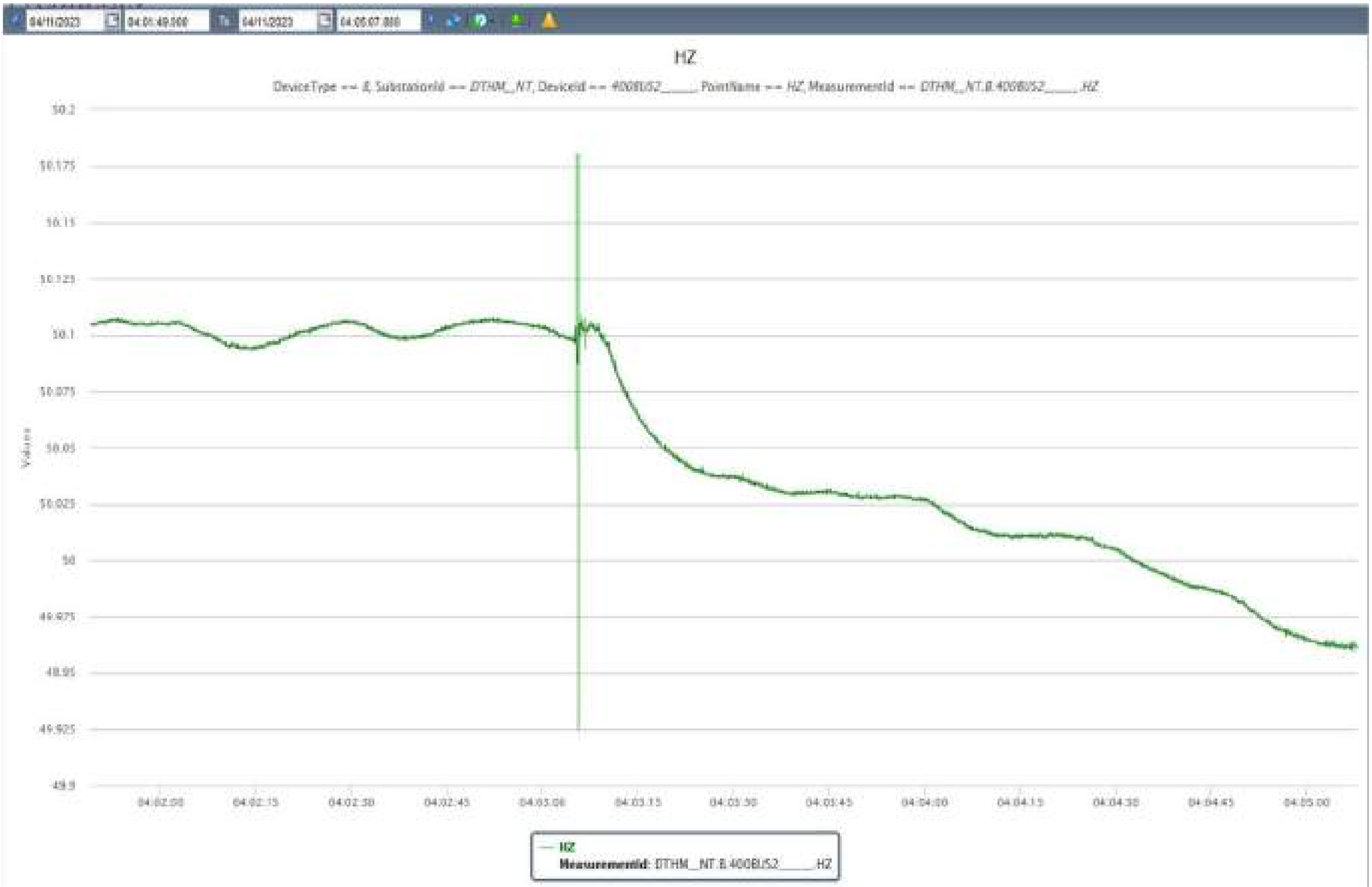


PMU Plot of MW loading of 500kV HVDC Rihand-Dadri ckt-1&2

04:03hrs/04-Nov-23

PMU Plot of frequency at Dadri Thermal(NTPC)

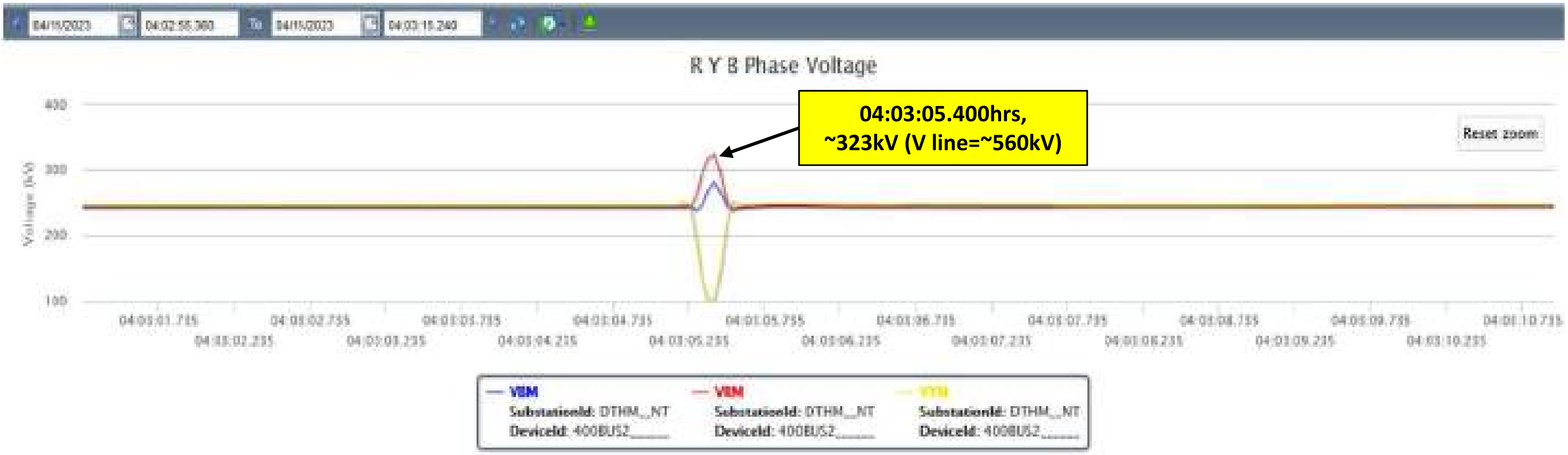
04:03hrs/04-Nov-23

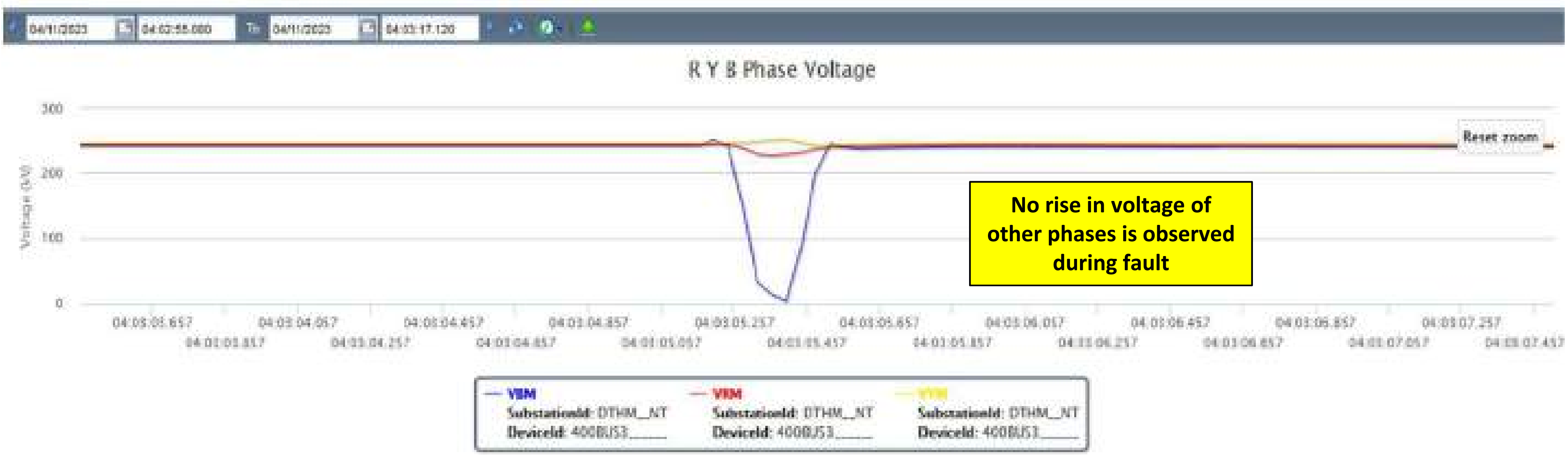


PMU Plot of phase voltage magnitude of 400kV Mandola ckt-1 at Dadri TPS 04:03hrs/04-Nov-23

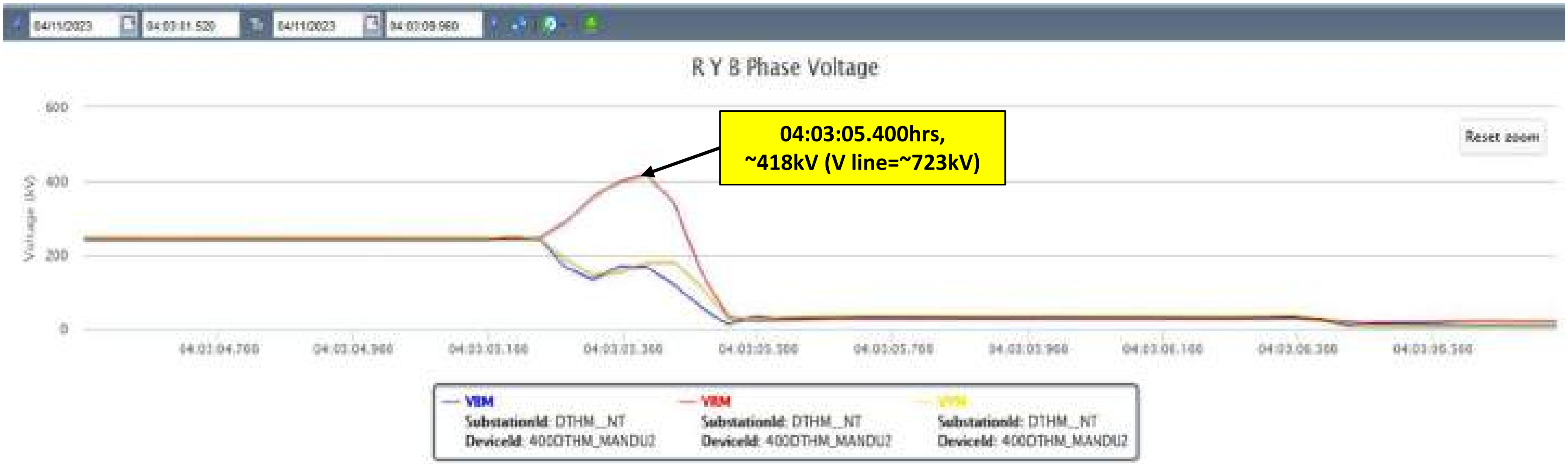
PMU Plot of phase current magnitude of 400kV Mandola ckt-1 at Dadri TPS 04:03hrs/04-Nov-23

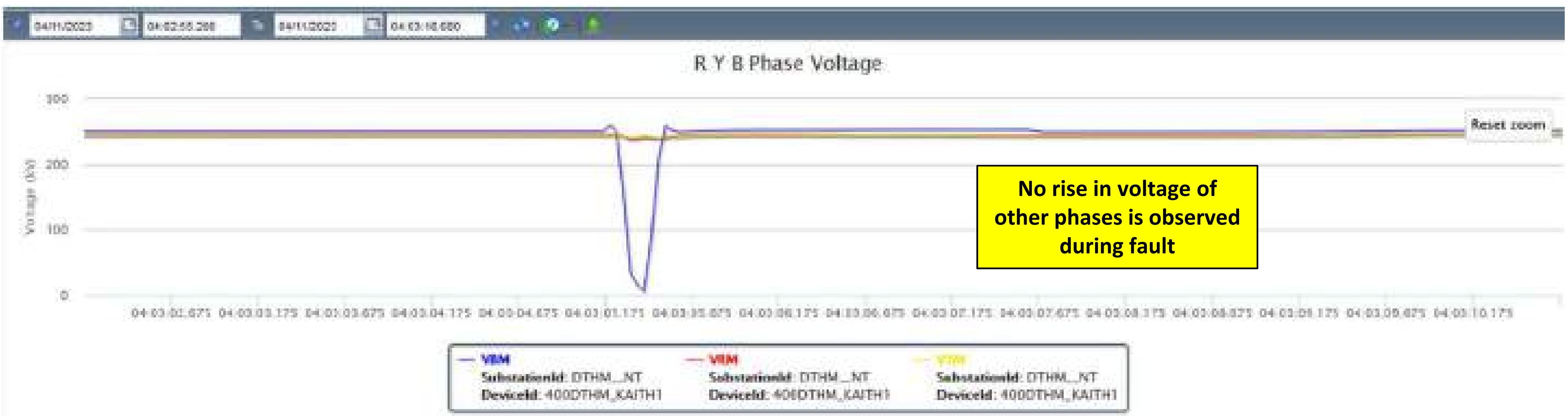
PMU Plot of phase voltage magnitude of 400kV Bus-2 & Bus-3 at Dadri TPS 04:03hrs/04-Nov-23



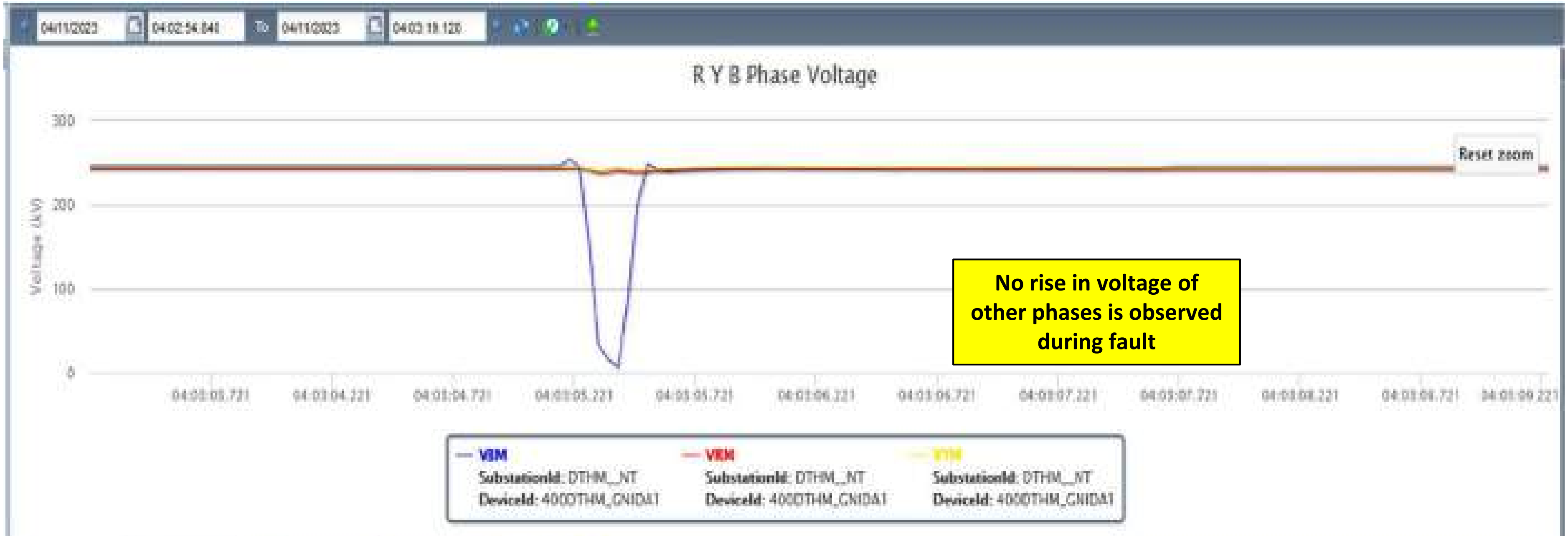


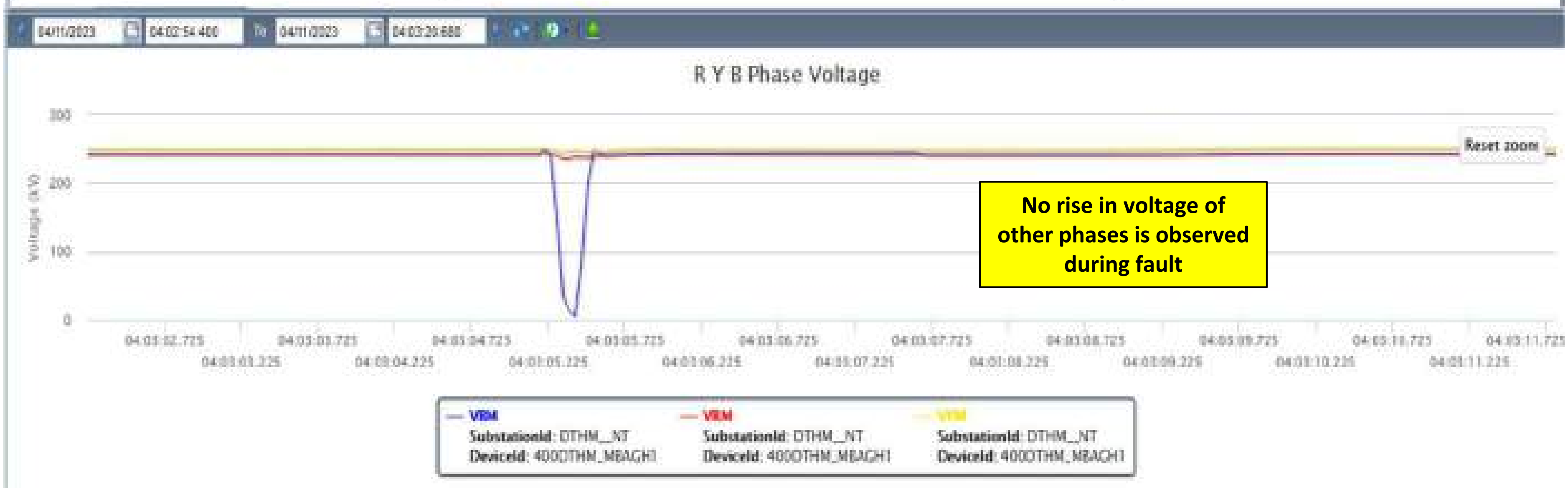
PMU Plot of phase voltage magnitude of 400kV Mandola ckt-2 and Kaithal ckt at Dadri TPS 04:03hrs/04-Nov-23



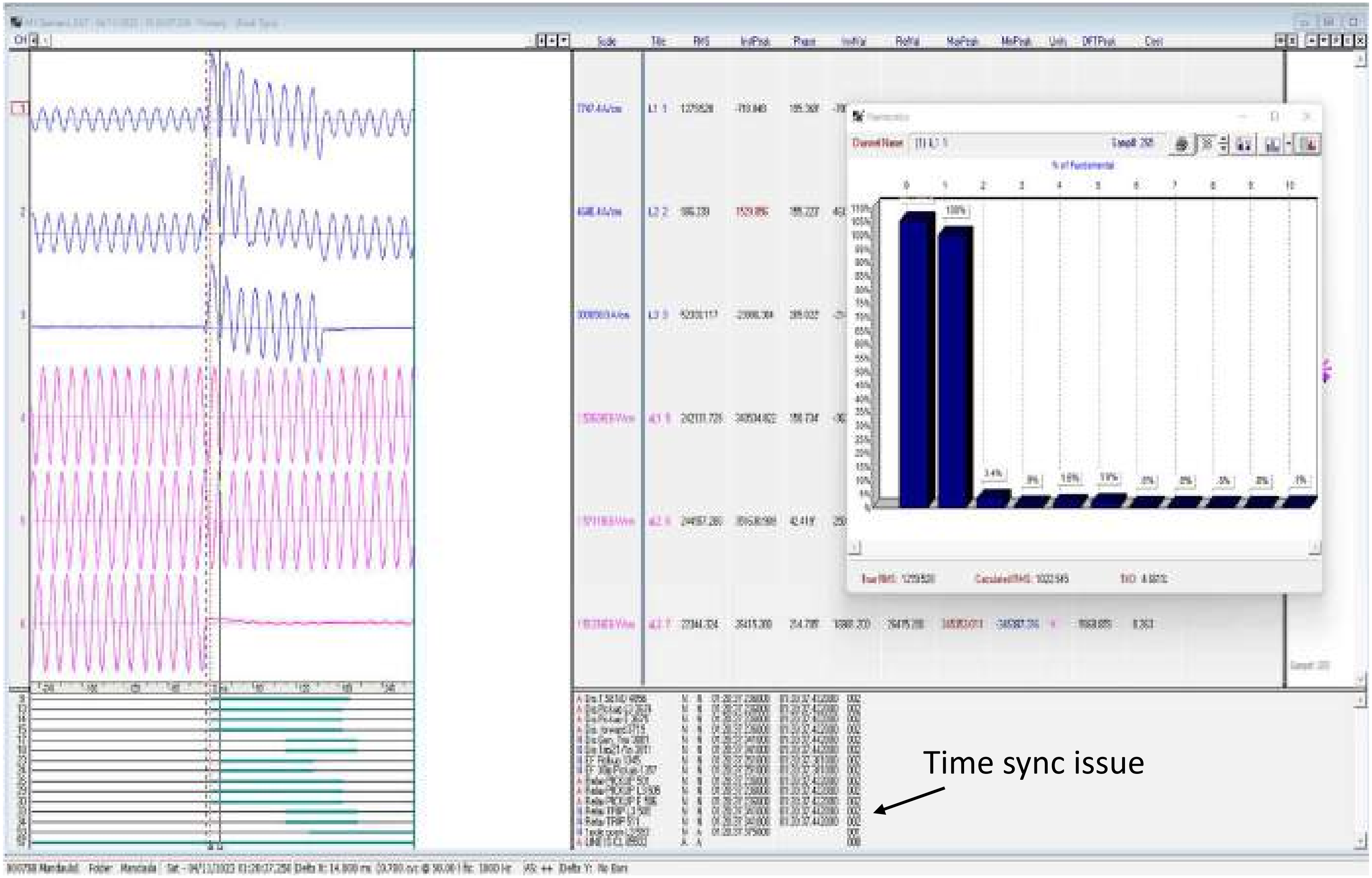


PMU Plot of phase voltage magnitude of 400kV Gr. Noida and Maharanibagh ckt at Dadri TPS 04:03hrs/04-Nov-23



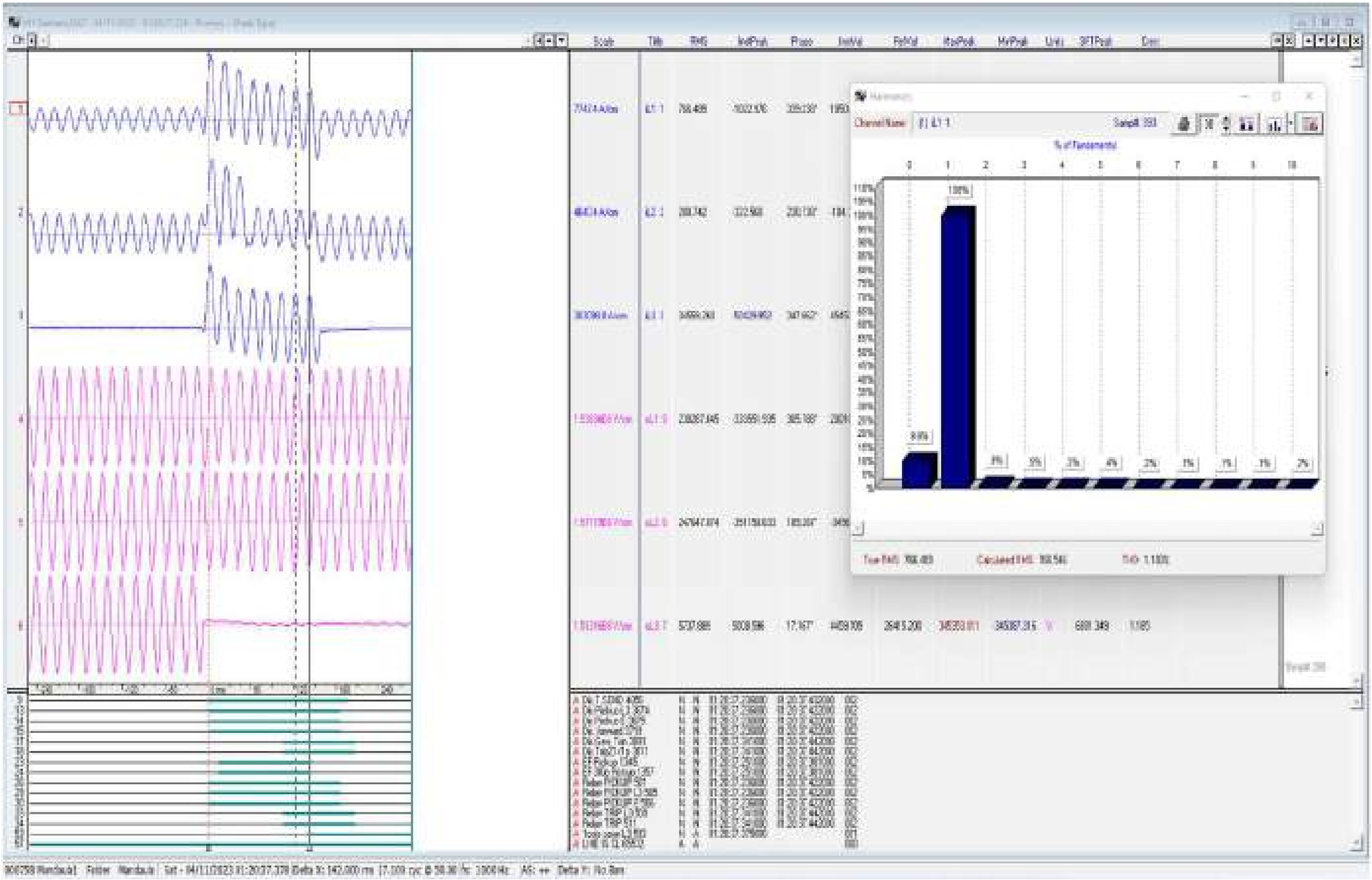


DR of 400kV Dadri TPS (end)-Mandola ckt-1



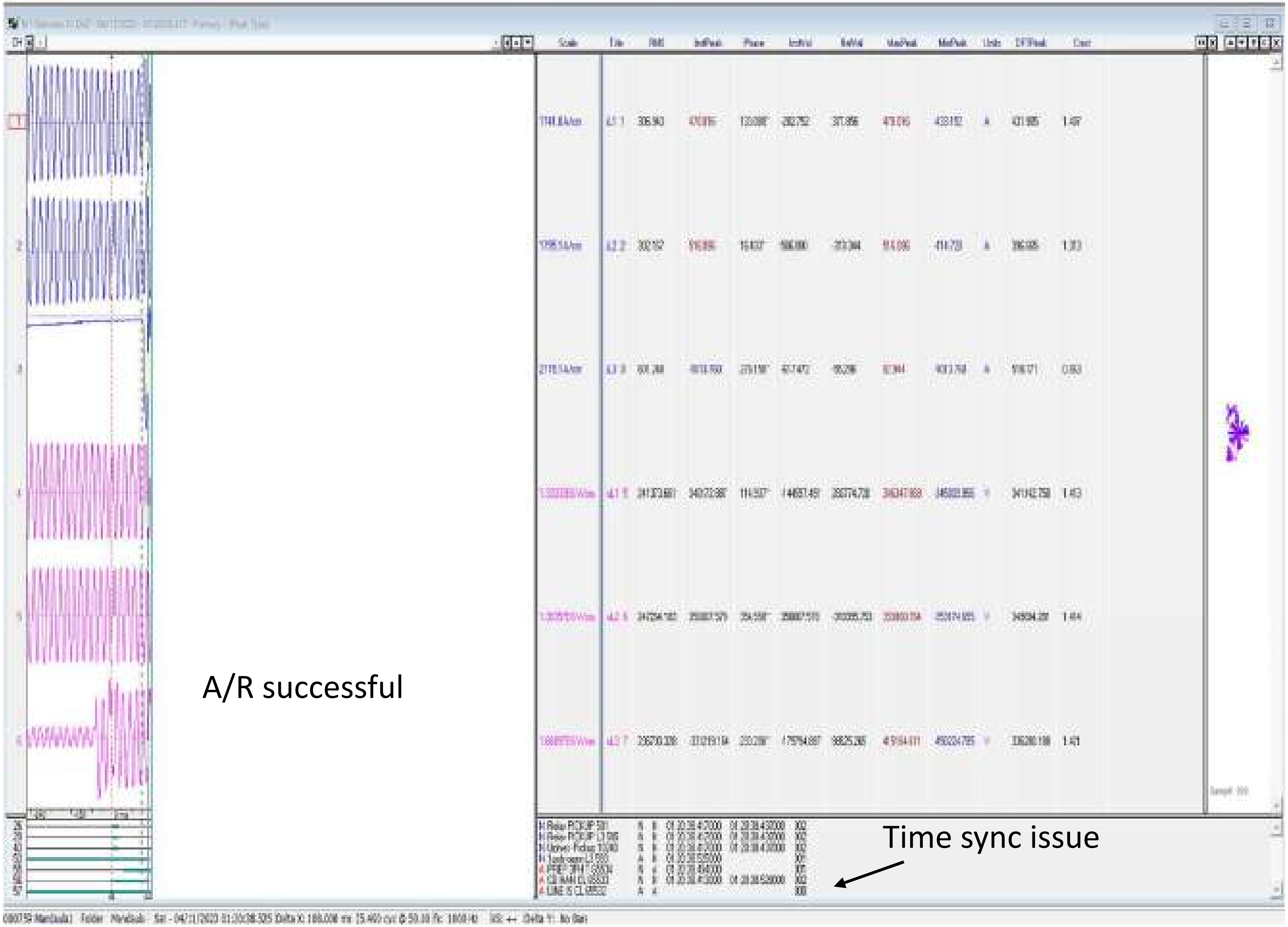
B-N fault, Z-1, A/R started, Ir=52kA (transient), steady state: ~35kA

DR of 400kV Dadri TPS (end)-Mandola ckt-1

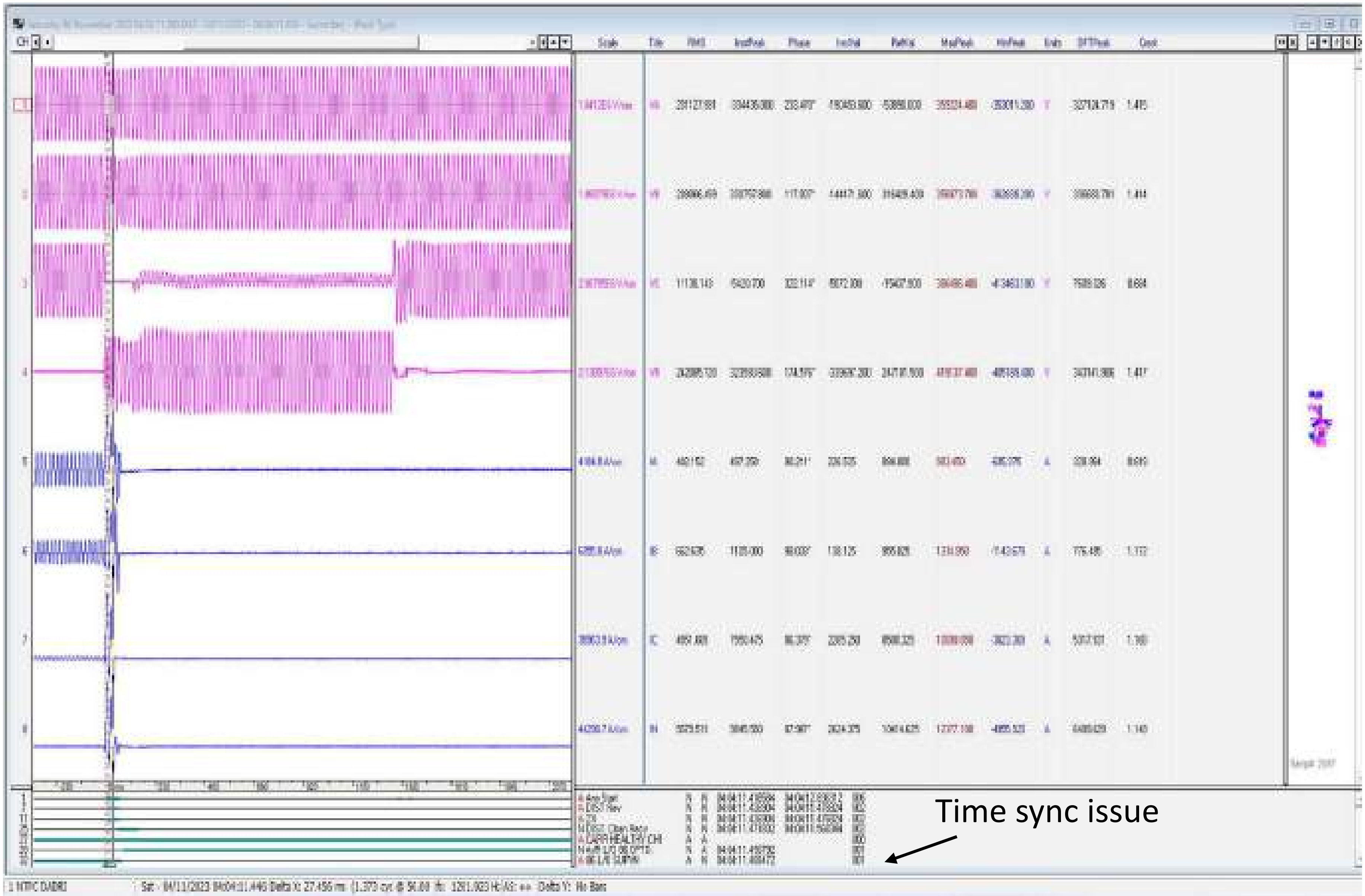


B-N fault, Z-1, A/R started, Ir=52kA (transient), steady state: ~35kA

DR of 400kV Dadri TPS (end)-Mandola ckt-1

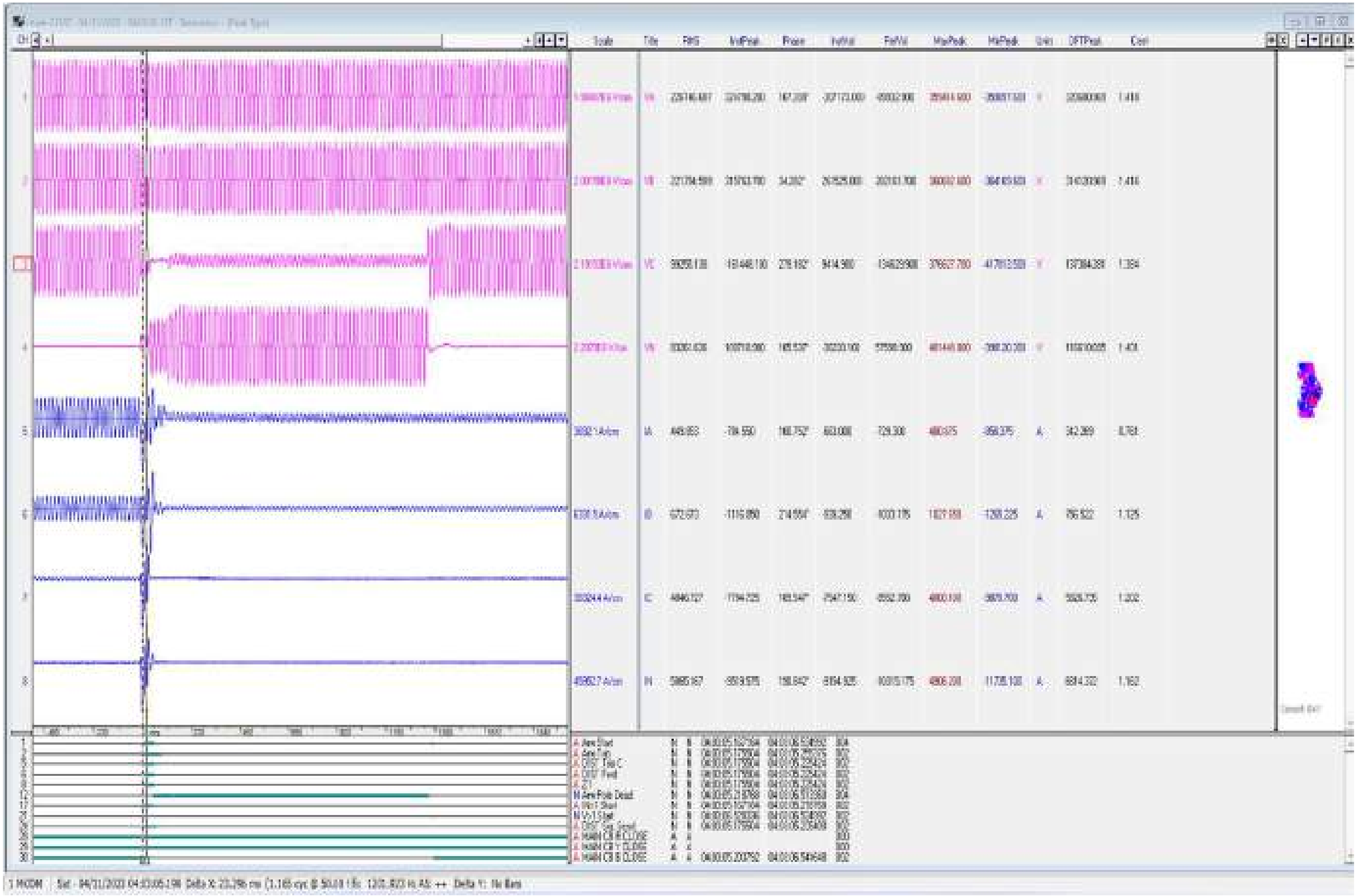


DR of 400kV Dadri TPS (end)-Harshvihar ckt-2



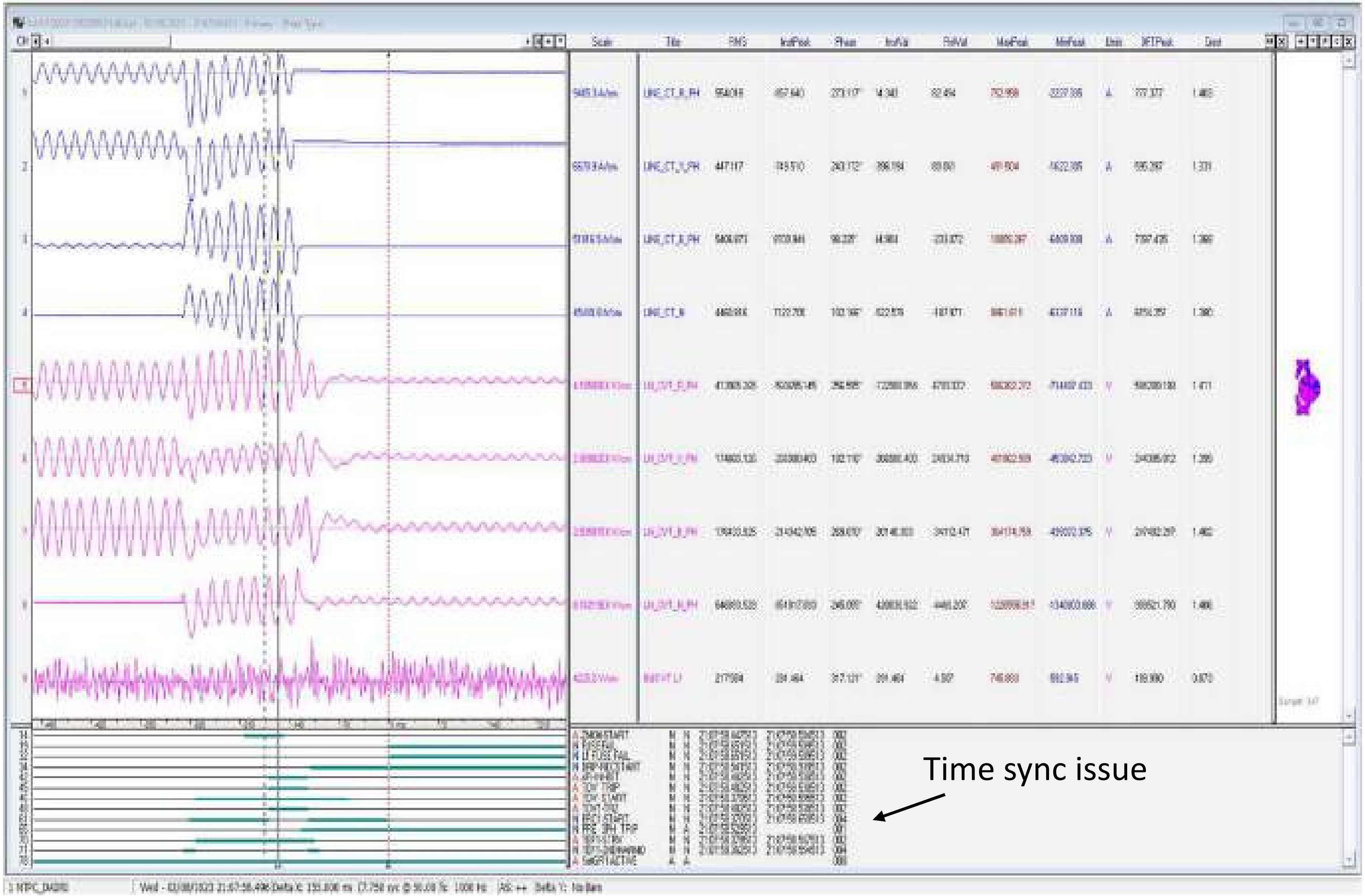
B-N fault, Z-4, three phase trip from Dadri end

DR of 400kV Dadri TPS-Harshvihar(end) ckt-2



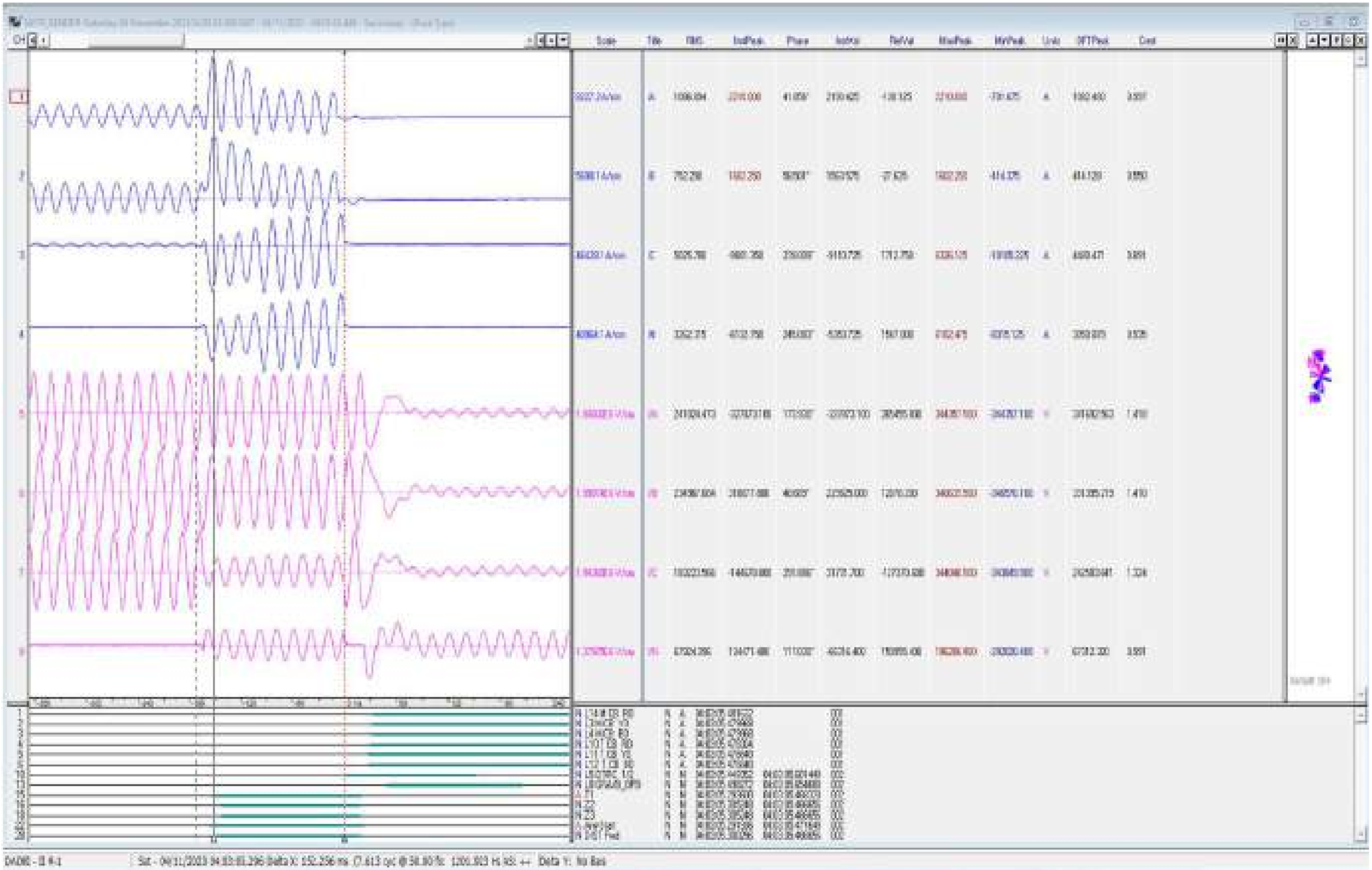
B-N fault, Z-1 (over reach suspected), A/R successful from Harshvihar end

DR of 400kV Dadri TPS (end)-Mandola ckt-2



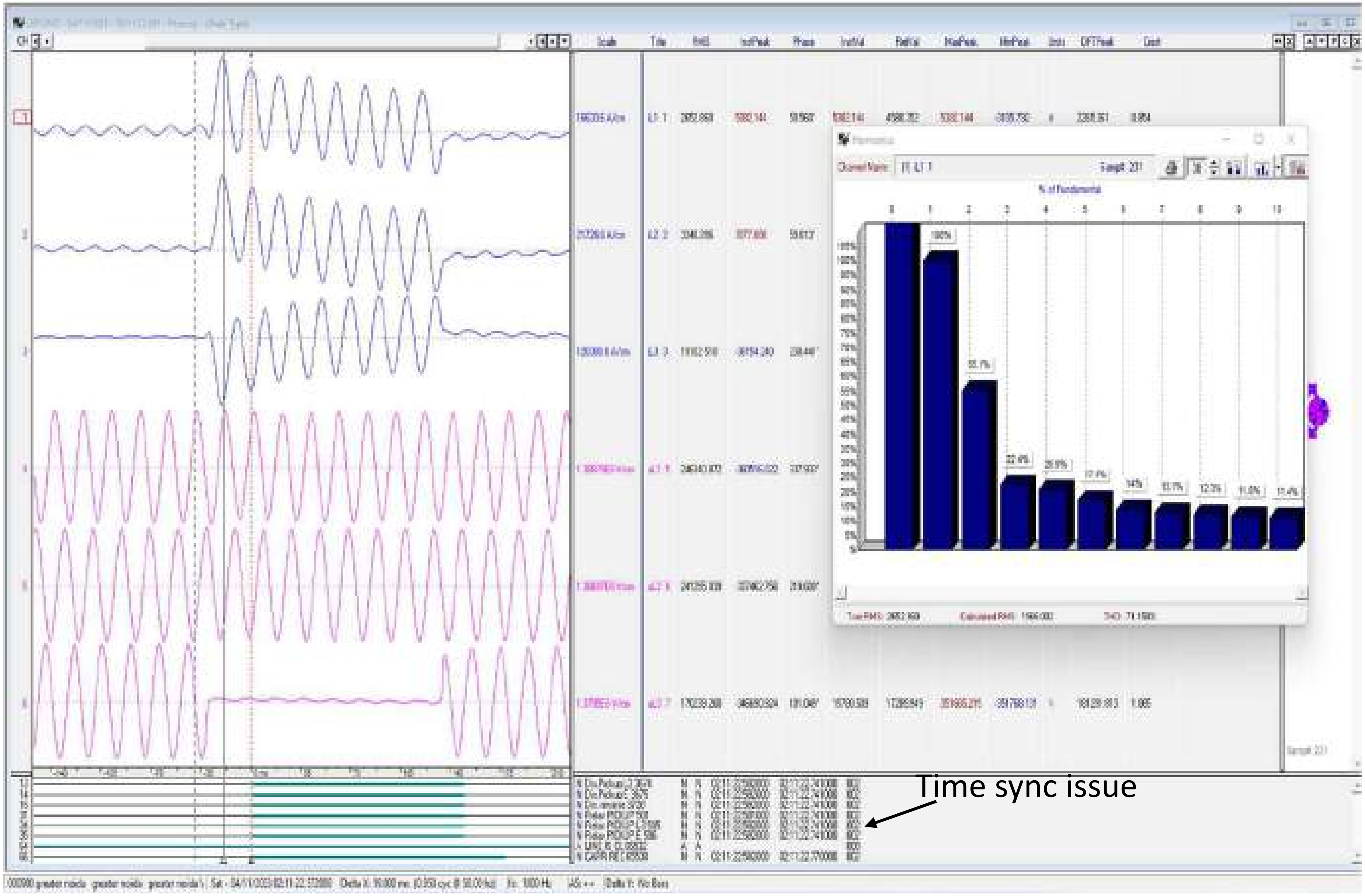
B-N fault, Z-4, Over voltage stage-2 operated, peak voltage recorded: Vr=414kV ph voltage

DR of 400kV Dadri TPS-Mandola(end) ckt-2



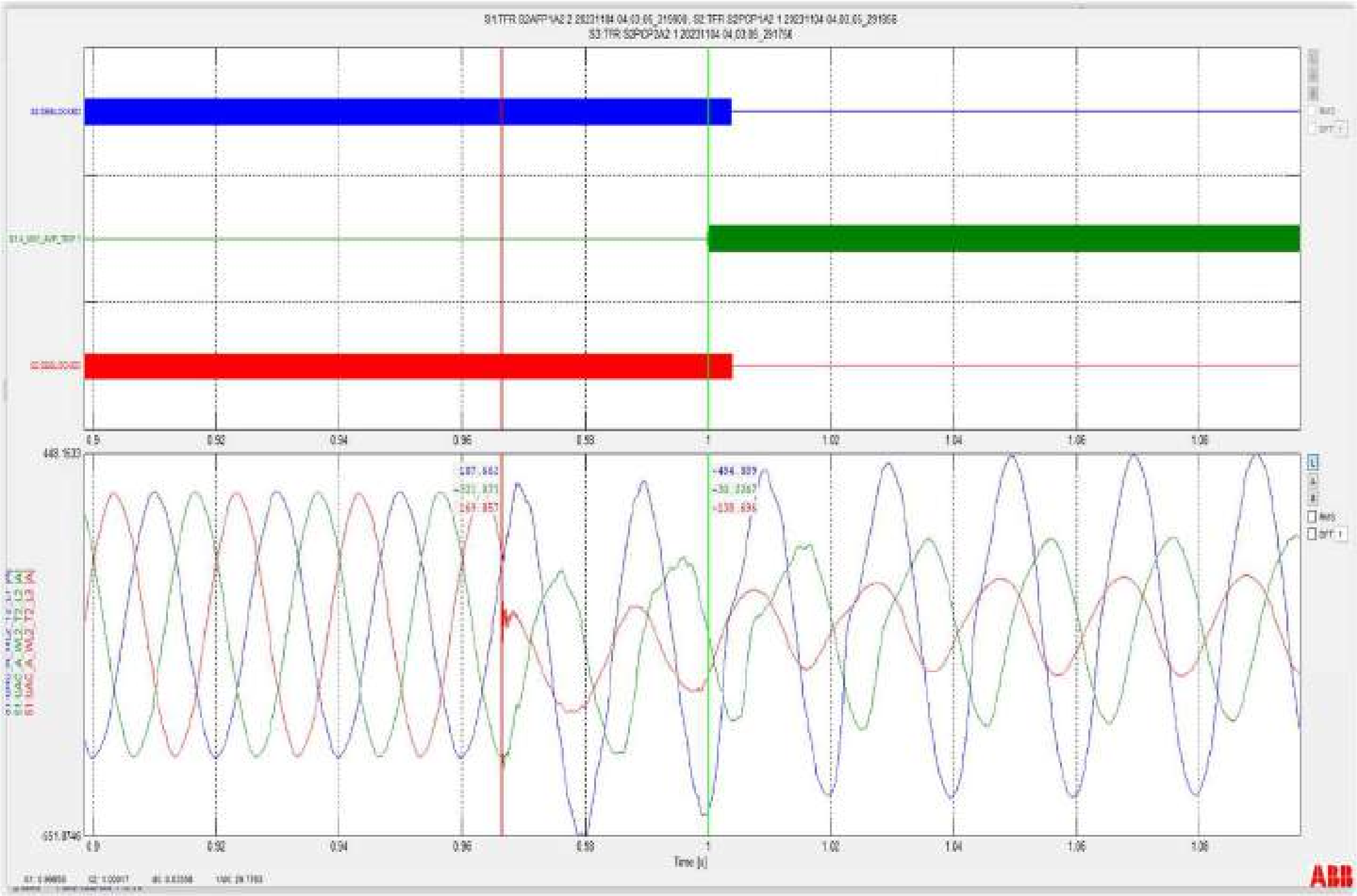
DT received at Mandola(PG) end

DR of 400kV Dadri TPS (end)-Gr Noida ckt



B-N fault, Z-4, Ib=~20kA

TFR of 400kV Bus at Dadri HVDC



SCADA SOE

Time	Station Name	Voltage	Element Name	Element Type	Element Status	Remarks
04:03:05,389	DADRI (TH)	400kV	23MB1HR2	Circuit Breaker	Open	Main & Tie CB at Dadri end of 400kV Dadri-Harshvihar ckt-2 opened
04:03:05,406	DADRI (TH)	400kV	LIHARSH2	Circuit Breaker	Open	
04:03:05,468	DADRI_HVDC	400kV	11CPBK1	Circuit Breaker	Open	
04:03:05,483	DADRI (TH)	400kV	20GN1MA2	Circuit Breaker	Open	Main & Tie CB at Dadri end of 400kV Dadri-Mandola ckt-2 opened
04:03:05,487	DADRI (TH)	400kV	19MANDU2	Circuit Breaker	Open	
04:03:05,511	DADRI_HVDC	400kV	23TIE	Circuit Breaker	Open	Main & Tie CBs of filters banks at Dadri HVDC opened
04:03:05,545	RIHND_HVDC	400kV	31CPBK3	Circuit Breaker	Open	
04:03:05,545	RIHND_HVDC	400kV	Z32	Circuit Breaker	Open	
04:03:05,545	RIHND_HVDC	400kV	33TIE	Circuit Breaker	Open	
04:03:05,547	DADRI_HVDC	400kV	31CPBK3	Circuit Breaker	Open	
04:03:05,547	DADRI_HVDC	400kV	33TIE	Circuit Breaker	Open	
04:03:05,553	RIHND_HVDC	400kV	22CPBK2	Circuit Breaker	Open	
04:03:05,553	RIHND_HVDC	400kV	Z21	Circuit Breaker	Open	
04:03:05 ***	MANDAULA	400kV	17DTH2R1	Circuit Breaker	Open	
04:03:05,573	RIHND_HVDC	400kV	11CPBK1	Circuit Breaker	Open	
04:03:05,573	RIHND_HVDC	400kV	Z12	Circuit Breaker	Open	
04:03:05,582	DADRI_HVDC	400kV	22CPBK2	Circuit Breaker	Open	
04:03:05,585	RIHND_HVDC	400kV	23TIE	Circuit Breaker	Open	
04:03:05,637	DADRI_HVDC	400kV	13TIE	Circuit Breaker	Open	
04:03:05,767	RIHND_HVDC	400kV	13TIE	Circuit Breaker	Open	

Actions taken:

- Delayed tripping initiation in Z-1 (400kV Dadri-Mandola ckt-1) was due to Z-1 time delay setting which was kept as 100msec at Dadri instead of instantaneous. As informed by NTPC Dadri, Z-1 time delay has been set as 0 sec (instantaneous).
- A Shutdown of 400 KV Bus A was availed on 4th Nov 2023 and following works were carried out:

✓ CVT Secondary circuit was checked for any double earthing and no double earthing was found in the secondary circuit.

✓ Megger testing of 400 KV Bus A CVT Control cable was carried out and same was found to be in order.

✓ CVT secondary box and marshalling box was checked for any loose connection.

✓ Loop resistance of CVT Secondary circuit was carried out and same was found to be in order.

Observations:

- During fault time, over voltage of the magnitude of approx. 723kV in 400kV Dadri-Mandola ckt-2 at Dadri end and approx. 560kV in 400kV Bus-2 at Dadri TPS is observed (as per PMU at Dadri TPS). No over voltage is observed in other circuits. Reason of the same need to be identified.
- Mismatch is suspected in nomenclature of 400kV Bus at Dadri TPS in SCADA & PMU, it need to be checked.
- Exact reason of tripping of 400kV Dadri-Harshvihar ckt-2 from Dadri end need to be identified.
- DR of Dadri TPS end are not time synced. Time sync of DRs with GPS need to be ensured.
- Z-1 over reach at Harshvihar end on fault in 400kV Dadri-Mandola ckt-1 need to be reviewed.
- Event logger and disturbance recorder detail of tripping of HVDC Rihand-Dadri ckt-1&2 need to be shared.
- Reason of over voltage in Dadri HVDC bus is yet to be identified.

Tripping report Rihand Dadri HVDC Bipole Link
Dated: 04 Nov 2023

Presentation HVDC Dadri Sub-station

Bipole of Rihand Dadri HVDC Link tripped from Dadri end on 04th Nov 2023 at 04:03:05 Hrs. on 400KV AC BUS Overvoltage Protection.

Condition before tripping:

Power flow: - Pole 1: 300 MW, Pole 2: 300 MW

Condition after tripping:

Power flow: - Pole 1: 0 MW, Pole 2: 0 MW

Sequence of events is as follows:

04.03.05.2917 Hrs. : - Commutation failure detected in Both Pole 1 and Pole 2

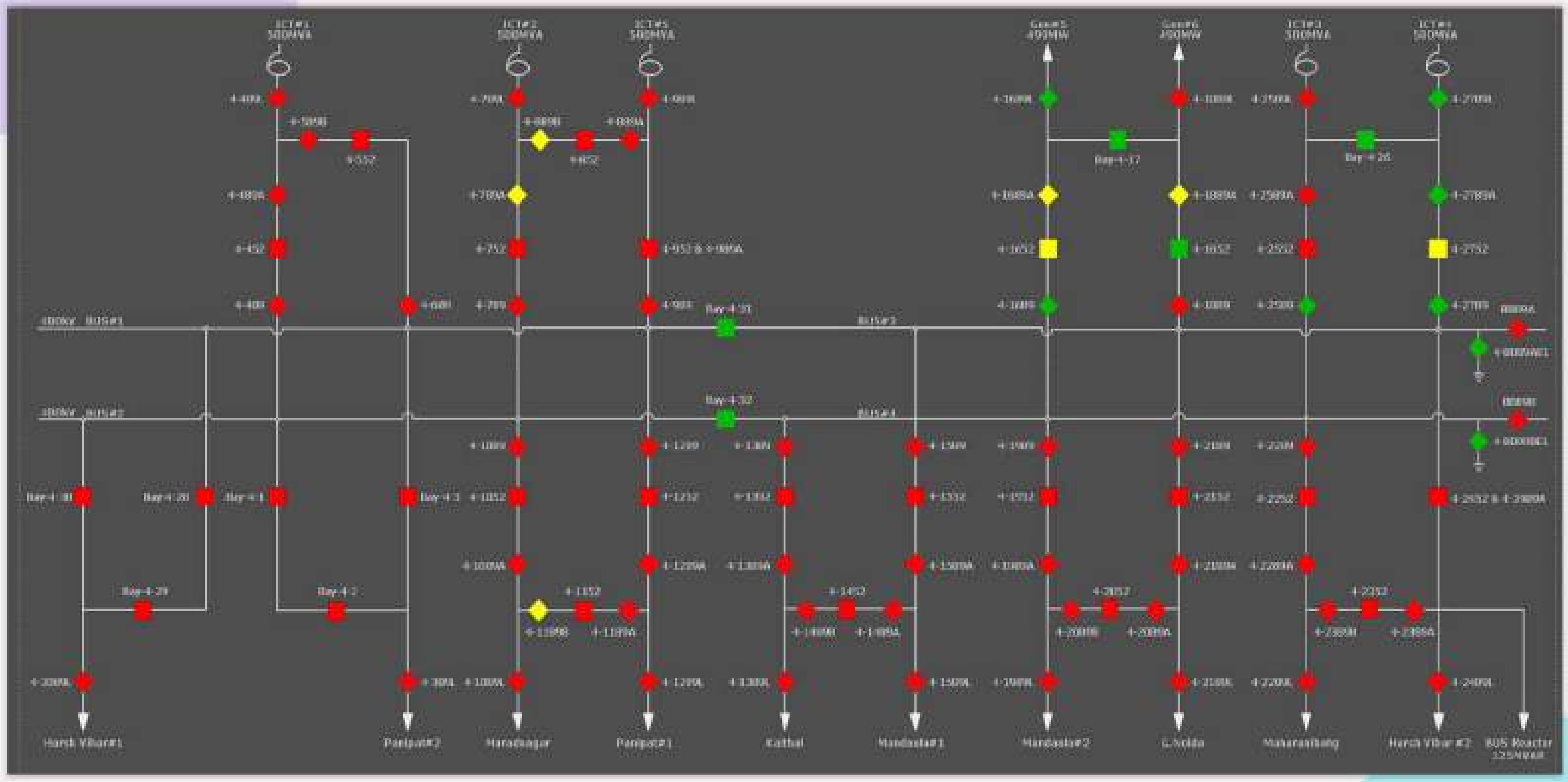
04.03.05.3199 Hrs. : - All three AC Filter banks at Dadri tripped on Overvoltage protection

04.03.05.3271 Hrs. : - HVDC Bipole blocked on Y block due to all three filter banks tripping

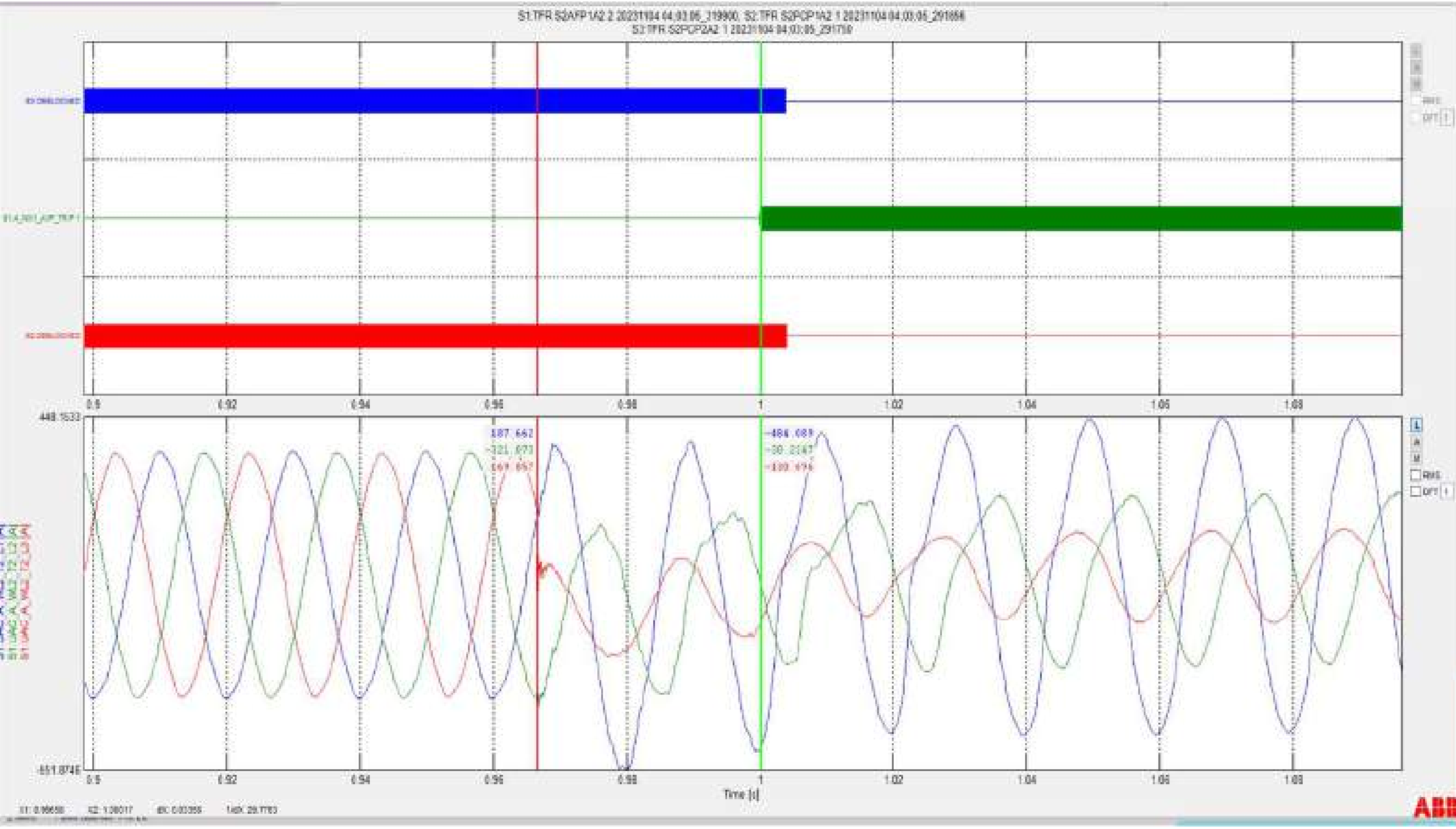
Analysis of tripping

- At Dadri, Commutation failure detected at 04.03.05.2917 Hrs. dated 04.11.2023 due to close in line fault in B-Phase of 400KV Dadri Mandola 1 Line.
- At 04.03.05.3199 Hrs. All three AC Filter banks at Dadri tripped on Overvoltage protection.
- At 04.03.05.3271 HVDC Bipole blocked on Y block due to all three filter banks tripping.
- 400KV Dadri Harsh Vihar 2 Line tripped at 04.03.05.3525 Hrs. on DT received from Harsh Vihar end.
- 400KV Dadri Mandola 1 Line auto reclose started at 04.03.05.4291 Hrs. after 8 cycles from initiation of fault. Subsequently line reclosed successfully.
- 400KV Dadri Mandola 2 Line tripped on transient overvoltage protection in R phase at 04.03.05.4403 Hrs.
- As reported by NTPC, Generator Unit 6 (490MW) tripped on vibration protection.
- Bipole charged on 05.50 Hrs. dated 04.11.2023.

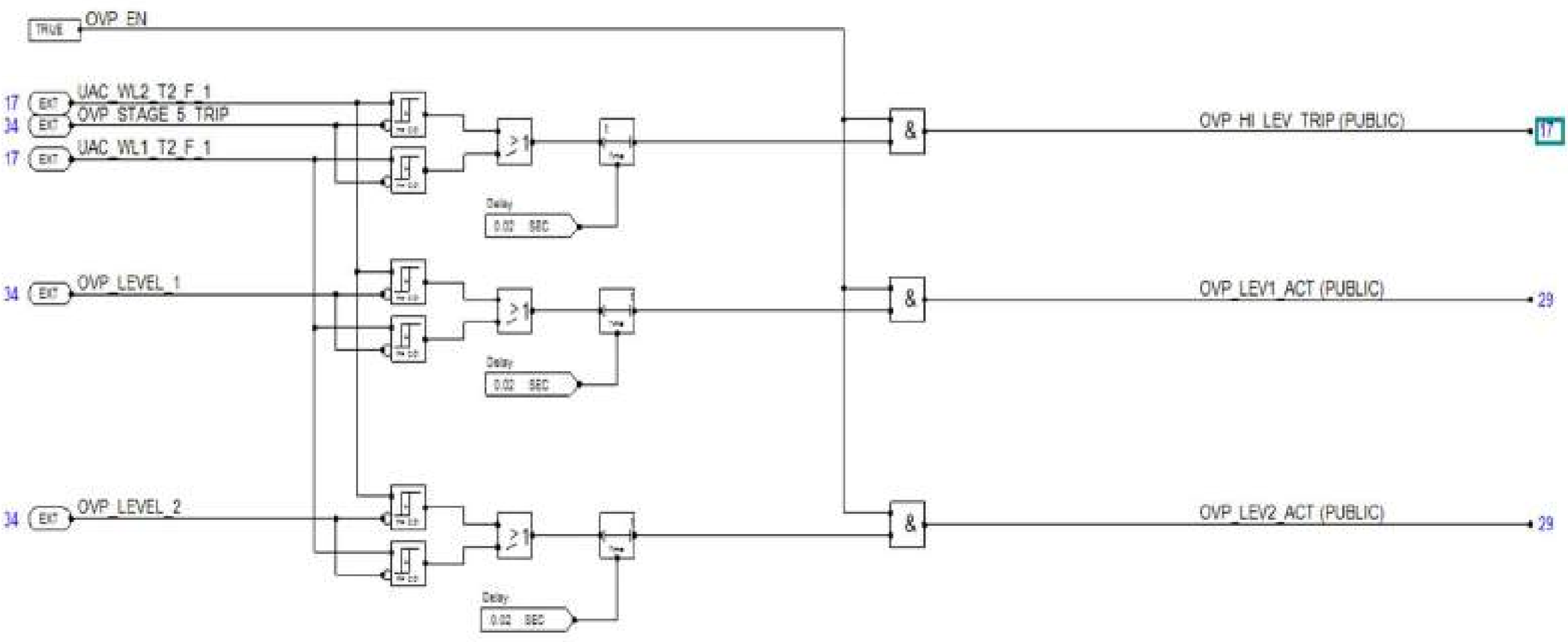
All HVDC protection systems are healthy and operated as per logic.



400KV NTPC S/Y SLD



0.9
0.92
0.94
0.96
0.98
1
1.02
1.04
1.06
1.08
448.1533
-551.8746
RMS
DFT
Time [s]
ABB



Over Voltage Protection Settings

Pick up Value for Over Voltage Protection: 489.89 KV
Pick Up Delay: 20ms

Work carried out during Shutdown of 400 KV Bus A

A Shutdown of 400 KV Bus A was availed on 4th Nov 2023 and following work was carried out:

- CVT Secondary circuit was checked for any double earthing and no double earthing was found in the secondary circuit.
- Megger testing of 400 KV Bus A CVT Control cable was carried out and same was found to be in order.
- CVT secondary box and marshalling box was checked for any loose connection.
- Loop resistance of CVT Secondary circuit was carried out and same was found to be in order.

THANK YOU

Multiple elements tripping at 220kV Ropar GGSTP(PS)

30th November 2023

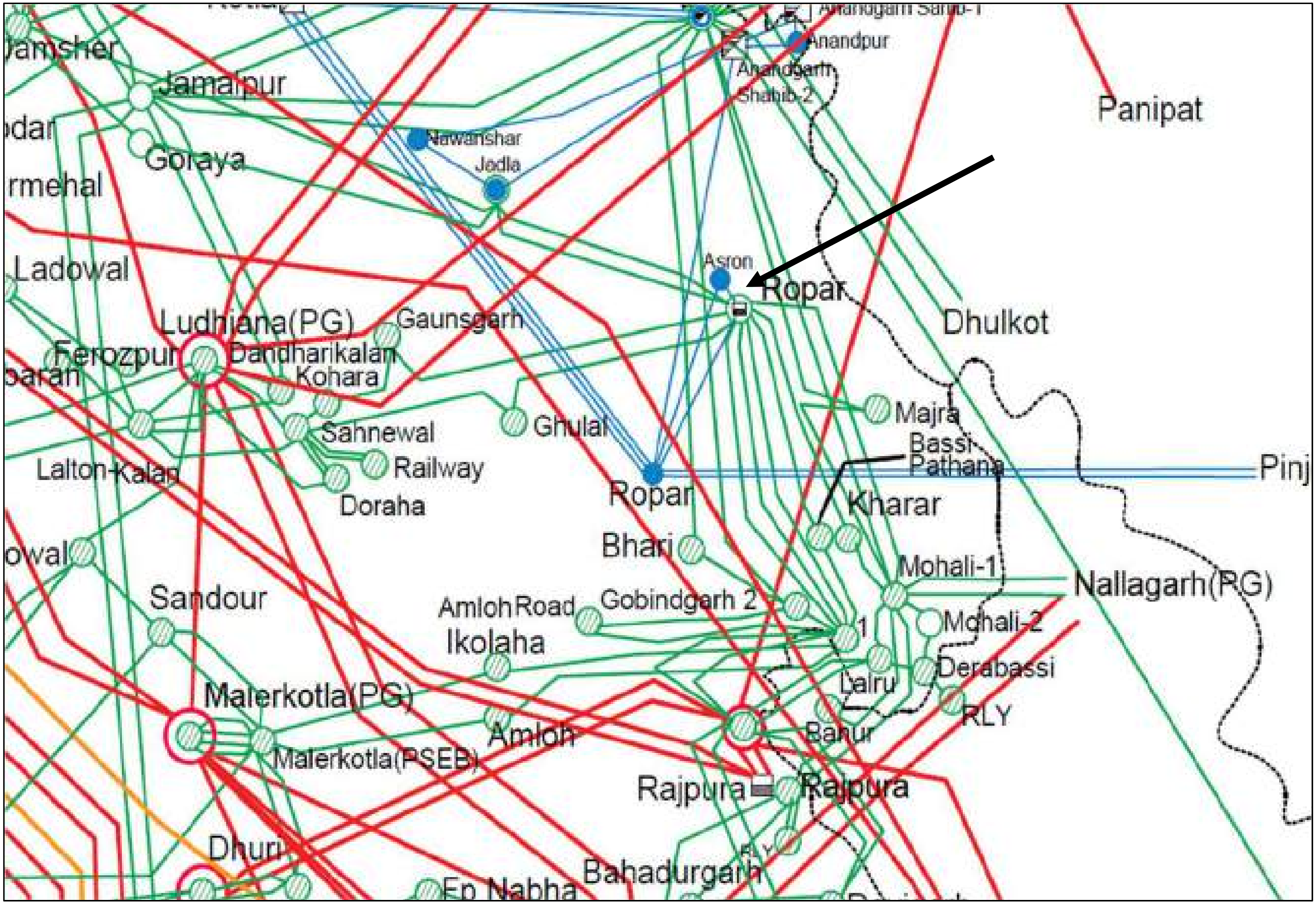
Brief of event:

- 220/132kV Ropar GGSTP(PS) has main and transfer bus scheme at 220kV level.
- During antecedent condition, 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 4 (carrying ~164MW), UNIT 5 (carrying ~148MW) & UNIT 6 (carrying ~151MW) and 220kV feeders to Kharar, Mohali & Gobindgarh-2 were connected to 220kV main Bus section-III. Rest of the elements were connected to main Bus section-I & II.
- As reported, at 06:51 hrs, 220kV GGSTP-Kharar Ckt tripped on R-N phase to earth fault (zone-1 distance protection operated) with fault current of 4.071kA and fault distance of 33.91km from GGSTP end. Fault occurred due to heavy lightening.
- On this fault, all other elements connected to 220kV main Bus section-III tripped. (Exact reason yet to be shared)
- As reported by GGSTP Ropar, 220kV GGSTP-Bassi Pathana Ckt (connected to 220kV main Bus section-I) and 220kV GGSTP-Gobindgarh Ckt-1 (connected to 220kV main Bus section –II) also tripped during the same time. (Exact reason yet to be shared)
- As per SCADA SOE, 66kV Morinda-Kharar(PS) ckt also tripped at the same time. (Exact reason yet to be shared)
- As per PMU at Jalandhar(PG), R-N phase to earth fault is observed with delayed fault clearance time of 440ms.
- As per SCADA, generation loss of approx. 463MW occurred at Ropar GGSTP.
- As per SCADA load loss of approx. 60MW is observed in Punjab control area.

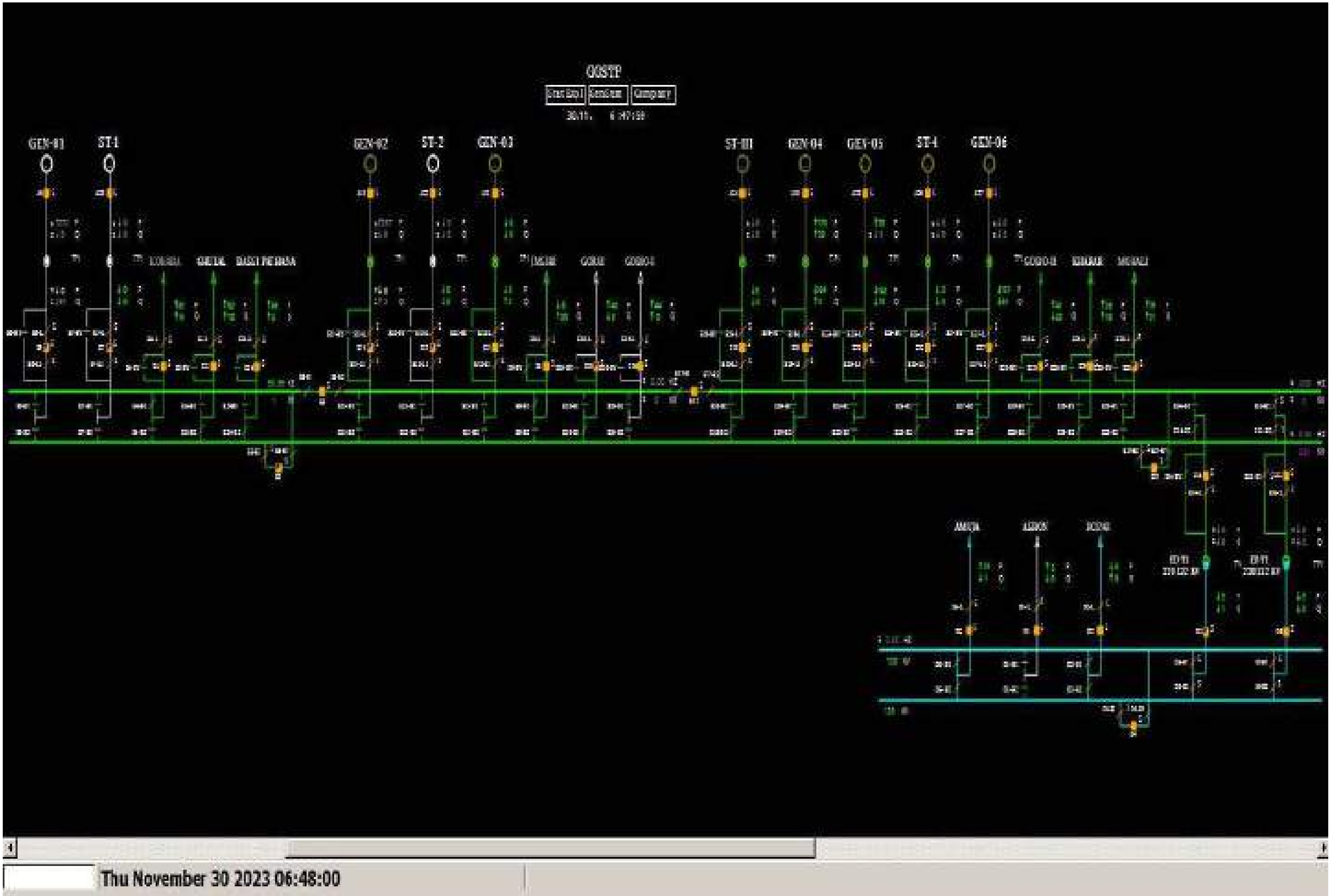
Elements tripped:

i. 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 4
ii. 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 5
iii. 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 6
iv. 220kV GGSTP-Kharar Ckt
v. 220kV GGSTP-Mohali Ckt
vi. 220kV GGSTP-Bassi Pathana Ckt
vii. 220kV GGSTP-Gobindgarh Ckt-1
viii. 220kV GGSTP-Gobindgarh Ckt-2

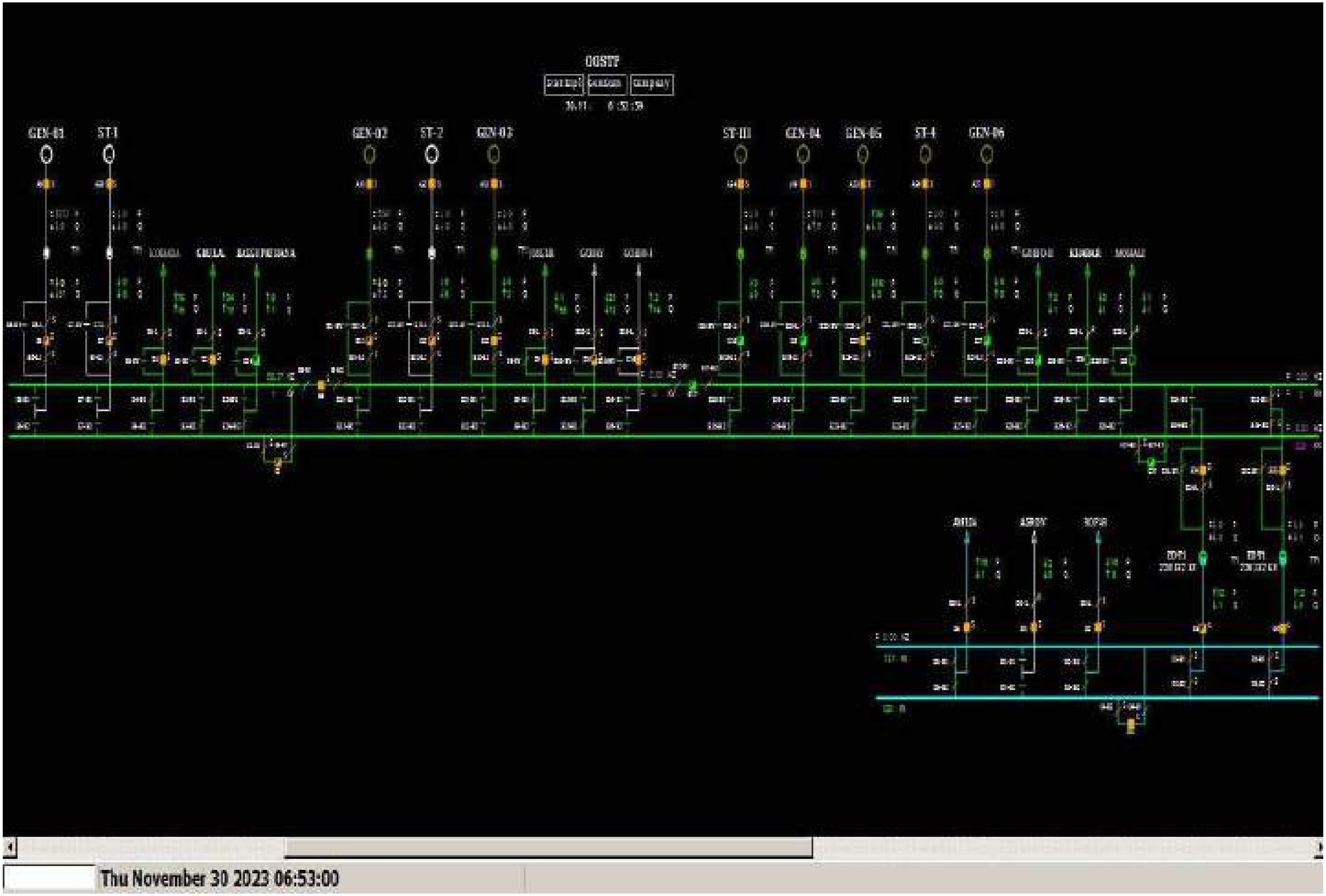
Network Diagram



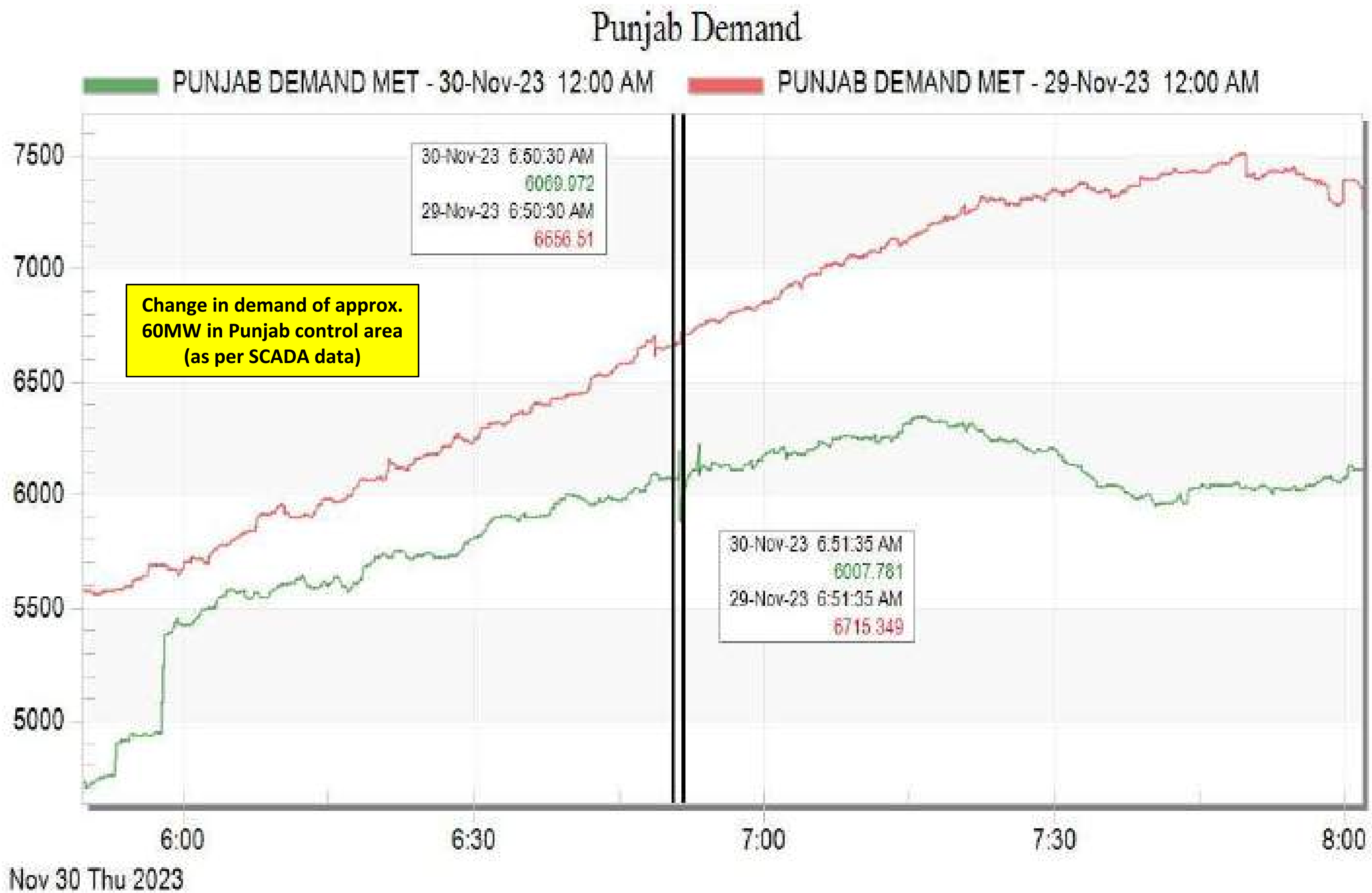
SCADA SLD of 220/132kV Ropar GGSTP before the event



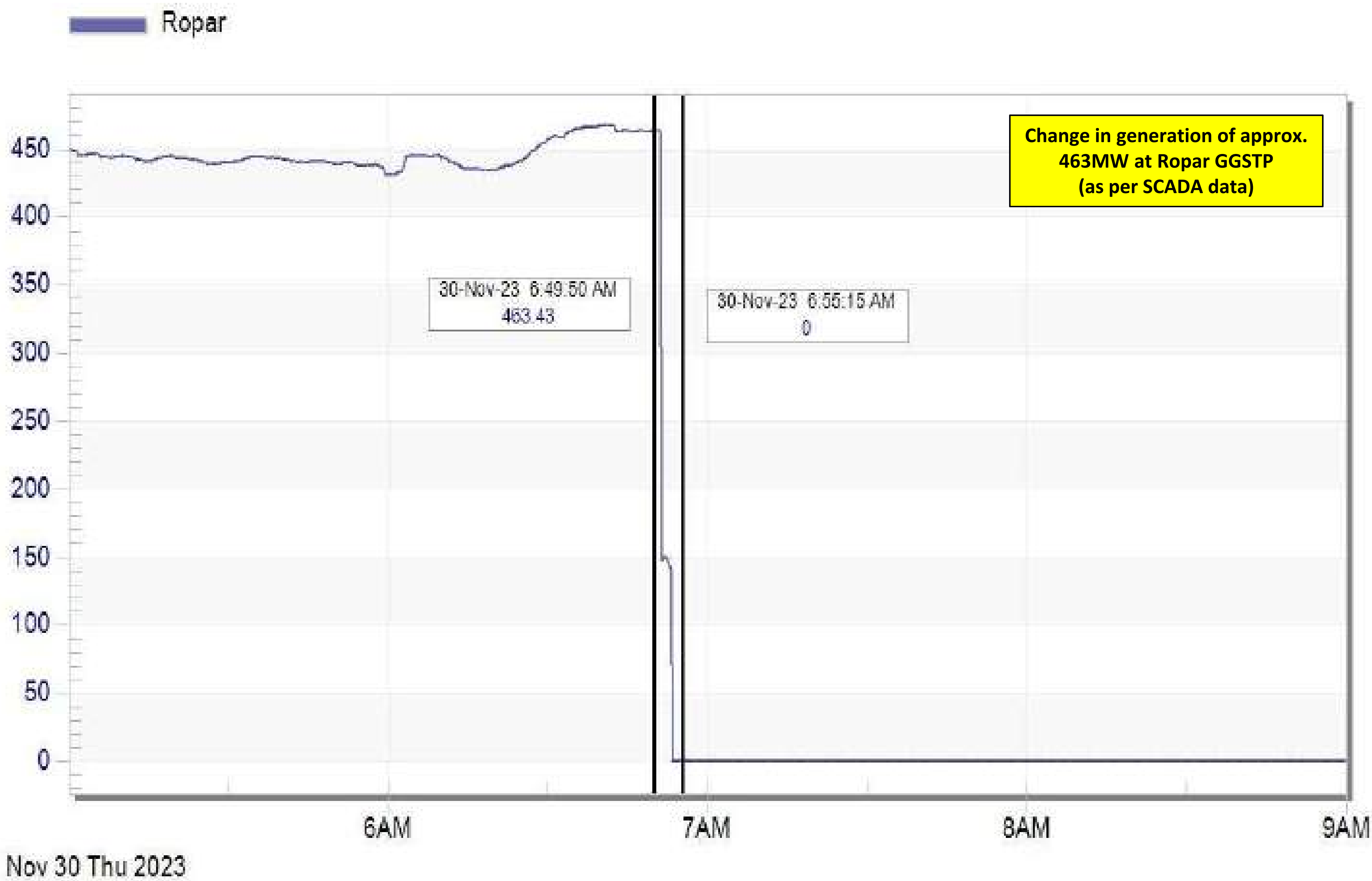
SCADA SLD of 220/132kV Ropar GGSTP after the event



Punjab demand during the event

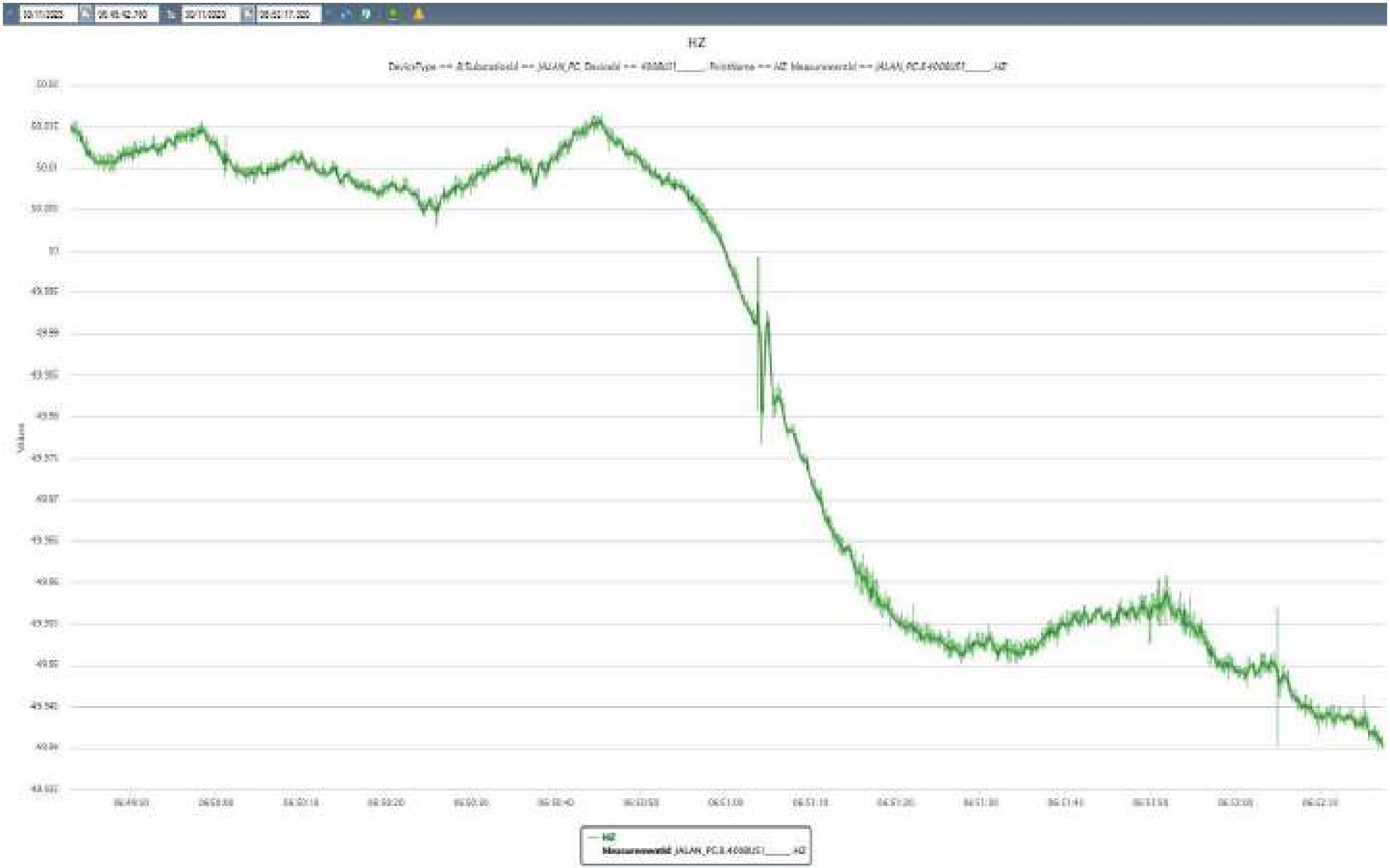


Ropar GGSTP generation during the event



PMU Plot of frequency at Jalandhar(PG)

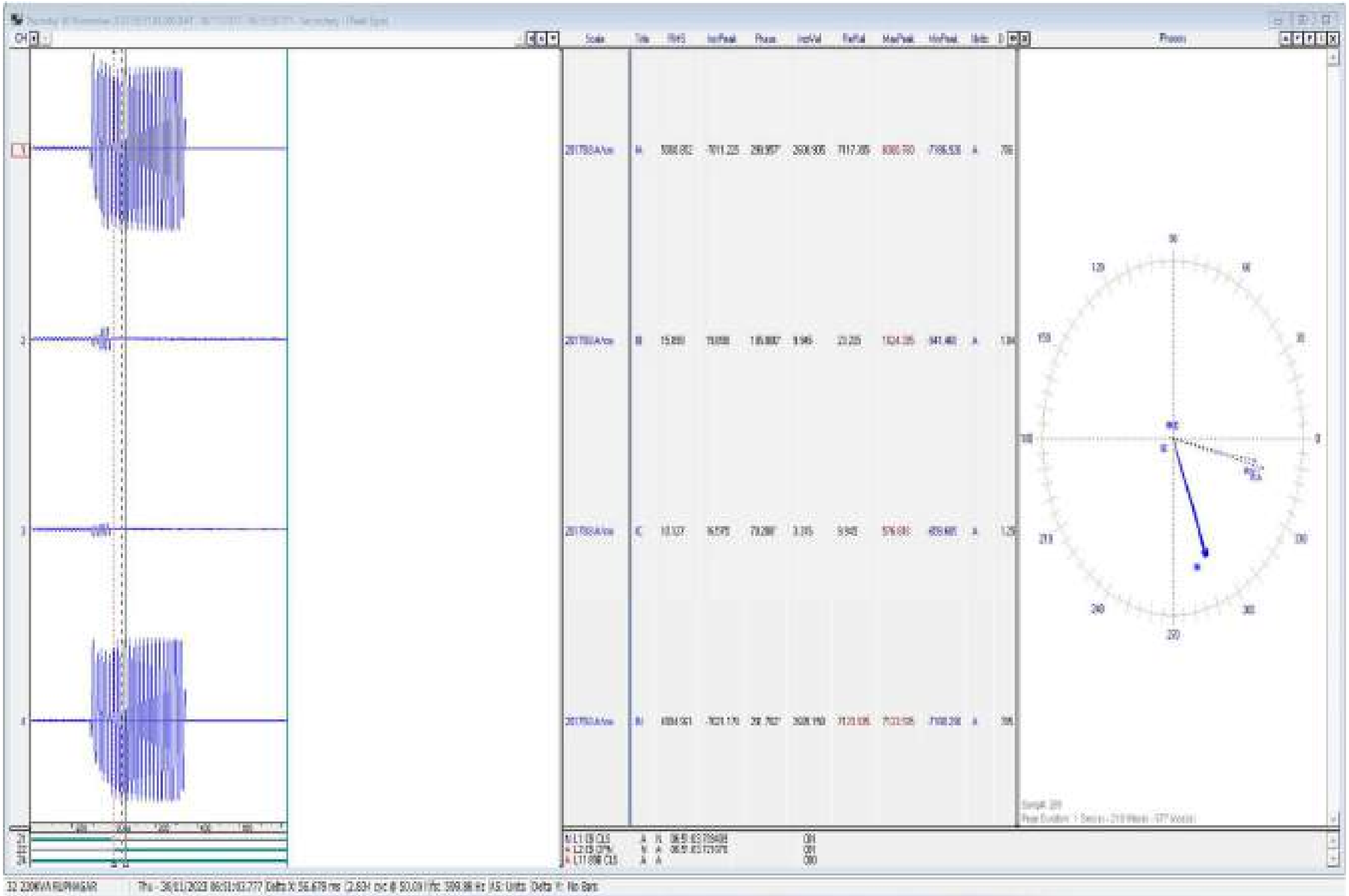
06:51 hrs/30-Nov-23



PMU Plot of phase voltage magnitude at Jalandhar(PG)

06:51 hrs/30-Nov-23

DR received from Punjab



Roopanagar station, R-N fault with delayed clearance of ~450msec

SCADA SOE

Time	Station Name	Voltage	Element Name	Element Type	Element Status	Remarks
06:50:44,667	KHRAR_PS	66kV	13MRNDA	Circuit Breaker	disturbe	
06:50:45,709	KHRAR_PS	66kV	13MRNDA	Circuit Breaker	Open	Line CB at Kharar end of 66kV Morinda-Kharar(PS) ckt opened
06:51:03,096	GGSTP_PS	220kV	26KHRAR	Circuit Breaker	Open	Line CB at GGSTP end of 220kV GGSTP-Kharar(PS) ckt opened
06:51:03,372	GGSTP_PS	220kV	25ST4	Circuit Breaker	Open	CB at 220kV side of ST-4 connected to 210 MW Guru Gobind Singh TPS (Ropar) - UNIT 4 opened
06:51:07,084	GGSTP_PS	220kV	28MOHLI	Circuit Breaker	Open	Line CB at GGSTP end of 220kV GGSTP-Mohali(PS) ckt opened
06:51:10,132	KHRAR_PS	220kV	1GGSTP	Circuit Breaker	disturbe	
06:51:12,582	KHRAR_PS	220kV	1GGSTP	Circuit Breaker	Open	Line CB at Kharar end of 220kV GGSTP-Kharar(PS) ckt opened
06:51:19,747	GGSTP_PS	220kV	22GOBIO3	Circuit Breaker	disturbe	
06:51:19,747	GGSTP_PS	220kV	20GOBIO2	Circuit Breaker	disturbe	
06:51:19,747	GGSTP_PS	220kV	18ST3	Circuit Breaker	disturbe	
06:51:19,747	GGSTP_PS	220kV	19T04	Circuit Breaker	disturbe	
06:51:20,497	GGSTP_PS	220kV	24BSPTN	Circuit Breaker	disturbe	
06:51:20,497	GGSTP_PS	220kV	27T06	Circuit Breaker	disturbe	
06:51:20,497	GGSTP_PS	220kV	21MBC	Circuit Breaker	disturbe	
06:51:20,497	GGSTP_PS	220kV	17BS	Circuit Breaker	disturbe	

Point of discussion

i. Details of protection operated in all other elements connected to 220kV main Bus section-III need to be shared.
ii. Exact reason of tripping of 220kV GGSTP-Bassi Pathana Ckt (connected to 220kV main Bus section-I) and 220kV GGSTP-Gobindgarh Ckt-1 (connected to 220kV main Bus section –II) need to be shared.
iii. Reason of delayed clearance of fault need to be shared.
iv. DR/EL of each tripped element along with tripping report of the event need to be shared from both the ends.
v. Remedial action taken report to be shared.

pstcl
PUNJAB STATE TRANSMISSION CORPORATION LIMITED

Tripping Report for Tripping on Dt 30-11-2023 at 220KV S/s Guru Gobind Singh STPS Ropar PSTCL

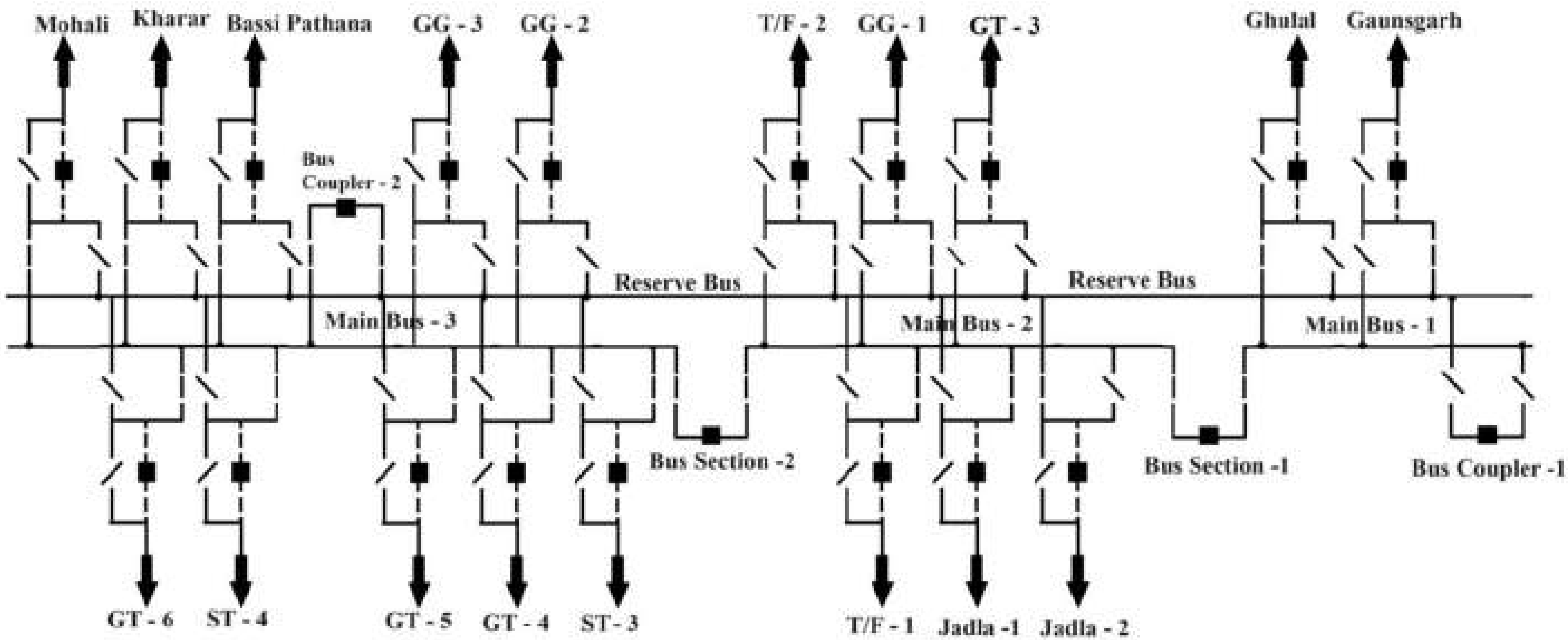
	Detailed Report	
a.	Time and date of event (GPS Sync time)	**30.11.23 06:51 Hrs**
b.	Location.	Ropar (Punjab),
c.	Equipment tripped.	• **220 kV Ropar – Mohali** • **220 kV Ropar – Kharar** • **220 kV Ropar – Bassi Pathana** • **220 kV Ropar – Gobindgarh 3** • **220 kV Ropar – Gobindgarh 2** • **220 kV GT Unit – 6** • **220 kV GT Unit – 5** • **220 kV GT Unit – 4** • **220 kV ST - 4** • **220 kV ST - 3** • **220 kV Bus Coupler**
d.	Single line diagram showing the connection (isolators) of various 400 KV lines, bus coupler, ICT's etc	Attached
e.	Description and cause of event.	R-phase to ground fault at 220kV Kharar line and delayed opening of R-phase CB led to LBB operation of all other 220kV elements connected to Main Bus-3
f.	Antecedent conditions of load and generation, including frequency, voltage and the flows in the affected area.	Generation Loss- 463 MW Load Loss- appr. 60 MW Voltage – 232 kV
g.	Time duration of tripping including Weather Condition prior to the event.	Weather Condition - Heavy rain and lighning
h.	Duration of interruption and Demand and/or Generation (in MW and MWh) interrupted.	Nil
i.	All Relevant system data including copies of records of all recording instruments including Disturbance Recorder, Event Logger, DAS etc of DPR's of affected lines.	Attached
j.	Sequence of tripping with time.	#
k.	Details of Relay Flags.	
l.	Remedial measures.	*

220 kV S/S GURU GOBIND SINGH STPS ROPAR

Loading condition **Before** and **After** the Power System Fault Occurrence.
P.S Fault DATE: 30/11/2023 TIME: 06:51

Bus-Section	S.No	T/Line or ICT Description	Load in Amp (at 06:00 Hrs)	Load in Amp (at 07:00 Hrs.)
3	1	220 kV Ropar – Mohali	79	Trip
	2	220 kV Ropar – Kharar	115	Trip
	3	220 kV Ropar – Bassi Pathana	103	Trip
	4	220 kV Ropar – Gobindgarh 3	86	Trip
	5	220 kV Ropar – Gobindgarh 2	86	Trip
	6	220 kV GT Unit – 4	382	Trip
	7	220 kV GT Unit - 5	349	Trip
	8	220 kV GT Unit - 6	388	Trip
	9	220 kV ST – 3	23	Trip
	10	220 kV ST – 4	16	Trip
	11	220 kV Bus-coupler-2	65	Trip
2	12	220 kV GT Unit - 3	Shutdown	Shutdown
	13	220 kV Ropar- Gobindgarh 1	93	42
	14	100 MVA T/F – 1	25	39
	15	100 MVA T/F – 2	25	39
	16	220 kV Ropar – Jadla ckt- 1	93	49
	17	220 kV Ropar – Jadla ckt - 2	93	49
1	18	220 kV Ropar - Ghulal	199	80
	19	220 kV Ropar - Gaunsgarh	208	78
	20	220 kV Bus-coupler-1	OFF	OFF

Single Line diagram of 220/132 kV GGSSTP ROPAR



#Tripping Sequence

Section – 3

220 kV Ropar – Kharar

Ropar end:-

- Distance protection relay picked R-phase to ground fault in Zone-1 with fault current – 4.071 kAmp, Fault location – 33.91 km.
- Y phase and B phase CB open detected at 06:51:03.721 Hrs but R-phase CB did not open (**Ref to Annexure – 1**) and fault current isolated at 06:51:04.084 Hrs. (**Ref to Annexure – 2**) (Fault clearing time – 363 msec)

Kharar end (Time not synch, Actual time = Relay time – 10min 55sec.) -

- Distance protection relay picked R-phase to ground fault in Zone-1 at 07:00:46.298 Hrs. with fault current – 7202 kAmp, Fault location – 2.895 km. (**Ref Annexure -3**)
- Relay issued instant protection instant trip command to R-phase CB. CB open detected at 07:00:46.351 Hrs.
- Auto-reclose operated at 07:00:47.299 Hrs. and 3-pole open detected at 06:51:49.527 Hrs.

220kV Ropar – Mohali

Ropar end:- LBB Operation

Mohali end:- Line did not trip from this end.

220kV Ropar – Bassi Pathana

Ropar end: - Line tripped with LBB Operation.

Bassi Pathana:- Line did not trip from this end.

220kV GT UNIT – 4,5 & 6 :- Breaker tripped with LBB Operation.

220kV ST – 3 & 4:- Breaker tripped with LBB Operation.

220 kV Bus Couppler-2: - Breaker tripped with LBB operation

NOTE:- 220 kV Ropar – kharar line Rph CB delayed opening led LBB operation of all other 220 kV elements connected to Section 3 from this end, buscoupler-2 isolated the fault from section-3 main bus. **Bus Section 2 and Bus Section 1** remain charged.

220 kV Kharar end

- **66kV Kharar – Morinda ckt-1** (06:50 Hrs. to 07:24 Hrs.){Trip data not available in relays} :-
  - B-phase, Fault current – 4.42 kAmp, Fault location – 3.6 km

- **66kV Kharar – Morinda ckt-2** (06:50 Hrs. to 07:33 Hrs.) (Actual time = Relay time – 10min 55sec):-
  - Distance protection relay picked B-phase to ground fault at 06:58:19.719 Hrs. (Ref to **Annexure – 4**) and unpicked after 67 msec.
  - OC/EF protection relay operated at 06:58:21.090 Hrs. (**Ref to Annexure-5**)

Note (Reason of 66kV tripping):- Due to lightning

Conclusion :-

220/132 kV Ropar S/s

- 220kV Kharar line DPR operated for R-phase to ground fault in **Zone-1 at 06:51 Hrs.** and issued instant trip command but R-phase CB did not open in time, due to which fault feeding continued for 363 msec, this led to tripping of other 220kV elements connected to **Bus Section – 3** by **LBB relay operation** (Setting – 200 msec) and Section – 3 blacked out at Ropar. 220 kV Bus-coupler 2 also tripped at 220 kV Ropar which isolated Main Bus- 1 and 2 from Main Bus – 3 as Section-3 elements were only connected to Main Bus-3 and not with Reserve bus.
- 220 kV Ropar - Gobindgarh -1, T/F 1 & 2, Jadla ckt – 1 & 2 and GT Unit -3 were remain charged as it was part of Main bus-2 and similarly Ghulal, Gaunsgarh, and GT-1 were also remain charged as it was part of Main bus-1.

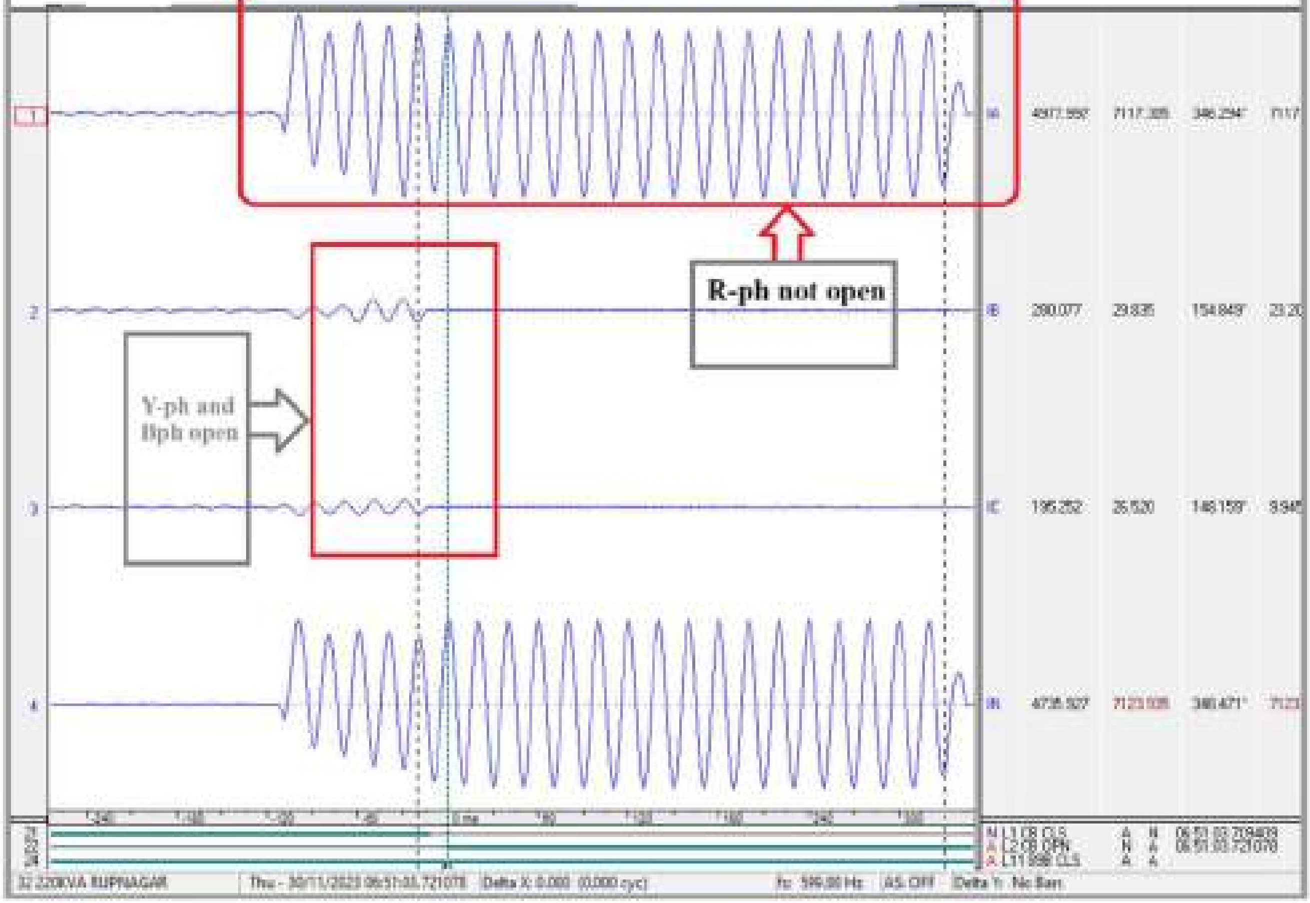
220 kV Kharar S/s

- 220 kV Ropar line end also tripped from Kharar end in **R-ph Zone-1**.
- 66 kV Kharar – Morinda ckt -1 & 2 tripped on line fault of **B-phase** (due to heavy lightning), Khara-morinda tripping has time gap of around 2 min 26 sec. from Ropar – Kharar tripping which indicates different faults.

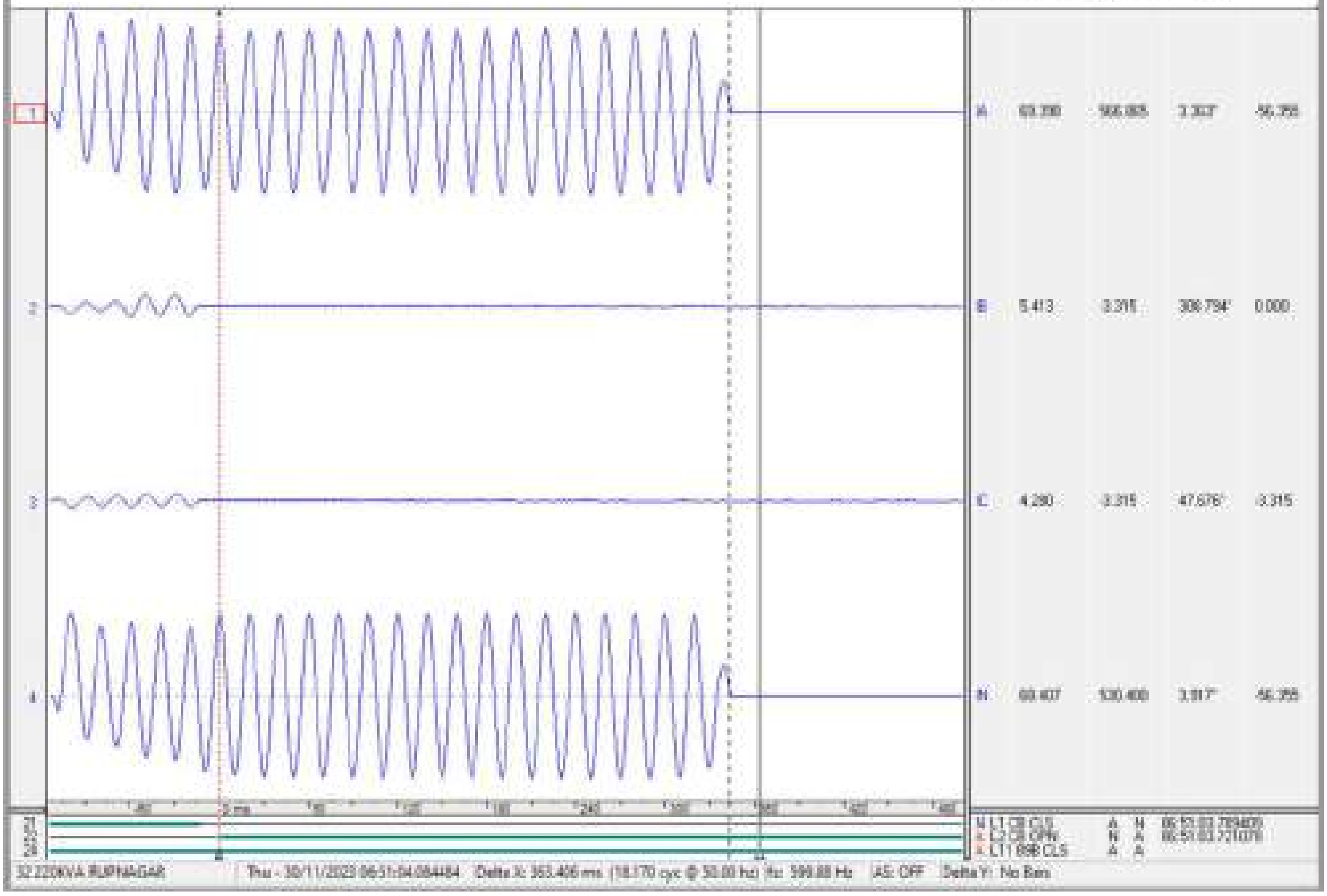
***Remedial Measure:-**

- Overhauling of **220kV kharar** Bay R-phase breaker started on **01.12.2023** by CGL Engineer and completed on 07.12.23. Huge pitting was found on R-phase moving & fixed contacts (**Ref to pictures attached**). Complete pole has been replaced. Other two phase CB found healthy and required preventive maintenance also carried out. 220kV Kharar Feeder re-energized on **dt 07.12.2023**.
- Overhauling of other feeder breakers also in progress and expected to be completed by May-2024.

Annexure - 1



Annexure - 2



Annexure - 3

- Time Stamp   Thursday 30 November 2023: 07:00:46.298
- Fault Alarms: 0100000000
  - 0 VT Fail Alarm: OFF
  - 1 CT Fail Alarm: OFF
  - 2 CB Status Alarm: OFF
  - 3 AR Lockout Shot>: OFF
  - 4 V<1 Alarm: OFF
  - 5 V<2 Alarm: OFF
  - 6 V>1 Alarm: OFF
  - 7 V>2 Alarm: OFF
  - 8 COS Alarm: ON
  - 9 CVT Alarm: OFF
- System Frequency: 49.99 Hz
- Fault Duration: 48.34ms
- Relay Trip Time: 80.02ms
- Fault Locatio XY   2895: m
- IA: 7202 A
- IB: 293.9 A
- IC: 329.5 A
- VAN: 15.13kV
- VBN: 142.6kV
- VCN: 147.6kV
- Fault Resista XY: 190.3mOhm
- Fault in Zone   Zone: 1
- Tripped Elts 2: 000000
  - 0 Trip I2>2: OFF
  - 1 Trip I2>3: OFF
  - 2 Trip I2>4: OFF
  - 3 Trip VN>1: OFF
  - 4 Trip VN>2: OFF
  - 5 Trip Zq: OFF

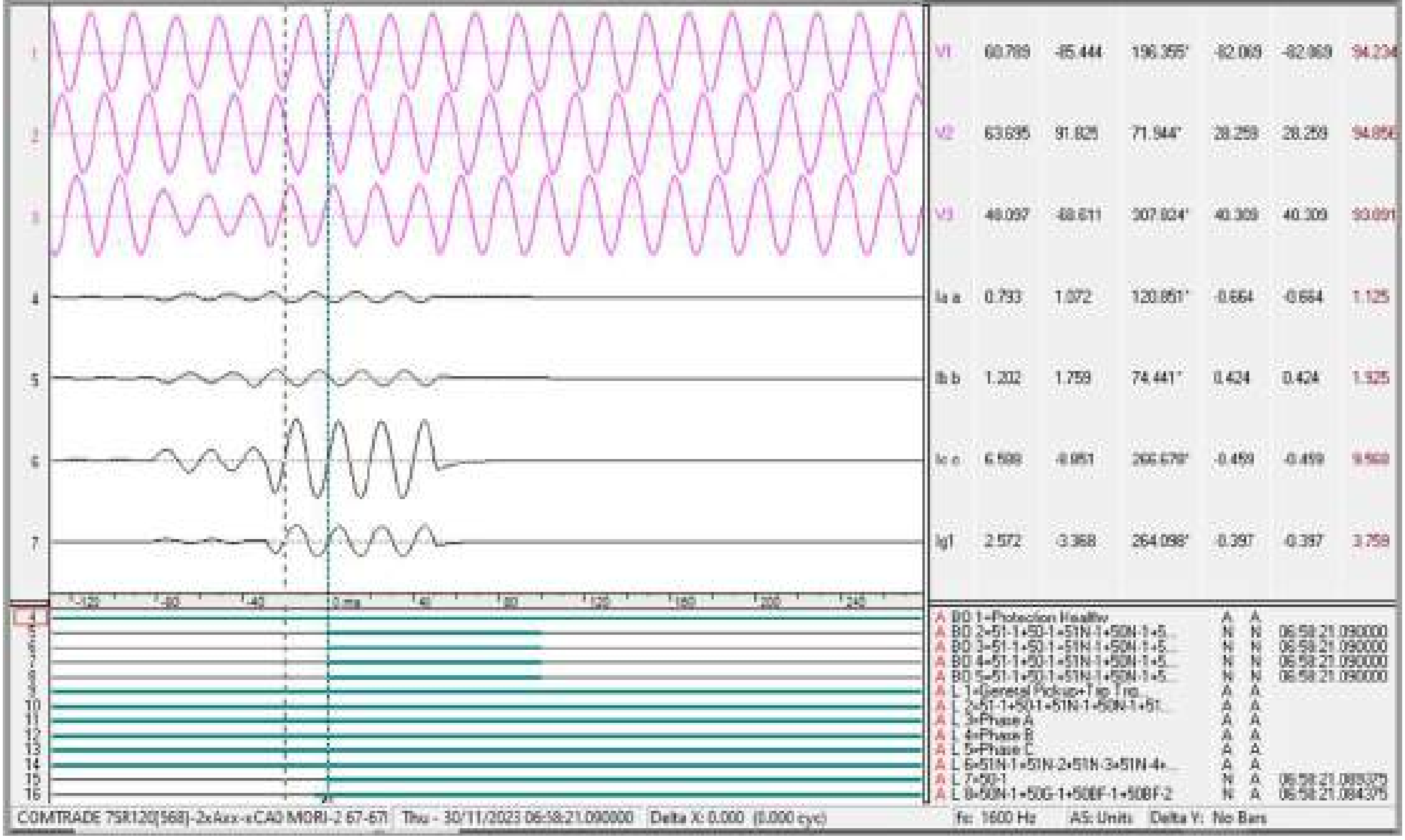
Annexure - 4

1.1 Trip Log - 000499 / 11/30/2023 6:58:19.719 AM - PSTCL_KARAR / Kharar / 66 kV / 66 kV_7SA611_MORINDA-2/7SA611 V04.74.02

Trip Log - 000499 / 11/30/2023 6:58:19.719 AM - PSTCL_KARAR / Kharar / 66 kV LINE / 66 kV_7SA611_MORIND 2/7SA611 V04.74.02

Number	Indication	Value	Date and time	Cause	State
00301	Power System fault	499 - ON	30.11.2023 06:58:19.719		
00302	Fault Event	500 - ON	30.11.2023 06:58:19.719		
03688	Distance Pickup L3E	ON	1 ms		
03703	Distance Loop L3E selected forward	ON	1 ms		
01335	Earth fault protection Trip is blocked	ON	11 ms		
03671	Distance PICKED UP	OFF	67 ms		
03703	Distance Loop L3E selected forward	OFF	67 ms		

Annexure - 5



V1 60.789 -85.444 196.355° -82.069 -82.069 94.234
V2 63.695 91.825 71.944° 28.259 28.259 94.856
V3 48.097 -68.611 307.024° 40.309 40.309 93.091
Ia a 0.793 1.072 120.851° -0.664 -0.664 1.125
Ib b 1.202 1.759 74.441° 0.424 0.424 1.925
Ic c 6.598 -8.951 266.679° -0.459 -0.459 9.560
Ig1 2.572 -3.368 264.098° -0.397 -0.397 3.759
0 ms
A BO 1=Protection Healthy A A
A BO 2=51-1+50-1+51N-1+50N-1+5... N N 06:58:21.090000
A BO 3=51-1+50-1+51N-1+50N-1+5... N N 06:58:21.090000
A BO 4=51-1+50-1+51N-1+50N-1+5... N N 06:58:21.090000
A BO 5=51-1+50-1+51N-1+50N-1+5... N N 06:58:21.090000
A L 1=General Pickup+Trip Trig... A A
A L 2=51-1+50-1+51N-1+50N-1+51... A A
A L 3=Phase A A A
A L 4=Phase B A A
A L 5=Phase C A A
A L 6=51N-1+51N-2+51N-3+51N-4+... A A
A L 7=50-1 N A 06:58:21.089375
A L 8=50N-1+50G-1+50BF-1+50BF-2 N A 06:58:21.084375
COMTRADE 7SR120[568]-2xAxx-xCA0 MORI-2 67-67I
Thu - 30/11/2023 06:58:21.090000
Delta X: 0.000 (0.000 cyc)
Fs: 1600 Hz
AS: Units
Delta Y: No Bars

220kV Kharar Bay R-phase Breaker

220kV Kharar Bay R-phase Breaker

220kV Kharar Bay R-phase Breaker

Multiple elements tripping at Kurukshetra (HVDC) (PG)

09th January 2023

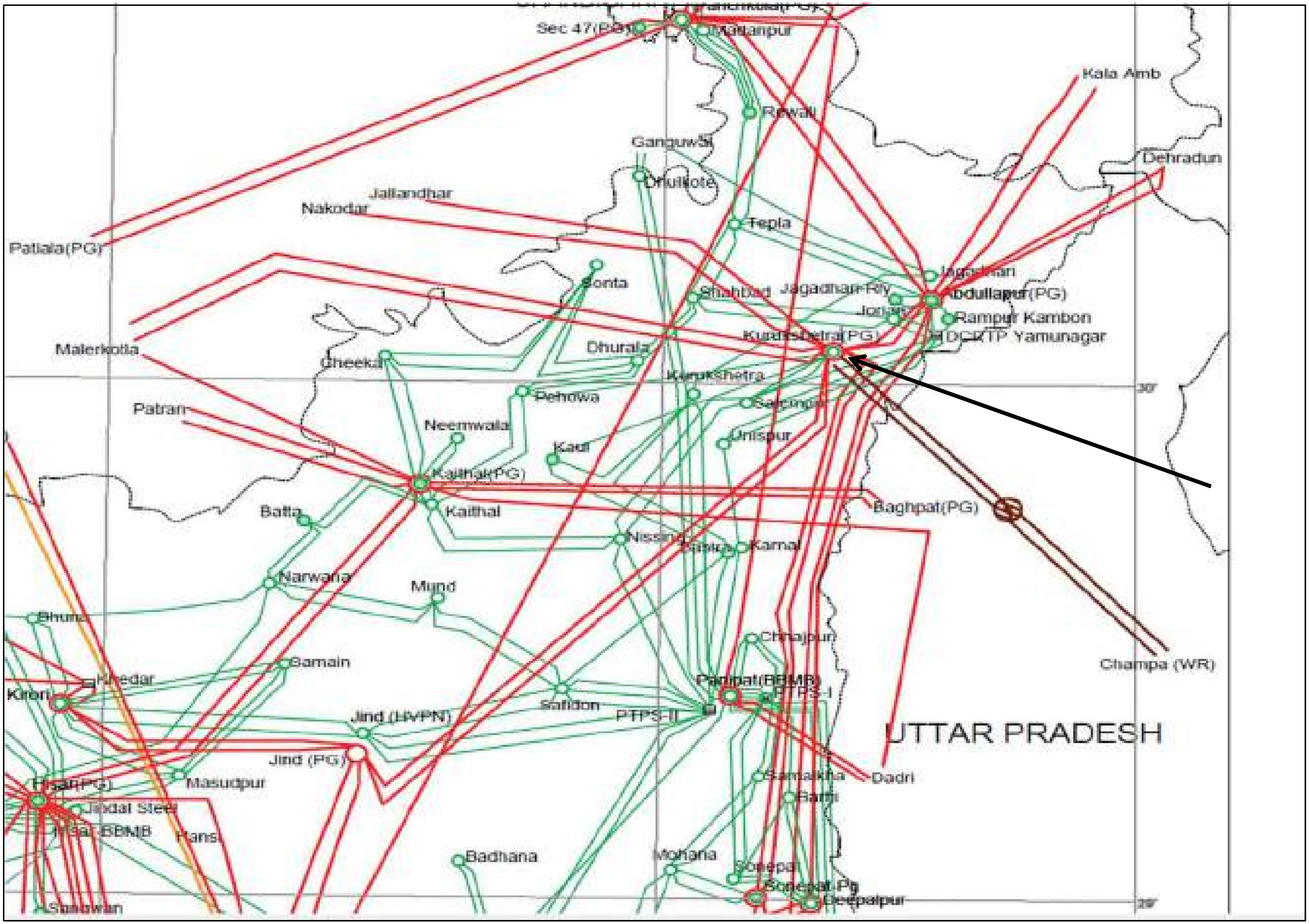
Brief of event:

- During antecedent condition, 800kV HVDC Champa-Kurukshetra Bipole was carrying total 2500MW (625MW each pole).
- As reported at 14:00:20hrs, ''commutation failure detected'' and "Pole4 Instability Detected by SSAD" protection latched in Pole4 which initiated CATA2 sequence for blocking of Pole4 and isolated Pole4 from parallel Pole2.
- Further after ~800msec of initiation of CATA2 sequence by Pole4 on Instability protection, opening sequence to HVHS at both ends didn't initiate which led to failure of protective isolation of faulty Pole4 and generated CATB alarm leading to tripping of parallel Pole2 also.
- Furtehr at 14:01:17 hrs, 17hrs, "Instability detected" protection latched in Pole1 also which initiated CATA2 sequence for protective isolation from Pole3.
- Further at 14:01:18hrs, like Pole4, CATA2 sequence in Pole1 also failed to initiate HVHS opening leading to protective sequence failure which generated CATB alarm that resulted in tripping of parallel Pole3.
- Due to tripping of all four (04) poles, power order redcued from 2500MW to 0MW.
- As per PMU, fluctuation in power order was observed.

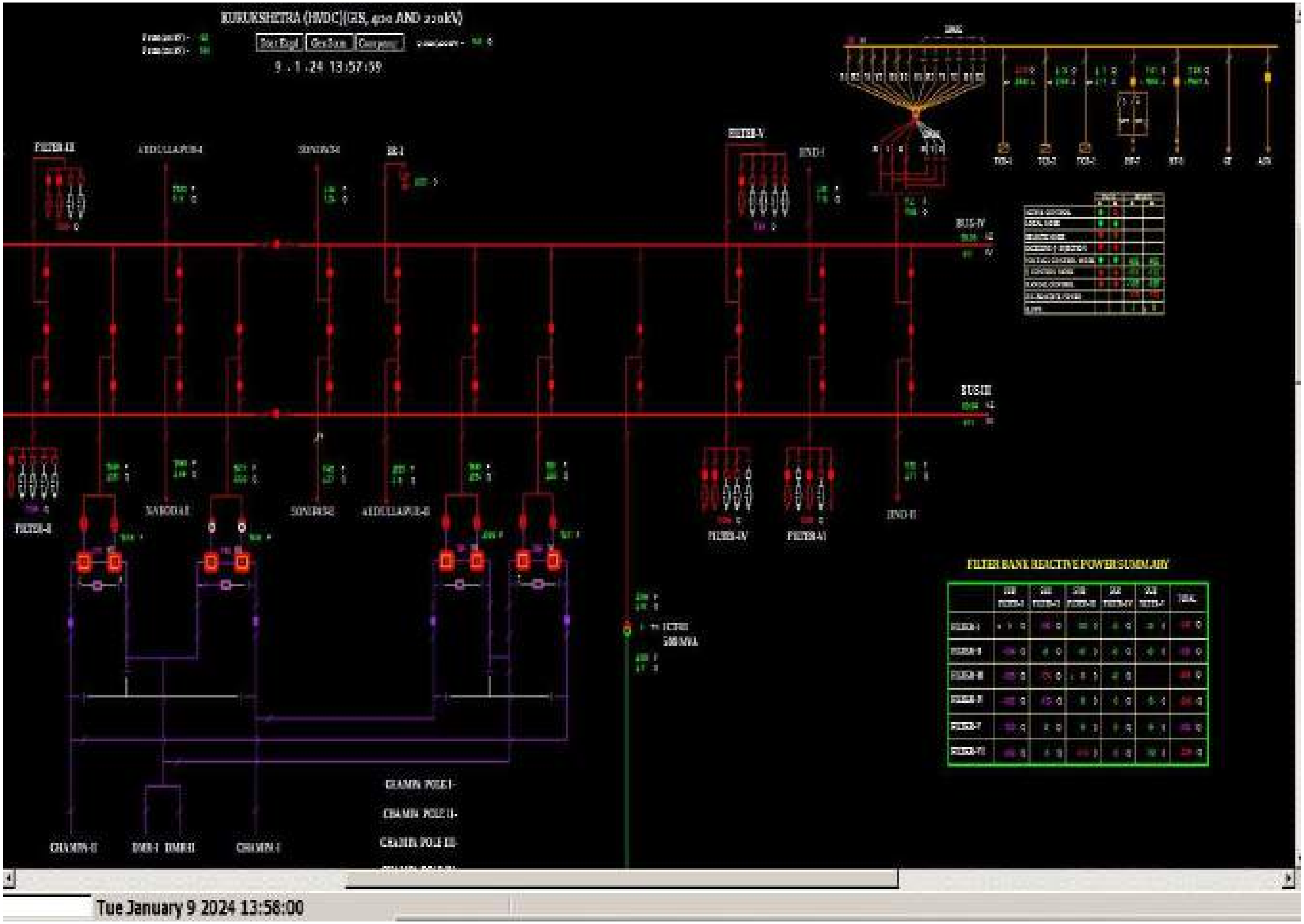
Elements tripped:

i. 800 KV HVDC Kurukshetra(PG)-Champa(PG) (PG) Ckt-1
ii. 800 KV HVDC Kurukshetra(PG)-Champa(PG) (PG) Ckt-2
iii. 800 KV HVDC Kurukshetra(PG)-Champa(PG) (PG) Ckt-3
iv. 800 KV HVDC Kurukshetra(PG)-Champa(PG) (PG) Ckt-4

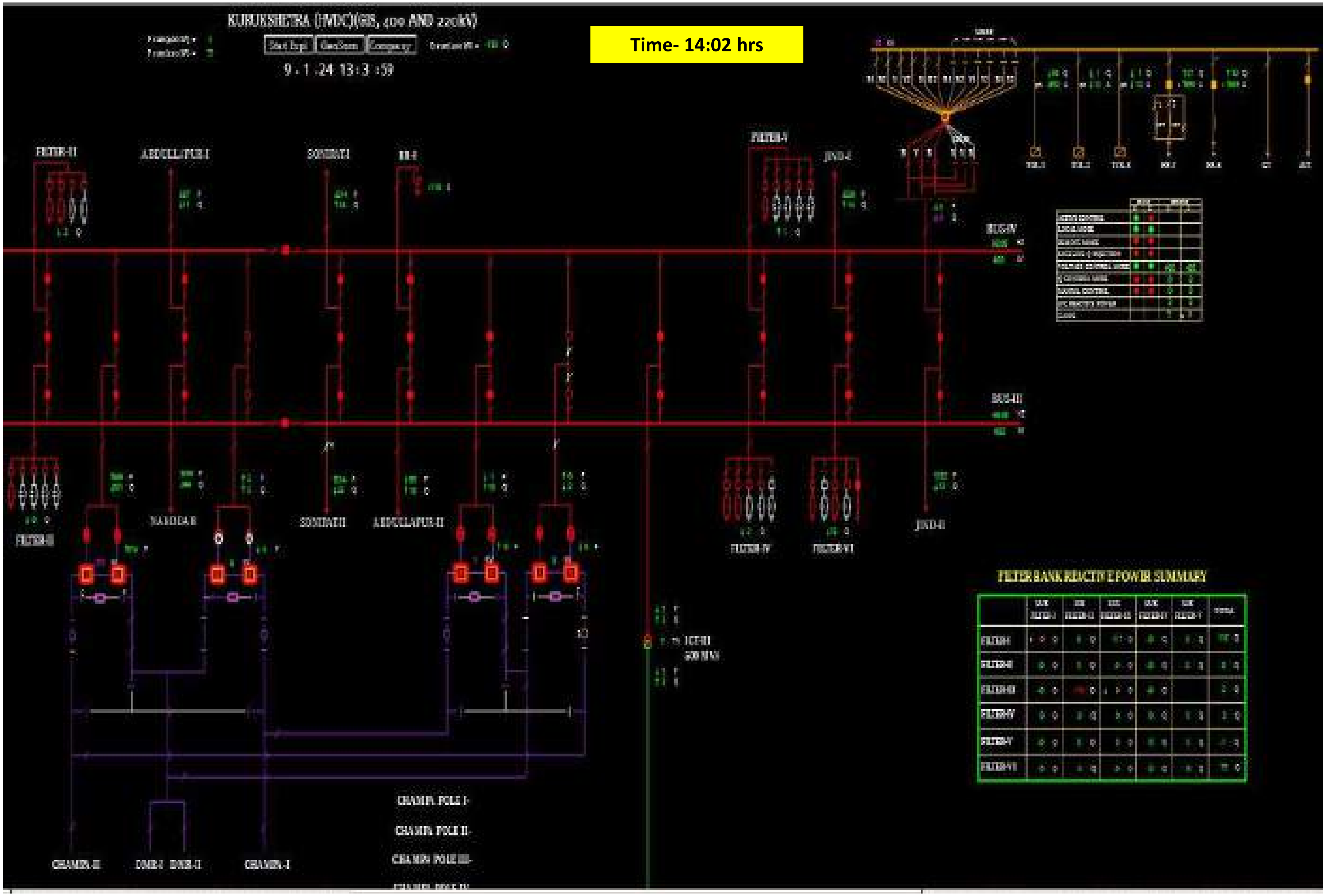
Network Diagram



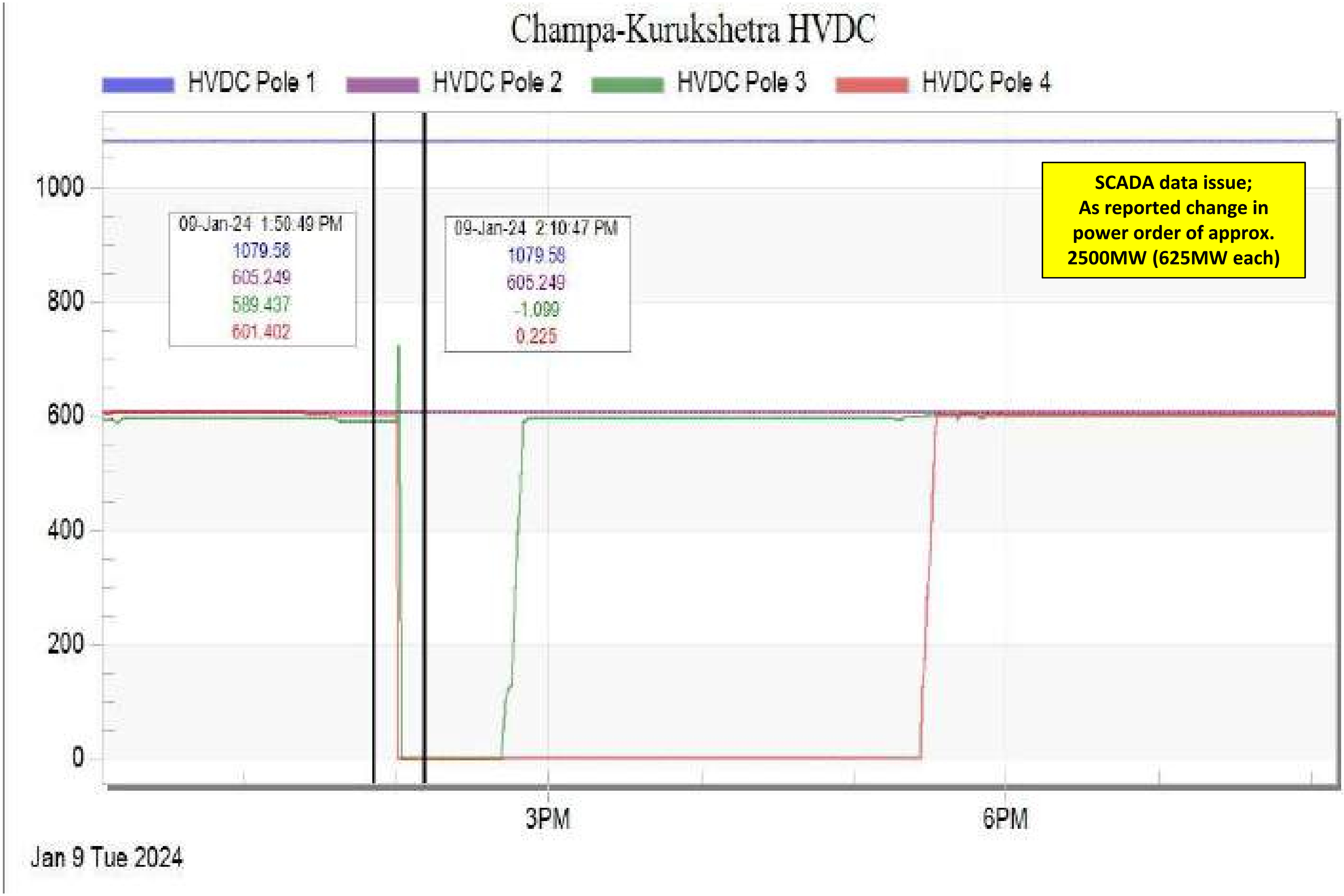
SLD of Kurukshetra (HVDC) before the event



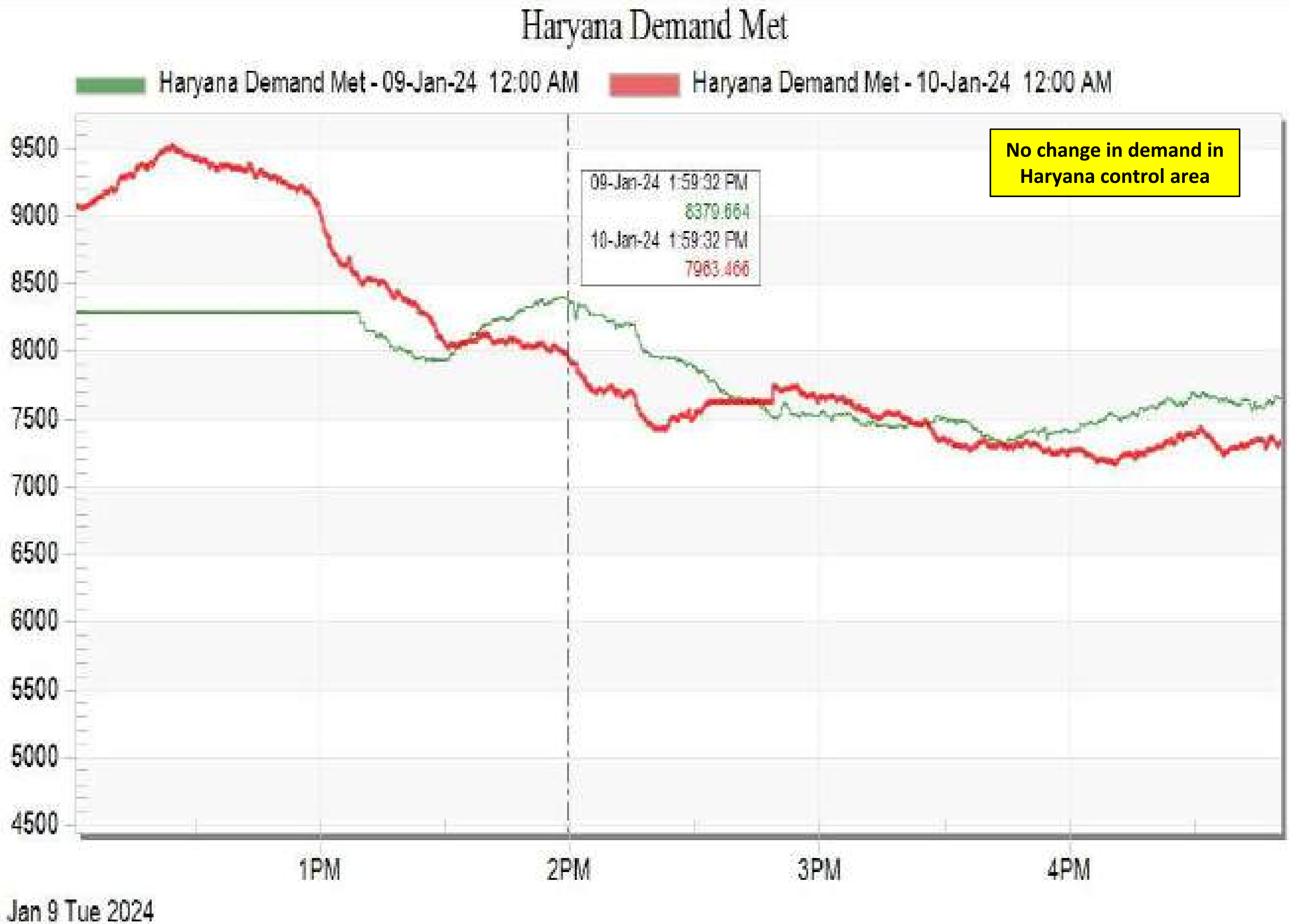
SLD of Kurukshetra (HVDC) after the event



HVDC Kurukshetra Power Flow during the event

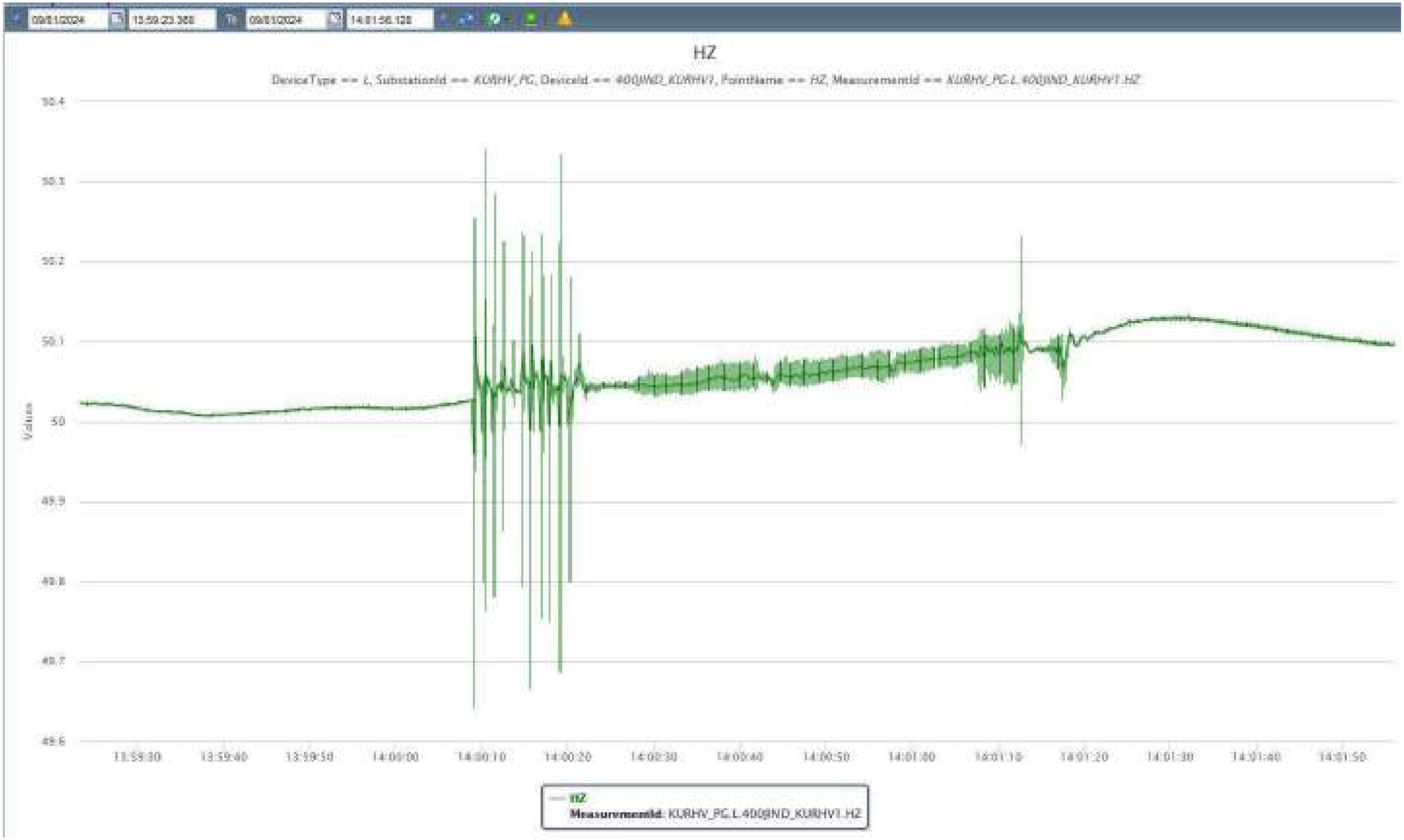


Haryana Demand during the event



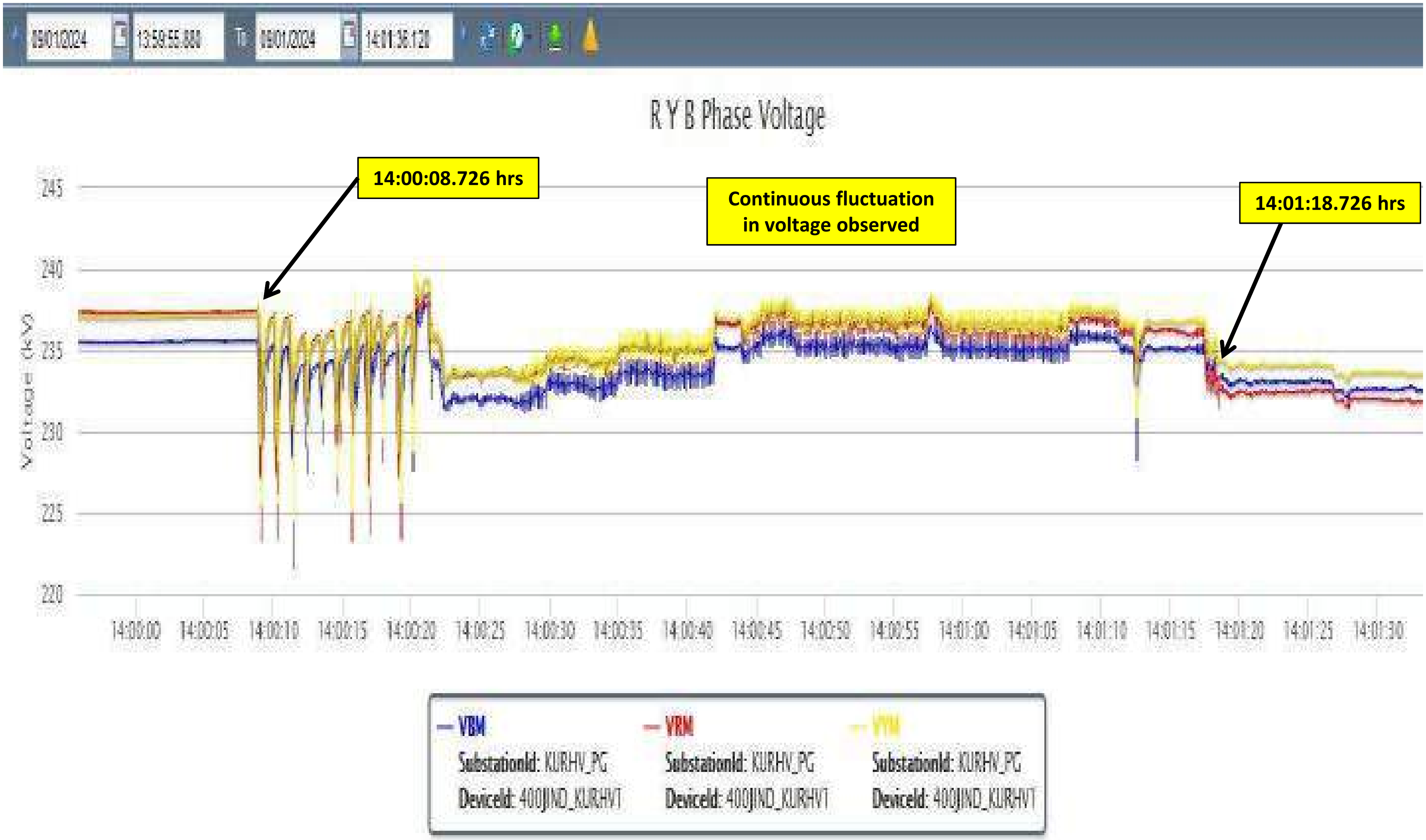
PMU Plot of frequency at Kurukshetra(PG)

14:00 hrs/09-Jan-24



PMU Plot of phase voltage magnitude at Kurukshetra(PG)

14:00 hrs/09-Jan-24



SCADA SOE

Time	Station Name	Voltage	Element Name	Element Type	Element Status
14:00:20,394	KURHV_P	400kV	33HV4TIE	Circuit Breaker	Open
14:00:20,395	KURHV_P	400kV	32KURHV4	Circuit Breaker	Open
14:00:21,084	KURHV_P	800kV	808_B	Circuit Breaker	disturbe
14:00:21,095	KURHV_P	800kV	808_B	Circuit Breaker	Open
14:00:21,169	KURHV_P	800kV	802_A	Circuit Breaker	Open
14:00:22,175	KURHV_P	400kV	BKC3_2	Circuit Breaker	Open
14:00:22,254	KURHV_P	400kV	BKC6_3	Circuit Breaker	Open
14:00:29,720	KURHV_P	400kV	BKC5_2	Circuit Breaker	Close
14:00:34,956	KURHV_P	400kV	BKC2_2	Circuit Breaker	Close
14:00:45,261	KURHV_P	400kV	BKC3_3	Circuit Breaker	Close
14:00:47,772	KURHV_P	400kV	BKC5_2	Circuit Breaker	Open
14:01:17,502	KURHV_P	400kV	BKC1_2	Circuit Breaker	Open
14:01:17,503	KURHV_P	400kV	BKC3_1	Circuit Breaker	Open
14:01:17,504	KURHV_P	400kV	BKC2_2	Circuit Breaker	Open
14:01:17,504	KURHV_P	400kV	BKC2_1	Circuit Breaker	Open
14:01:17,504	KURHV_P	400kV	BKC1_1	Circuit Breaker	Open
14:01:17,651	KURHV_P	400kV	20HV1TIE	Circuit Breaker	Open
14:01:17,651	KURHV_P	400kV	19KURHV1	Circuit Breaker	Open
14:01:18,315	KURHV_P	400kV	BKC5_1	Circuit Breaker	Open
14:01:18,315	KURHV_P	400kV	BKC4_1	Circuit Breaker	Open
14:01:18,318	KURHV_P	400kV	BKC4_2	Circuit Breaker	Open
14:01:18,477	KURHV_P	800kV	802_B	Circuit Breaker	Open
14:01:18,583	KURHV_P	800kV	808_A	Circuit Breaker	disturbe
14:01:18,594	KURHV_P	800kV	808_A	Circuit Breaker	Open
14:01:45,423	KURHV_P	400kV	BKC6_1	Circuit Breaker	Open

Point of discussion

i. Corrective actions taken/planned to be taken to minimise the frequent tripping of HVDC Chmapa-Kurukshetra Bipole and ensure its reliability?

पावरग्रिड
POWERGRID

पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड
(भारत सरकार का उद्यम)
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)

FAULT OCCURANCE/ANALYSIS REPORT

HVDC KURUKSHETRA

1. **Pole-4 blocked due to Instability Detected (SSAD) protection operated at Kurukshetra end.**
2. **Pole 2 blocked due to protective isolation failure of Pole 4 which initiated CAT B sequence leading to tripping of Pole 2.**
3. **Pole 1 blocked due to Instability Detected (SSAD) protection operated at Kurukshetra end.**
4. **Pole 3 blocked due to protective isolation failure of Pole 1 which initiated CAT B sequence leading to tripping of Pole 3.**

Date & Time of Blocking:	**Date & Time of Restoration:**
09.01.2024 @ 14:00:20 Hrs. (Pole-4)	09.01.2024 @ 17:26 Hrs. (Pole-4)
09.01.2024 @ 14:00:20 Hrs. (Pole 2)	09.01.2024 @ 14:33 Hrs. (Pole 2)
09.01.2024 @ 14:01:17 Hrs. (Pole 1)	09.01.2024 @ 14:32 Hrs. (Pole 1)
09.01.2024 @ 14:01:17 Hrs. (Pole 3)	09.01.2024 @ 14:42 Hrs. (Pole 3)

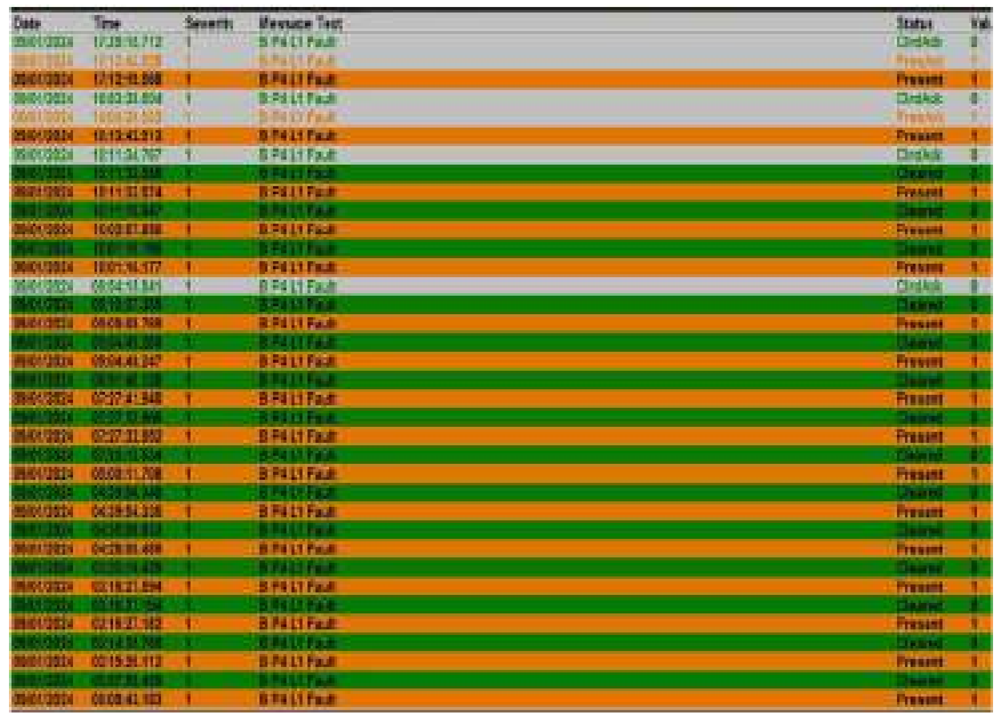
Antecedent Conditions:

- **Pole in Service** : Pole-1, Pole 2, Pole 3 & Pole 4 in service.
-
- **Operation mode** : DMR1//DMR2, Master Control Mode
- **Power Level** : 2500 MW (625 MW in each Pole)
- **St. Master Control** **:** Champa
- **Telecom** : Available
- **Bay in Service** : All converter bays & all ACF bays in service at KKR
- **Weather Conditions** : Clear at Kurukshetra.

Pole	Lane in control
Bipole-1	Lane-2
Bipole-2	Lane-1
Pole-1	Lane-1
Pole-2	Lane-2
Pole-3	Lane-1
Pole-4	Lane-2

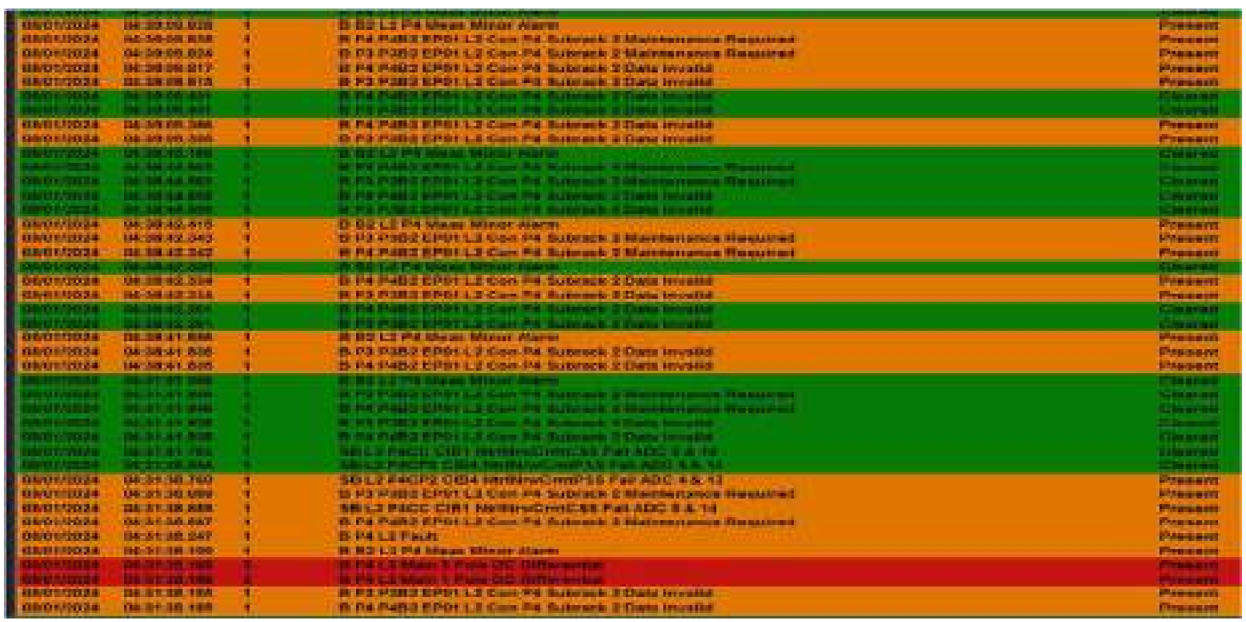
Sequence of Events:

- 00:08 hrs., 09.01.2024: “Pole 4 lane 1 fault” alarm appeared at Kurukshetra substation. After analysing Apex logs, it was found that “Lane 1 5005 card” of 1A4 Sub rack in VBE panel was faulty. Accordingly, lane 1 was rebooted from VBE panel and fault got reset. However, lane 1 fault repeated several times and became permanent at 10:13 hrs.



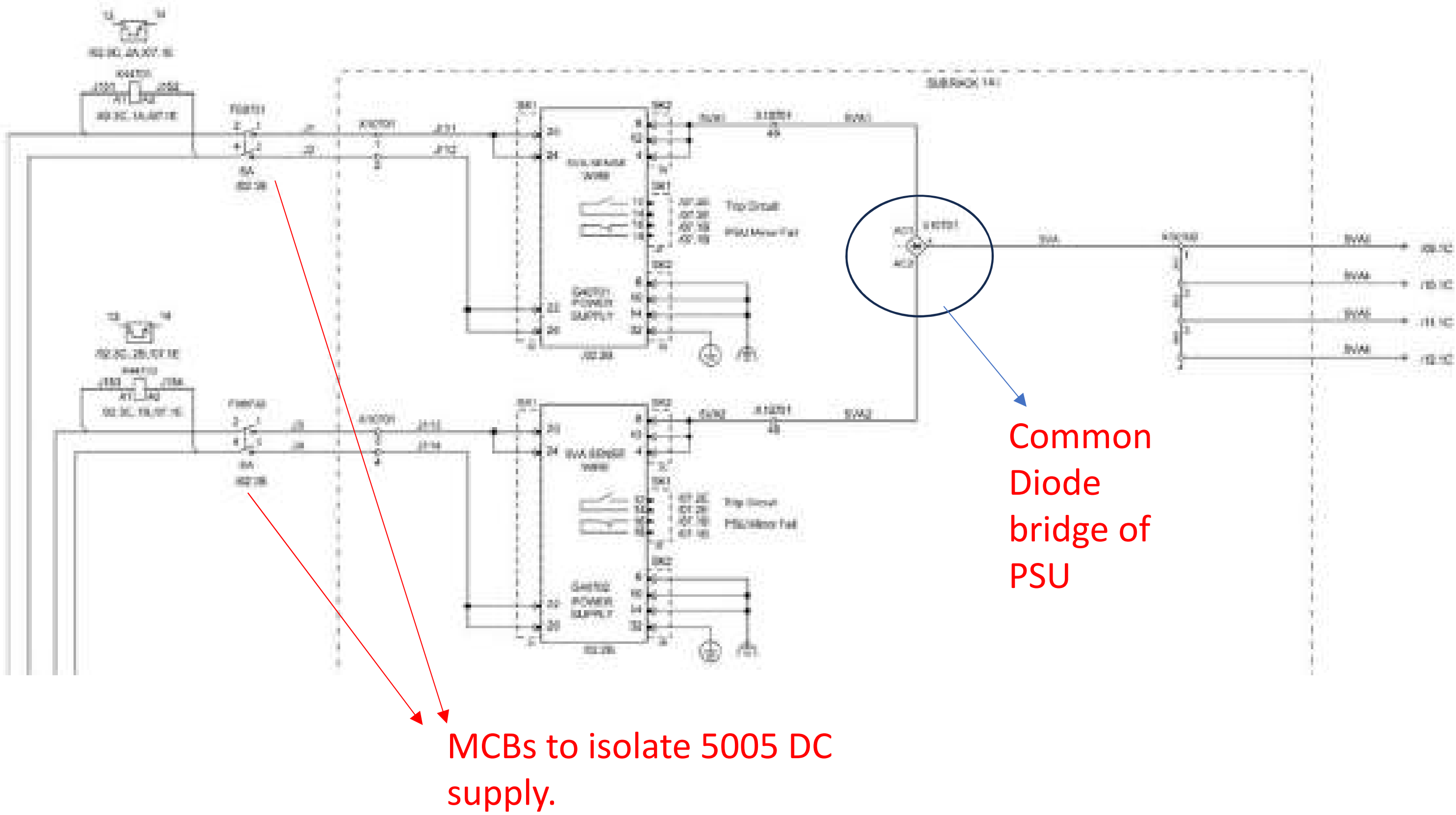
Sequence of Events:

- 09.01.2024: Due to permanent latching of Pole 4 lane 1 fault, system was running with lane 2 only and no redundancy was present. Also, there were multiple instances of Pole 4 lane 2 fault on 08.01.2024 due to COSI CT issue of Pole 4 lane 2 subrack 2. With Pole 4 lane 1 already faulty and reliability issues in Pole 4 lane 2 due to DCCT issue, there was high probability of both lanes failure in Pole 4 and such scenario would have resulted in tripping of multiple Poles. Accordingly urgent action to rectify Pole 4 lane 1 was required to maintain reliability of Pole 4 operation.



Sequence of Events:

❖ 09.01.2024 11:00 hrs.: Pole 4 lane 1 was kept in maintenance mode and accordingly work to troubleshoot Pole 4 lane 1 fault was started.



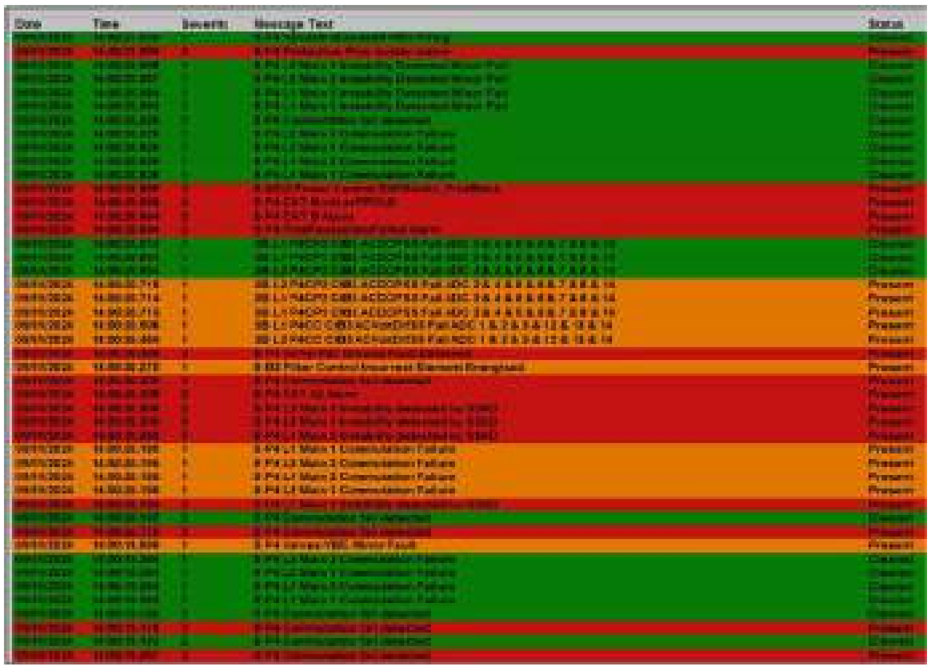
Sequence of Events:

❖ To isolate Power supply of Lane 1 5005 card, MCB F08731 & F08732 were needed to be switched off. When MCB 8732 was switched off, persistent Voltage fluctuations started with MCB F08731 switched on. The Voltage at TB X10702 was measured and found to be 4.6 Volt which is lower than permissible limit of 5±0.1 Volt. Accordingly, it was suspected that primary reason of 5005 card fault is low 5V DC Voltage due to faulty PSU G40701. The suspected PSU was replaced with spare healthy one, but the problem persisted even after replacing the faulty PSU.

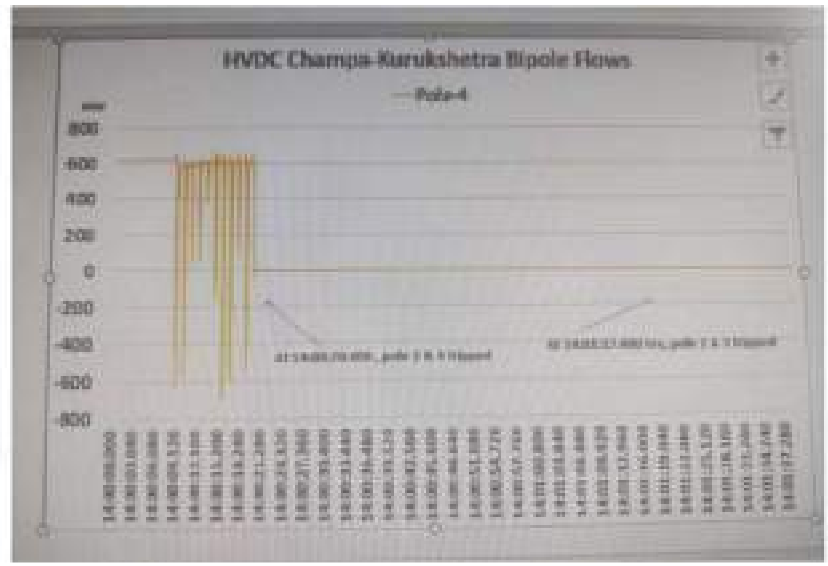
Suspected PSU replaced with spare healthy one.

Sequence of Events:

❖ 14:00:20 hrs.: Even after replacing suspected PSU, the issue of 5V voltage fluctuations continued. In the meantime, “Commutation failure” detected and “Pole 4 Instability Detected by SSAD” protection latched in Pole 4 which initiated CAT A2 sequence for blocking of Pole 4 and isolating Pole 4 from parallel Pole 2.



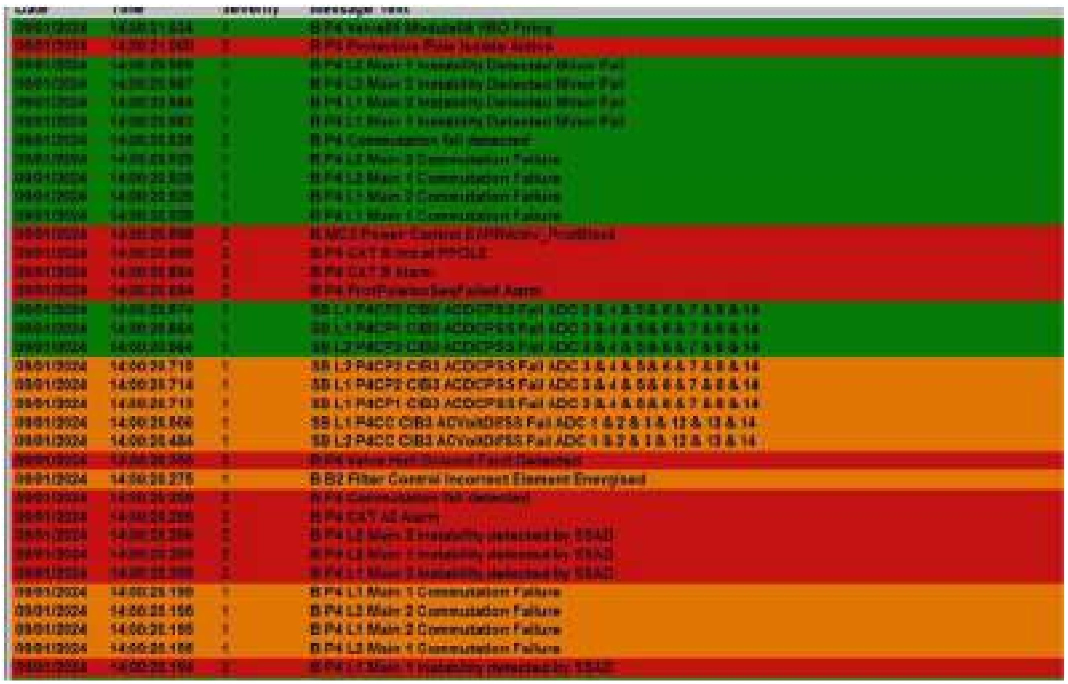
Date	Time	Severity	Message Text	Status



Severe Power Fluctuations observed in Pole 4

Sequence of Events:

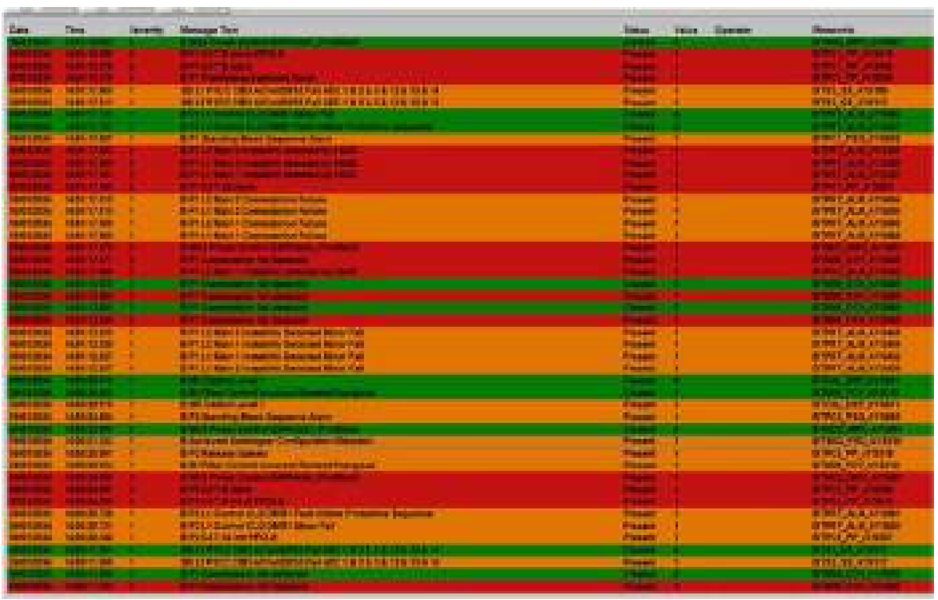
- ❖ 14:00:20:898 hrs.: After initiation of CAT A2 sequence by Pole 4 on Instability protection, opening sequence to HVHS at both ends was not initiated which led to failure of protective isolation of faulty Pole 4 and generated CAT B alarm leading to tripping of parallel Pole 2 also. The non initiation of protective isolate sequence by CAT A2 protection at Inverter end is a serious software issue and raises doubts on newly installed software in CK project on 05.01.2024.

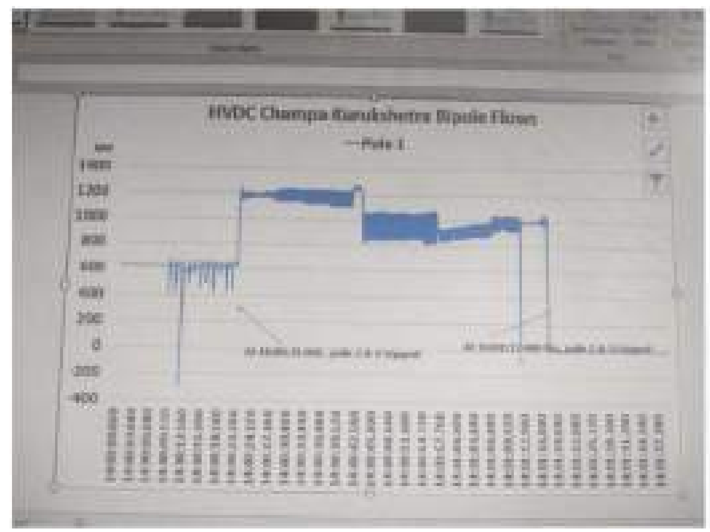


Sequence of Events:

- 14:01:17 hrs. : “Instability detected” protection latched in Pole 1 also which initiated CAT A2 sequence for protective isolation from Pole 3.

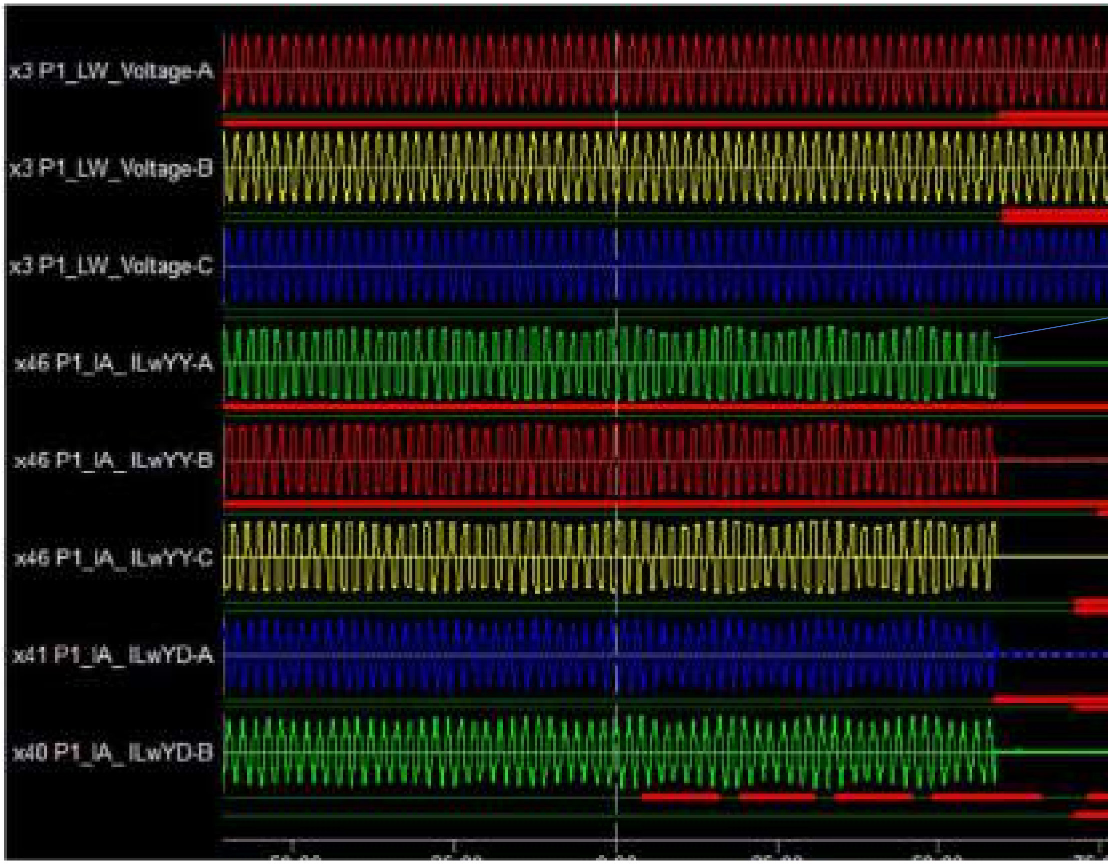
- 14:01:18 hrs.: Like Pole 4, CAT A2 sequence in Pole 1 also failed to initiate HVHS opening leading to protective sequence failure which generated CAT B alarm that resulted in tripping of parallel Pole 3.





Even after tripping of Pole 2 & Pole 4, severe oscillations observed for 1 minute in Pole 1 & 3

Pole 1 TFR



Severe Sub-synchronous oscillations observed in Pole 1 line winding current due to grid conditions which led to tripping of Pole 1 on Instability protection.

Sequence of Events:

14:42 hrs.: Pole 1 deblocked at 14:32 hrs., Pole 2 deblocked at 14:33 hrs. and Pole 3 deblocked at 14:42 hrs. Pole 4 charging was delayed to resolve Pole 4 lane 1 fault.

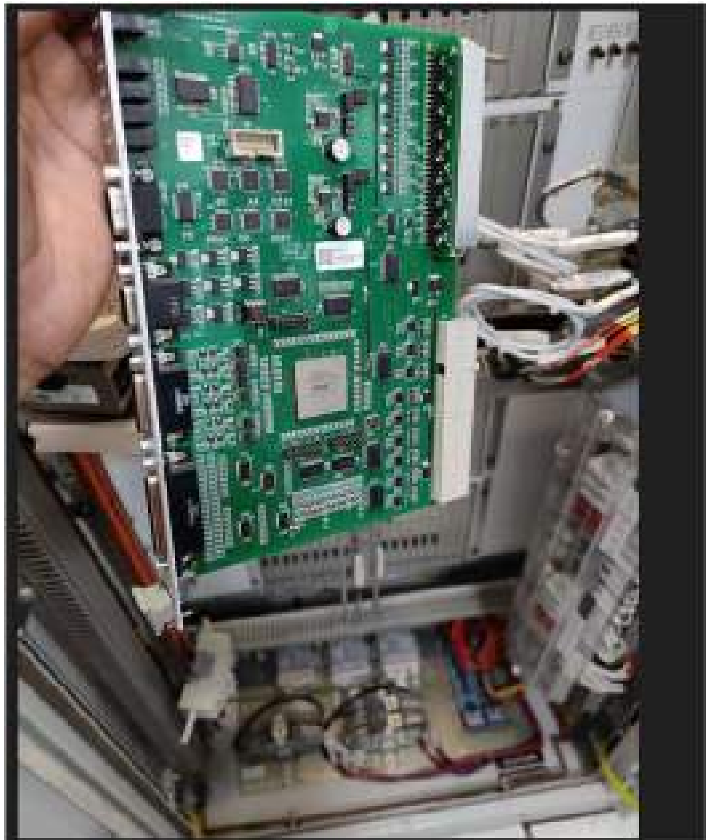
Troubleshooting in Pole 4:

* The work to troubleshoot Pole 4 lane 1 was again started after restoring tripped Poles.

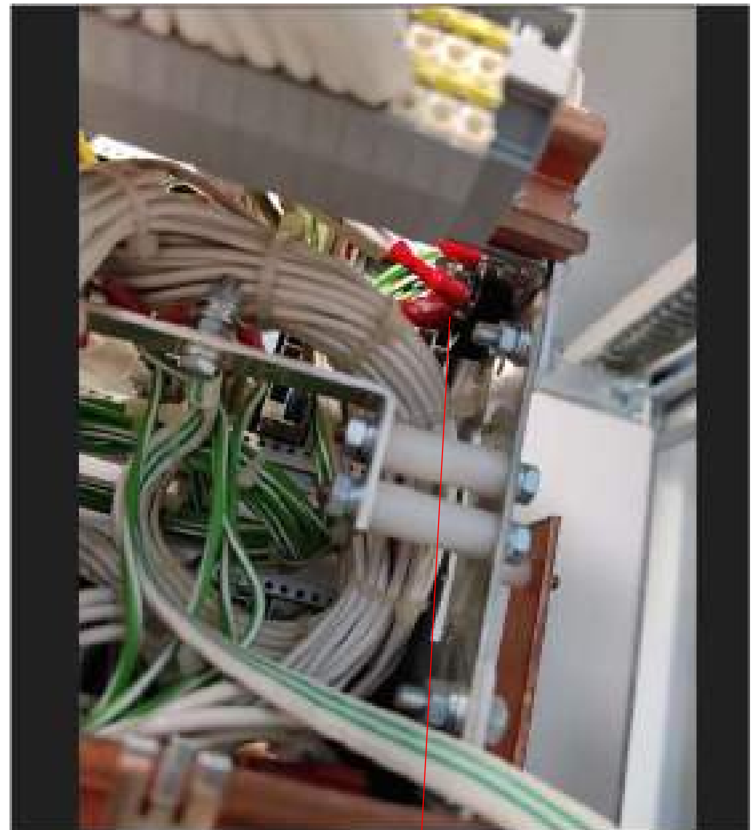
* As replacing suspected PSU failed to solve the problem, the whole PSU circuit was checked to identify the root cause of the problem. The diode wires in the output circuit of PSU were opened, cleaned and tightened again to ensure healthiness of PSU circuit. Also, the suspected 5005 card of A4 rack was replaced with spare healthy one.

*After performing above rectifications, no voltage fluctuations were observed in VBE lane 1 and also VBE fail error got healthy in A4 rack of VBE panel.

*The output Voltage at X10702 TB which was earlier observed beyond lower range was now measured to be 5.1 Volt which is within permissible range.



Faulty 5005 card replaced with spare one.



PSU output Diode contacts were opened, cleaned and retightened to ensure healthiness of PSU circuit.

Conclusion:

1. Tripping of Pole 2 & Pole 3 due to failure of Protective Isolation during CAT A2 sequence of parallel Pole is critical issue of new software version installed on 05.01.2024 and need to be addressed on priority to avoid further unwanted tripping of healthy Poles. The same has been intimated to GE for prompt action at their end.

2. Tripping of Pole 1 on "Instability Detected by SSAD" protection is due to response of HVDC controller to external grid conditions and need to be further analysed for avoiding future occurrences.

3. Recently several events of hardware failures have been observed at Kurukshetra terminal which require frequent manual intervention in online condition for resolution of issues. The major of them are listed below:

i) 05.01.2024 - Failure of 15 V PSU supply in Pole 2 lane 1. The faulty PSU replaced with spare one.

ii) 05.01.2024 – Failure of 5015 CIB card in Pole 3 lane 1. The faulty CIB card replaced with spare one.

iii) 05.01.2024 – Failure of 5008 card in Pole 3 lane 1 resulting in abnormal Inbs_oPole current in Pole 3lane 1 main 2 protection. The same was replaced with spare 5008 card in online condition.

Iv) 05.01.2024 – Failure of COSI CT subrack 2 in Pole 3 lane 2 due to high TEC temperature alarm. The same was replaced with already faulty COSI CT repaired at Kurukshetra site recently.

V) 06.01.2024 – Sys Fail appeared in Pole 4 lane 1. The same was rectified by rebooting Pole 4 lane 1 in online condition.

vii) 07.01.2024 – Pole 3 lane 1 COSI CT subrack 2 DI/MR alarm appeared frequently due to Optical loss in both Current sensor modules.

vi) 08.01.2024 – Failure of 5008 cards in Bipole 2 lane 1 and Bipole 2 lane 2 resulting in abnormal Pole 3 CVT voltage and Pole 3 line winding current respectively in Bipole 2 system. Both 5008 cards were replaced in online condition in order to maintain the system in healthy condition.

vii) 08.01.2024 – Pole 4 lane 2 COSI CT subrack 2 DI/MR alarm appeared frequently due to Optical loss in Current sensor module.

4. The majority of hardware failures observed recently are due to failure of 5008 cards and Optical CTs. The issue has been raised with GE several times but no concrete solution for the issues has been provided by M/s GE which affects the reliability of the system.

Annexure-XIV

DISTURBANCE RECORDER (DR) PARAMETER STANDARDIZATION

REPORT OF FOLD WORKING GROUP - 3

ACKNOWLEDGEMENT

The members of the Working Group-3 would like to extend gratitude to the FOLD management for being given the opportunity to be involved with this initiative. We would like to acknowledge the participation of each utility and organization (TRANSCOs, GENCOs, SLDCs, NLDC and RLDCs) for sharing valuable information, engaging in fruitful discussions, collection and improvisation of ideas related to different protection and operational philosophies and procedures which formed the basic building blocks for drafting the report on "Standardization of Disturbance Recorder Parameters".

Table of Contents

ACRONYMS

DR ………………………………………...Disturbance Recorder

DRPC…………………………. ………….DR Personal Computer

EL………...…………………………...Event Logger

ROT..Relay Operating Time

GPS………………………..……………Global Positioning Satellite

IDMT………………………………………Inverse Minimum Definite Time

TOR…………………..................................Terms of Reference

BCU……………………………………..Bay Control Unit

SAS……………………………………...Substation Automation System

HMI………………………………..…….Human Machine Interface

DCDB……………………………………....Direct Current Distribution Board

ACDB…………………………………….Alternating Current Distribution Board

IED……………………………………….Intelligent Electronic Device

NGR……………………………………..Neutral Grounding Reactor

CB………………………………………..Circuit Breaker

CEA…..Central Electricity Authority of India

CERC…………………………………….Central Electricity Regulatory Commission

IEGC……………………………….........Indian Electricity Grid Code

RTU……………………………………..Remote Terminal Unit

PREFACE

As per the discussion in 41st FOLD Meeting, a Working Group was constituted to streamline the Disturbance Recorder (DR) Parameter Standardization. According, a detailed study of the philosophies adapted by the power utilities in India and abroad was carried out. This report may be used by the power utilities as a guide for effective and optimal Disturbance Recorder Parameter Settings/Configuration in order to enable effective post-fault analysis for finding the root cause of an eventand suggest remedial measures. The present day modern IED's are IEC 61850 complaint and provide all standard features of DR configuration. The same can be utilized by the power utilities to incorporate all the necessary field level data (protection functions, switchgear status, and auxiliary device status) to provide valuable information to the event analysis group.

The **Terms of Reference (TOR)** of this group was to survey and compile prevailing national and international practices and standard regarding DR configuration, health monitoring and DR reader application software. Accordingly Working Group shall submit recommendations on the following aspects:

1. Triggering criteria of DR (Criteria for start of recording)
2. Sampling rate to be adapted for DR to enable verification of system models and to capture harmonics related to transient conditions
3. Recording window to cover pre-trigger, trigger (fault) and post-fault duration
4. Data format for raw data files of DR
5. Power supply arrangement for DR and associated equipment like GPS Receive/Clock, the SCADA/EMS RTU, modems and any other equipment supplying signals to the DR
6. Protocol for monitoring healthiness of DR including loss of supply, time synchronization

The group was mandated to prepare a report and submit within 3 months from the date of constitution of the Working Group.

MEMBERS OF FOLD WORKING GROUP

SN	NAME OF MEMBERS	DESIGNATION	CONTANCT NO.	AFFILIATION
1	Sh. Bimal Swargiary	Chief Manager	9435499779	NERLDC
2	Sh. Shashank Tyagi	Chief Manager	9599441243	NRLDC
3	Sh. Mohit Kumar Gupta	Manager	9650430505	NLDC
4	Sh. Akash Modi	Manager	8584072082	ERLDC
5	Sh. Vamshi Ballikonda	Manager	9480811828	SRLDC
6	Sh. Selvamani Prabaharan M	Deputy Manager	9629125521	WRLDC
7	Sh. Rupanka Kumar Goswami	AGM	9613146565	AEGCL, Assam
8	Ms. Barsha Kashyap	Deputy Manager	9706692773	AEGCL, Assam
9	Sh. Abhishek Kalita	Deputy Manager	8486213068	AEGCL, Assam
10	Sh. Nishanta Baruah	Asst. Manager	8473036988	AEGCL, Assam
11	Ms. Laishram Ritu	DGM	7008178772	SLDC, Manipur
12	Ms. Steffi Okram	Manager	8974724715	SLDC, Manipur
13	Ms. Jayela Wahengbam	DM	9856875084	SLDC, Manipur
14	Sh. B. M. Shah	EE	9925212836	SLDC, Gujarat
15	Sh. Shikhar Nema	AE	9425805299	SLDC, MP
16	Sh. Madhav Pande	Executive Engr.	9833608212	SLDC, Maharashtra
17	Ms. Smita Aparajita Pattanaik	Asst. Manager	9438908321	SLDC, Orissa
18	Sh. P. Balaji	Executive Engr.	9492129949	APTRANSCO
19	Sh. Sandeep Yadav	SE	9310404372	SLDC, Haryana
20	Sh. Munish Satija	Executive Engr.	9315016211	SLDC, Haryana

CHAPTER 1

INTRODUCTION

The Electricity Grid serves as one of the most important contributors for country's economic growth and emergency services. However, power system is prone to various types of faults and disturbances which can range from transient faults on transmission lines and switchyard equipments to system-wide disturbances. Investigation and root cause analysis of each grid disturbance is utmost necessary and critical for optimizing the performance of protection system and increasing reliability of the grid network.

Disturbance Recording devices have been in use since many decades. With advancement in technology and introduction of numerical relays, the capability of the Disturbance Recorder function in the relay has increased manifold. Standalone DR systems were used when internal DR recording facility for relays and BCUs were not available. For systems which still function with external DR recording devices may also incorporate the parameter standards proposed in this report accordingly (subjected to the features available in standalone DR or EL recording system). Recording of analog inputs with high sampling frequency, monitoring the status of internal protection functions, switchgear elements and auxiliary devices are available in modern IEDs. The tools required to perform post-incident analysis include extracted Disturbance Recorder files (Oscillographic Fault Records which include the analog values of currents and voltages, digital status of switchyard equipments and auxiliary relays and status of protection signals with accurate time stamps) and Event Logger files which can capture pre-event, event and post-event system conditions with high degree of accuracy and precise GPS based time stamping.

In the view of the critical importance of DR and EL data for event analysis, IEGC mandates submission of DR and SOE outputs by various entities/utilities for post-event analysis within 24 hours with RLDC. Each grid connected entity has a distinct configuration for DR parameter settings, which pose a challenge while analyzing events involving multiple entities or wide area disturbances. A standard philosophy and set of guidelines for DR parameter settings, analog and digital channel configuration is therefore utmost necessary which can be incorporated by the various utilities for achieving maximum benefit and conclusive results from the DR equipment.

CHAPTER 2

PURPOSE

Post-Despatch Analysis forms an integral part for ensuring system security and reliability. Disturbance Recorder (DR) output from Numerical Relays is an important tool for event analysis, which helps in classifying the cause of fault based on signature patterns and protection event logs. The DR data collected from the IEDs of affected elements along with pre and post fault information of the interconnected grid elements helps in proper root cause analysis to prevent occurrence of such events in future. Submission of DR and EL output is also mandated as per various provisions of CERC (Indian Electricity Grid Code) Regulations, 2010 and CEA (Grid Standards) Regulations, 2010 for quick analysis of the Grid Events. The following regulations can be summarized in brief as below:

As per clause no 5.2 (r) of CERC IEGC, all the users, STU/SLDC and CTU shall send information/data including DR/EL output to RLDC within 24 hours.

As per section clause No. 4.6.3 of IEGC (System Recording Instruments), recording instruments such as Data Acquisition System/DR/EL/FL/Time Synch. Devices shall be provided by all users, STUs and CTUs and shall always be kept in working condition for recording dynamic performance of the system.

As per clause no 12(1) of CEA Grid Standard Regulation, any tripping of generating unit or transmission element shall be promptly reported by the respective Entity (along with relay indications), to the appropriate Load Despatch Centre in prescribed reporting formats.

As per clause no 15(3) of CEA Grid Standard Regulation, all operational data, including disturbance recorder and event logger reports, for analyzing the grid incidents and grid disturbances and any other data which in its view can be useful for analyzing grid incident or grid disturbance shall be furnished by all the Entities within twenty-four hours to the Regional Load Despatch Centre and concerned Regional Power Committee.

However, it has been observed that post-despatch analysis is not effective at times in finding out the root cause of the event due to non-standardization of DR output.

The purpose of this report is to provide a general understanding of the considerations required for standardization of Disturbance Recording output so that uniformity is maintained by the utilities during DR submission.

CHAPTER 3

TRIGGERING CRITERIA FOR DR

Triggers cause a Disturbance Recorder or Micro-processor based relay to capture waveforms for specific power system conditions. Recording events may be triggered by changes in measured analog values, calculated analog values, internal logical statements, operation of protection elements or by change in state of an external input.

The triggering criteria for DR generation should be "**Start of Any Protection Function and Trip Event**" as per the following observation:

During grid disturbances which results in cascade tripping events, studyingbehaviour pattern of various upstream and downstream relays is of utmost importance. The most general cause of underreaching/overreaching and maloperation of unit/non-unit protections are due toimproper grading of individual operating times resulting in inadequate time discrimination among different protections functions (TMS, preset time delay), impedance reach, external discrepancies, internal logical errors and deviation from standard setting guidelines.

If "Start of Any Protection Function and Trip Event" is set in the IEDs as triggering criteria for DR generation, the DR and EL files can be extracted from upstream/downstream and associated elements during a large-scale grid disturbance, a thorough study can be carried out to pinpoint the actual cause of maloperation of the protection scheme. The absence of "Any Start" signal as the triggering criteria will miss out DR generation at crucial places which might lead to a non-conclusive post event analysis.

The internal storage capacity of memory in IEDs may vary for different manufacturers. However, the memory clearing function follows the FIFO(First-In-First-Out) method when the storage memory gets filled up. It should be a practice to extract the DR files immediately after occurrence of a grid disturbance event and transfer the relevant files to a secondary storage device (DRPC or dedicated workstations). This would nullify the chances of overwriting of memory and loss of actual disturbance recorder files.

Recommendation: Triggering Criteria for DR should be "Start of Any Protection Function and Trip Event"

CHAPTER 4

SAMPLING RATE TO BE ADOPTED FOR DR TO ENABLE VERIFICATION OF SYSTEM MODELS AND TO CAPTURE HARMONICS RELATED TO TRANSIENT CONDITIONS

Sampling Frequency can be defined as the number of analog values samples collected per second by the IED. The Sampling Frequency is mostly inbuilt in the relays and is dependent on manufacturer and model number of IED. The same cannot be changed by the user (e.g. ABB, Siemens, MiCOM and ERL the sampling frequency is predefined). However, for GE make relays, the sampling frequency is selectable from a drop-down menu.

SN	Relay Make	Sampling Frequency (fs)
1.	ABB	1000 Hz
2.	SIEMENS	1000 Hz
3.	MICOM	Dependent on model No: P442: 1200 Hz P443: 2400 Hz
4.	GE	3200 Hz (Default) *Selectable
5.	ERL	4800 Hz
6.	ZIVERCOM	1600 Hz

TABLE 1: SAMPLING FREQUENCY VALUESFOR DIFFERENT RELAYS

Note: With increase in value of Sampling Frequency, the number of samples (Data for analog values) recorded or calculated per second increases and digital channels are more frequently time stamped which in turn increases the Data size of the DR file (.dat file)

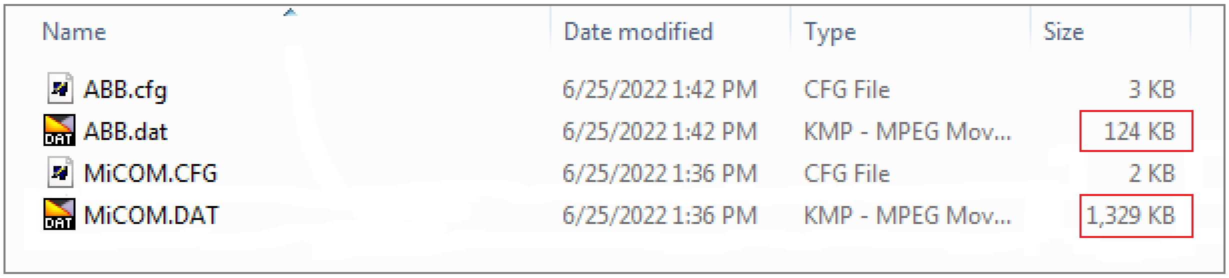


FIG 1: FILE SIZE COMPARISON OF GENERATED DR FILES BY DIFFERENT MAKE RELAYS FOR SAME EVENT

The above figure depicts the DR files generated for a 220kV Line with ABB make Main 1 relay and Alstom MiCOM make Main 2 relay (Difference in size of .dat file can be observed due to different sampling frequency). A comparison of data collected in the DR outputs for fs = 1000 Hz and fs = 2400 Hz for the same recording window, has been carried out with respect to root cause analysis.

Relay Make	**Model**	**Sampling Frequency (fs)**	**Data file size**	**Interval between successive samples**	**Fundamental and lower order harmonic values**
ABB	REL650	1000 Hz	124 KB	1ms apart	Approximately Same
MICOM	P443	2400 Hz	1329 KB	0.417ms apart	Approximately Same

TABLE 2: COMPARISON OF DATA DERIVED FROM DIFFERENT SAMPLING FREQUENCY

i) As per root cause analysis from recorded DR files, it can be observed that adopting a higher sampling frequency of 2400Hz does provide us more frequently collected fault data per interval but from a macroscopic point of view, a sampling frequency of 1000 Hz does not provide any less information for performing necessary observations and study.

ii) DR analysis particularly deals with observation of the sinusoidal trends of current and voltage waveforms (values of voltage, current, phase angle, harmonics etc.) along with the status of protection functions and various switchgear and auxiliary relays. A Sampling Frequency of >= 1000 Hz would be acceptable as each sample can be viewed in the DR at an interval of 1ms apart

iii) Relay Operating Time for Unit Protection functions are instantaneous (<30ms) whereas for backup protection functions it may vary from 50ms to >1 second (e.g. IDMT curve settings, definite time delays). Hence, sampling at 1ms interval is sufficient for analysis of the sequence of events (start and trip of protection functions and analyzing the sinusoidal values of voltages and currents) for root cause analysis.

Recommendation: Sampling Rate to be adopted should be greater than or equal to 1000 Hz

CHAPTER 5

PARAMETER SETTINGS FOR RECORDING WINDOW TO COVER PRE-TRIGGER, TRIGGER (FAULT) AND POST-FAULT DURATION EFFECTIVELY

Power system protection is basically divided into two parts:

i) Unit Protection
ii) Non-Unit Protection

The unit protections (Differential protection of transformers, line feeders, busbar, and inherent protection of transformers) should separate the faulty section instantaneously with higher accuracy of selectivity and reliability. Whereas the non-unit protections (IDMT overcurrent and earth fault, definite time delayed protections, delayed zones of distance protection) provide as a backup for the main protections in case of its non-operation or underreaching conditions.

The DR recording window should provide sufficient information for capturing the response of the above mentioned protection philosophies along with details about pre-fault scenario and post fault clearance scenario of the grid elements for thorough in-depth analysis.

The pre-fault recording window is an important aspect for DR analog and digital channels due to the following reasons:

i) The direction of power flow and loading prior to the fault
ii) Observing the trends of current and voltage waveforms in the pre-fault state
iii) The status of digital signals prior to the fault (e.g. Carrier Healthy status, CB ready status, VT fuse fail status are vital points for failure of Distance Protection schemes)

A recording window of 500ms to cover the pre-fault scenario may be considered adequate and sufficient for this purpose.

The post-fault time set for DR recording window should have ample recording time to capture the operation of non-unit protections and delayed operation of unit protections from their pickup time. Considering the Auto-reclose dead time of 1s/1.5s, Relay Operating Time for E/F and O/C as a backup for Zone 2/Zone 3 protections), it can be derived that a minimum of 2.5 seconds of post – fault recording time should be considered to record all the power system events during any generalized fault scenario.

Recommendation:

SN	Description	Settings
1.	Pre-fault Capture Time	500ms
2.	Post-fault Capture Time	2500ms
3.	Total time of DR Window	3000ms

TABLE 3: ALLOTTED TIME FOR CAPTURE TIME OF DR WINDOW

Note:

i) The basic minimum length of DR window to be set is as per the above table. However, utilities may increase the Recording Time if required.

ii) The above setting of "time window parameters" may vary with respect to relay models and manufacturers. E.g. MiCOM relay provide setting field for "Total DR Window Time" and "Trigger Position" in percentage value. The above philosophy can likewise be implemented with respect to different relays.

iii) DR Recording features like "Trigger Mode: Extended" for MICOM relays "Scope of Waveform data: Power System Fault" can be utilized to record the overall sequence of events into a single DR file.

DISTURB RECORDER	MICOM	
Duration	3.000 s	0C.01
TriggerPosition	17.00 %	0C.02
TriggerMode	Extended	0C.03

No.	Settings SIEMENS	Value
0402A	Waveform Capture	Save with Pickup
0403A	Scope of Waveform Data	Power System fault
0410	Max. length of a Waveform Capture Record	3.00 sec
0411	Captured Waveform Prior to Trigger	0.50 sec

FIG 2: DR PARAMETER SETTINGS EXAMPLE FOR MICOM AND SIEMENS RELAY

CHAPTER 6

DATA FORMAT FOR RAW DATA FILES OF DR

The recorded DR files should comply with the Comtrade Standard IEC 60255-24, IEEE C37.111-2013

Recorded COMTRADE files are basically divided into three parts:

i) .hdr (Header File)
ii) .cfg (Configuration File)
iii) .dat (Data File)

Files with extension .inf and. rioare also present for some manufacturers. (These files store information about the trip events in the relay)

The **.dat file** contains the values measured for each of the input channels defined in the DR configuration for each sample in the record. It also contains the sequence number and time stamp each set of samples. The **.cfg** file contains the information required to interpret the .dat file. The DRs are viewed in third party softwares e.g. Wavewin by ABB, Siemens SIGRA etc.

Recommendation:

i) .cfg and .dat files are sufficient for DR viewing purpose
ii) Other files generated by relays of different manufacturers can be used for other purposes (e.g. Comtrade playback with relay test kit via .rio file).
iii) The .cfg file and .dat file can be edited to alter the Disturbance Recorder viewable information. E.g. the name of digital channels, analog channels can be changed via .cfg file whereas the values of analog quantities can be altered by editing the .dat file using third party softwares (e.g. notepad++). However, the permission to mask and secure the data records of DR files is solely based on relay manufacturers. E.g. ABB masks the .dat file in non-readable format.

CHAPTER 7

POWER SUPPLY ARRANGEMENT FOR DR AND ASSOCIATED EQUIPMENTS LIKE GPS RECEIVER/CLOCK, THE SCADA/EMS RTU, MODEMS AND ANY OTHER EQUIPMENT SUPPLYING SIGNALS TO THE DR

The DR function is inbuilt in the IED which is powered by a DC source. The IED's are connected in a LAN configuration which is further extended to a centralized DRPC. The communication network is established with the help of Ethernet switches which are generally powered by DC source. Fibre Optic Cables, LAN cables, Light Interfacing Units etc. are used for establishing the Ethernet network. The GPS Receiver/Clock unit mostly has provisions for both AC and DC supply. Hence, it is utmost necessary to maintain two independent DC sources at the substation for redundancy.

Recommendation for redundancy in DC supply:

i) Two numbers of separate Battery Banks, Battery Chargers and DCDBs should be maintained
ii) Use of DC changeover relays in the C&R panel to ensure continuous DC supply for the IEDs, Ethernet switches, RTU's, GPS Units etc.

AC Supply is used by SAS Computers, Centralized DRPC, Metering PC and Gateway PCs. For SAS based substations, SAS HMIs plays a vital role in control and monitoring operations. The absence of AC supply can jeopardize the systematic and secure operations during time of emergency. Redundancy in AC supply is hence required to be maintained in the substation.

Recommendation for redundancy in AC supply:

i) Use of Inverters/UPS units (with immediate uninterrupted changeover) which bypasses the station AC supply to the equipments during healthy condition and inverts the DC supply from Battery banks during power supply failure

ii) Two separate set of inverters/UPS units should be used with the following configuration (if applicable) to promote redundancy:

Inverter 1: SAS-1, Gateway-1, DRPC

Inverter 2: SAS-2, Gateway-2, Metering PC etc.

Life contact/Watchdog contact can be utilized if available in case of *Standalone DR/EL system* to monitor its **healthiness** via *annunciator board*.

CHAPTER 8

PROTOCOL FOR MONITORING HEALTHINESS OF DR INCLUDING LOSS OF SUPPLY AND TIME SYNCHRONIZATION

A. Healthiness of IED:

Disturbance Recorder and Event Logger functions are inbuilt in the IEDs. Protection functions may depend on intra-IED Ethernet network link established in the substation (for GOOSE communication) based on adapted scheme. Hence, for monitoring the healthiness of the DR, it is mandatory to monitor the power supply to the IEDs and the healthiness of the Local Area Network.

IEDs come with self-supervision feature. Due to any internal hardware or firmware error, the IED automatically activates the "Error Mode" which can be observed by the 'Error LED' in front HMI or in the 'Event List' in the HMI. IEDs also comprise a "Watchdog/Self-supervision/Internal Fail potential free normally open (NO) contact which is latched in case of power supply failure or IED being in error mode. Such Watchdog contacts are also present in Ethernet switches and RTUs.

The healthiness of one relay can be monitored by the other relay by establishing a hard wiring between the watchdog contacts of the concerned relays with a Binary Input (Opto Input) of the other nearby relays. The same Binary Input can be linked with the DR digital channels.

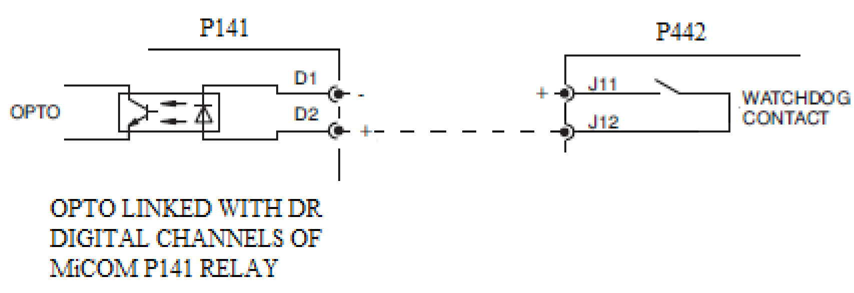


FIG 3: INTRA-IED HEALTHINESS MONITORING SCHEME WITH WATCHDOG CONTACT

E.g. For 132kV Lines, the protection scheme is based on Main Distance Protection relay and a backup Overcurrent and Earth fault relay. A case may arise when the Distance protection relay (say P442) failed to respond to a fault. In that case, if the healthiness of the P442 relay is monitored by the backup OC and EF relay (say P141), we may find from the extracted DR from P141 relay that, Dir. OC and EF protection had picked up for the fault along with a prevalent "Main relay Unhealthy" status. This would indicate the unhealthiness of the P442 relay during the instant of the fault and the doubt of discrepancy in relay settings can be left out.

Modern IEDs (IEC 61850 complaint) such a MiCOMP442 (in the above example) has inbuilt 'Logical Devices' viz. Control, Measurement, Protection, Records, Systems'. Each Logical Device has a 'Logical Node' called "LPHD" to monitor its health status. E.g. **Protection/LPHD1.ST.PhyHealth.stVal** can be used to monitor the healthiness of the Protection functions in the relay. However, these are suitable for tagging of SAS based alarms. For the purpose of DR channel configuration, fail proof Watchdog contacts should be utilized.

B. Healthiness of Time Synchronization:

The IEDs are in time synchronization with the GPS unit by IRIG-B (Inter-Range Instrument Group Time Code Format B) or SNTP (Simple Network Time Protocol)

For proper and in-depth analysis of power system faults (Sequence of Events, pickup and drop-off of protection functions), it is essential for relays at local and remote ends to be tie synched with the local standard time.

Basic Architecture of GPS time synchronization for IEDs in a substation

i) The GPS Receiver unit is present in the same Ethernet network as the IEDs. The GPS Antennae and the Time Display Unit is connected to the GPS Receiver
ii) The configuration for accessing the time through SNTP is present in the IED. E.g. ABB

SNTP: 1					
ServerIP-Add		172.16.0.140			
RedServIP-Add		0.0.0.0			

FIG 4: TIME SYNCHRONIZATION SETTINGS FOR ABB RELAY

In order to monitor the healthiness of the Time Synchronization, the following procedure can be followed. ABB, Siemens and MiCOM make relays are considered for the description:

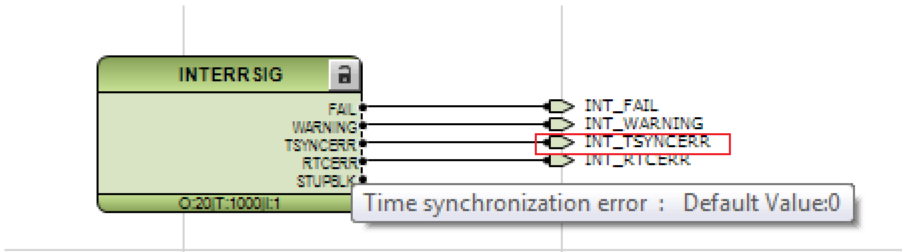


FIG 5: TIME SYNCHRONIZATION MONITORING FOR ABB MAKE RELAYS

The signal “TSYNCERR = Time Synchronization Error” form the functional block “INTERRSIG: Internal Error Signals” can be used. The annunciation and recording of Time Synch error can be achieved by:

i) The signal can be mapped to the DR digital channels
ii) The signal can be linked with SAS alarm tags
iii) The signal can be mapped with an LED of the relay
iv) The signal can be used to latch a Binary Output for connection to an external Annunciator Panel (for audible alarm) in case of loss of time synchronization

Information				Source							
Number	Display text	Long text	Type	BI	F	S	C	1	2	3	4
00067	Resume	Resume	OUT								
00068	Clock SyncError	Clock Synchronization Error	OUT								
00069	DayLightSavTime	Daylight Saving Time	OUT								
	SynchClock	Clock Synchronization	IntSP_E								
00070	Settings Calc.	Setting calculation is running	OUT								
00071	Settings Check	Settings Check	OUT								
00072	Level-2 change	Level-2 change	OUT								

FIG 6: TIME SYNCHRONIZATION MONITORING FOR SIEMENS MAKE RELAYS

The “Clock SyncError” signal in the Siemens relay can be mapped to the Disturbance Recorder Configuration; LED’s or tagged as SAS alarms.

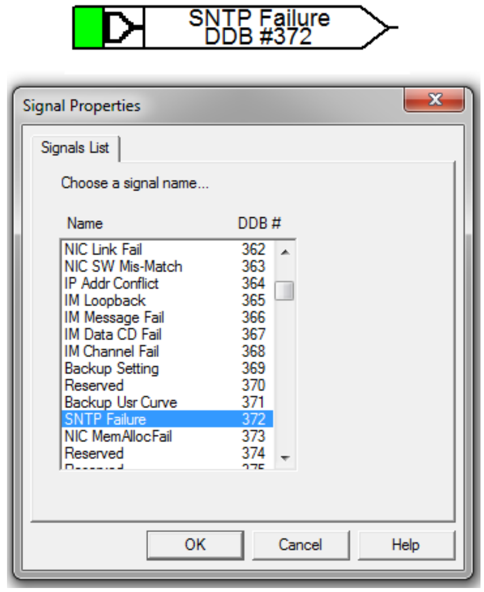


FIG 7: TIME SYNCHRONIZATION MONITORING FOR MICOM MAKE RELAYS

The Internal Input signal "SNTP Failure" can be mapped with the Disturbance Recorder Digital channels, LED's and SAS alarms.

Recommendations:

i) Use of Watchdog contact in IEDs to monitor its healthiness by establishing an intra-IED hard wired network and assigning the same to the digital channels of IED

ii) Use of internal Time Synchronization error signal in relays as input to the DR digital channel to monitor the time synch status of the relays during fault events.

iii) Integrating time synch error in station SCADA and remote RLDC end also

CHAPTER 9

INTERNATIONAL PRACTICES ADOPTED FOR DR PARAMETER SETTINGS

A. Triggering Criteria for DR

As per "An Examination of possible criteria for triggering swing recording in disturbance recorders" by Leonard Swanson & Jeffrey Pond, USA – a power equipment fault causes an instantaneous increase in current magnitude, decrease in the voltage magnitude, increase in power, local change in frequency, decrease in measured apparent impedance and changes in symmetrical component quantities. It is fairly localized in impact on the system. A criteria based on any one of these impacts can be used to determine the presence of a fault and trigger a fault recording event

- Change in magnitude of analog quantities
- Rate of Change of analog quantities
- Oscillation in frequency
- Change of state of External Inputs
- Relay internal logic (programmed) trigger

The above points refer to start or trip of a protection function, operation of relay logics and change of state of switchgear elements or auxiliary equipments.

As per "Requirements for a Fault Recording system" by Rich Hunt and Jeff Pond" – Triggering of records for protective relays is almost always based on the "**Pickup or operation of a protection function**".

B. Sampling rate to be adopted for DR

As per "Alberta Reliability Standard Disturbance Monitoring and Reporting Requirements PRC-002-AB-2" – Each legal owner of a transmission facility, generating unit and aggregated generating facility must have fault recording data that meets a minimum recording rate of 16 samples per cycle

As per “System Monitoring – Fault Recording” by National Grid Electricity Transmission (UK) (NGET), the sampling frequency of analog channels for fault recording purposes shall be at least 1 kHz. The measurements of analog channels shall have an accuracy of 1% or better.

C. Recording window to cover pre-trigger, trigger (fault) and post-fault duration

As per “An Examination of Possible Criteria for Triggering Swing Recording in Disturbance Recorders” by Leonard Swanson & Jeffrey Pond, USA – Recording of power equipment faults is used to verify the operation of the protection system, which should clear faults in a matter of cycles, so record lengths are typically in the range of 20 cycles to 10 seconds.

D. Data format for raw data files of DR

Data format to be followed should be as per IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for power systems. The recorded DR files should comply with the Comtrade Standard IEC 60255 – 24. DR files with extensions (.hdr, .cfg, .dat) are used for viewing the DR data.

E. Power supply arrangement for DR and associated equipments

As per “System Monitoring – Fault Recording” by National Grid Electricity Transmission (UK) (NGET), the fault record shall be stored in a non-volatile memory storage medium for subsequent retrieval by means of a Personal Computer (PC). The equipment shall be capable of retaining its selected parameterization and settings when its auxiliary energizing supply is removed and subsequent reinstated. Fault recording devices need to be powered via a UPS or other supply that would not be disrupted in the event of a de-energization of user’s connection.

F. Protocol for monitoring healthiness of DR including loss of supply and time synchronization

As per “Requirement for a Fault Recording System” by Rich Hunt and Jeff Pond –the following ideas are stated:

i) Redundancy in DFR
ii) Using a combination of devices to record the same fault
iii) Cross-triggering using contact wiring among IEDs or with intra-relay communication.

As per “Alberta Reliability Standard Disturbance Monitoring Equipment Installation and Data Reporting PRC-018-AB-1”, disturbance monitoring equipment should be equipped with internal clocks synchronized to within two (2) milliseconds or less of the Universal Coordinated time scale.

CHAPTER 10

RECOMMENDED LIST OF DR CHANNELS FOR GRID ELEMENTS

Generalized Protection schemes are considered for the configuration of the channels. The numbers of IEDs used at substation level may vary depending on the implemented scheme and to promote redundancy in protection schemes. The list of DR channels can be established with the segregation of protection functions and number of IEDs used.

Allocation and number of analog and digital channels varies for different manufacturers and models of relay. E.g. ABB (REL650) provides 40 numbers of analog configurable channels and 96 numbers of digital configurable channels. The “Trigger Decision” can be selected per channel.

MiCOM (P444) provides 8 analog channels and 64 digital channels (out of which the decision to trigger the DR can be set for 32 channels whereas the status of remaining 32 channels would be included in the DR when some protection function triggers it). MiCOM (P442) included 32 settable DR digital channels. Similarly, for Siemens relays, the numbers of allotted digital channels vary from 32 to 64+ depending on model used.

Based on study of practical fault scenarios and the DR analog and digital channels required to correctly arrive at a conclusive decision without ambiguity, the following list of DR channels are proposed for implementation. Keeping in view the constraints in number of allotted digital channels (for previous models of particular relays), the priority wise implementation can be carried out. Some relays have specific internal protection signals not common with other relays (e.g. phase selection logic in ABB relays). The same can be implemented in the DR if required. The following list contains the generalized group of signals which are present for all protection functions.

A. The protection scheme generally implemented for 132kV Transmission lines are as follows:

   i) Main 1: Distance Protection Relay (with associated functions)

   ii) Main 2: Backup Protection relay (with associated functions)

MAIN 1: DISTANCE PROTECTION RELAY

SL NO.	ANALOG CHANNELS	REMARKS
1	RØ VOLTAGE	
2	YØ VOLTAGE	
3	BØ VOLTAGE	
4	NEUTRAL VOLTAGE	
5	V_SYNCH (SYNCHRONIZING VOLTAGE)	WHEN TPAR IS IMPLEMENTED
6	RØ CURRENT	
7	YØ CURRENT	
8	BØ CURRENT	
9	NEUTRAL CURRENT (IN)	
10	MUTUAL COMPENSATION CURRENT (IM)	FOR PARALLEL LINES

TABLE 4:ANALOG CHANNELS FOR DISTANCE RELAY

SL NO.	DIGITAL CHANNELS	REMARKS
1	ZONE 1 PICKUP	
2	ZONE 2 PICKUP	
3	ZONE 3 PICKUP	
4	ZONE 4 (REV) PICKUP	
5	ZONE 1 TRIP	
6	ZONE 2 TRIP	
7	ZONE 3 TRIP	
8	ZONE 4 (REV) TRIP	
9	CARRIER AIDED ZONE TRIP (PUTT/POTT)	
10	AR BLOCK	
11	CB READY (AS PER AR LOGIC)	
12	AR START	
13	AR CLOSE COMMAND	
14	AR UNSUCCESSFUL	
15	AR SWITCH OUT	
16	SOTF INITIATION	
17	SOTF OPERATED	
18	VT FUSE FAIL	
19	BROKEN CONDUCTOR	
20	POWER SWING BLOCK	
21	CARRIER UNHEALTHY/FAIL	
22	CARRIER SWTICH OUT	
23	CARRIER SEND	

SL NO.	DIGITAL CHANNELS	REMARKS
24	CARRIER RECEIVE	
25	DT SEND	
26	DT RECEIVE	
27	CB CLOSE	
28	CB OPEN	
29	86 RELAY OPTD	
30	MAIN2/BACKUP RELAY/BCU FAIL	
31	TIME SYNCHRONIZATION STATUS	
32	LAN NETWORK STATUS	

TABLE 5: DIGITAL CHANNELS FOR DISTANCE RELAY

If the IED has more than 32 configurable digital channels (currently available IEDs provide more than 32 digital channels), these following signals are to be configured:

SL NO.	DIGITAL CHANNELS	REMARKS
1	RELAY 3Ø TRIP	
2	DISTANCE PICKUP (RØ-EARTH)	
3	DISTANCE PICKUP (YØ-EARTH)	
4	DISTANCE PICKUP (BØ-EARTH)	
5	DISTANCE PICKUP (RØ-YØ)	
6	DISTANCE PICKUP (YØ-BØ)	
7	DISTANCE PICKUP (BØ-RØ)	
8	AR IN PROGRESS	
9	AR SUCCESSFUL	
10	96 RELAY OPERATED	

TABLE 6: OTHER IMPORTANT DR DIGITAL CHANNELS

MAIN 2: BACKUP PROTECTION RELAY

SL NO.	ANALOG CHANNELS	REMARKS
1	RØ VOLTAGE	
2	YØ VOLTAGE	
3	BØ VOLTAGE	
4	NEUTRAL VOLTAGE	
6	RØ CURRENT	
7	YØ CURRENT	
8	BØ CURRENT	
9	NEUTRAL CURRENT (IN)	

TABLE 7: OTHER IMPORTANT DR DIGITAL CHANNELS

SL NO.	DIGITAL CHANNELS	REMARKS
1	RELAY 3Ø TRIP	
2	OVERCURRENT R PHASE START	
3	OVERCURRENT Y PHASE START	
4	OVERCURRENT B PHASE START	
5	OVERCURRENT OPEARTED	
6	EARTHFAULT START	
7	EARTHFAULT OPERATED	
8	CB OPEN	
9	CB CLOSE	
10	86 OPEARTED	
11	96 OPERATED	
12	MAIN1 RELAY FAIL	
13	TIME SYNCHRONIZATION STATUS	
14	LAN NETWORK STATUS	

TABLE 8: DIGITAL CHANNELS FOR BACKUP PROTECTION RELAY

OTHER PROTECTION FUNCTIONS

SL NO.	DIGITAL CHANNELS	REMARKS
1	LBB INITIATION	
2	LBB RETRIP	
3	LBB BUS/BACKUP TRIP	
4	CURRENT REVERSAL OPERATED	
5	WEAK INFEED/ECHO OPERATED	
6	UNDERFREQUENCY START	
7	UNDERFREQUENCY OPEARTED	
8	SPECIAL PROTECTION SCHEME OPERATED	

TABLE 9: DIGITAL CHANNELS OF OTHER PROTECITON FUNCTIONS (IF ENABLED)

*With respect to different relay manufacturers (additional internal protection signals e.g. Zone 1 single phase trip, Zone 1 multi-phase trip (Siemens); Phase selection start (indicating fault loop) in case of ABB etc. are present. These signals are a value addition in terms of DR analysis. If additional DR digital channels are present in the relays, the same can be added.

**The status of "CB Open" may also be utilized for triggering DR as per requirement to keep a track for CB operations (planned or spurious).

***If single pole CB is used for 132kV lines, refer (**TABLE 11)** for digital signals for Single phase Auto-reclosure and CB status.

B. The protection schemes and configuration at 220kV and above are as follows:

i) Main 1: Distance Protection (With associated Functions)

ii) Main 2: Distance Protection (With associated Functions)

SL NO.	ANALOG CHANNELS	REMARKS
1	VOLTAGE RØ	
2	VOLTAGE YØ	
3	VOLTAGE BØ	
4	VOLTAGE NEUTRAL	
5	CURRENT RØ	
6	CURRENT YØ	
7	CURRENT BØ	
8	CURRENT NEUTRAL (IN)	
9	MUTUAL COMPENSATION CURRENT (IM)	FOR PARALLEL LINES

TABLE 10: ANALOG CHANNELS FOR MAIN 1 AND MAIN 2 RELAYS FOR 220kV LINE

SL NO.	DIGITAL CHANNELS	REMARKS
1	TRIP RØ	
2	TRIP YØ	
3	TRIP BØ	
4	ZONE 1 PICKUP	
5	ZONE 2 PICKUP	
6	ZONE 3 PICKUP	
7	ZONE 4 (REV) PICKUP	
8	ZONE 1 TRIP	
9	ZONE 2 TRIP	
10	ZONE 3 TRIP	
11	ZONE 4 (REV) TRIP	
12	CARRIER AIDED ZONE TRIP (PUTT/POTT)	
13	AR BLOCK	
14	CB READY (AS PER AR LOGIC)	
15	AR START	
16	AR CLOSE COMMAND	
17	AR UNSUCCESSFUL	
18	AR SWITCH IN/OUT	
19	SOTF INITIATION	
20	SOTF OPERATED	
21	VT FUSE FAIL	
22	BROKEN CONDUCTOR	
23	POWER SWING BLOCK	
24	CARRIER UNHEALTHY/FAIL	
25	CARRIER SWTICH OUT	
26	CARRIER SEND	
27	CARRIER RECEIVE	
28	DT SEND	
29	DT RECEIVE	
30	EARTH FUALT START	

SL NO.	DIGITAL CHANNELS	REMARKS
31	EARTH FAULT OPERATED	
32	CB RØ CLOSE	
33	CB RØ OPEN	
34	CB YØ CLOSE	
35	CB YØ OPEN	
36	CB BØ CLOSE	
37	CB BØ OPEN	
38	86 RELAY OPTD	
39	96 RELAY OPEARTED	
40	MAIN2/MAIN1/BCU FAIL	
41	TIME SYNCHRONIZATION STATUS	
42	LAN NETWORK STATUS	

TABLE 11: DIGITAL CHANNELS FOR MAIN 1 AND MAIN 2 RELAY OF 220kV LINE

FOR 400kV AND ABOVE LINES WITH 1 AND ½ CB SCHEME

SL NO.	ANALOG AND DIGITAL CHANNELS	REMARKS
1	RØ TIE CT CURRENT	**TABLE 10** and **11** are also applicable for 400kV and above lines. **TABLE 12** are the additional signals which should be configured. N.B. **Pole Discrepancy** relay(PDR) is present in the CB Marshalling box, the status of which may be received in the relay and configured as Digital Input if potential free contact is available.
2	YØ TIE CT CURRENT	
3	BØ TIE CT CURRENT	
4	TIE CT NEUTRAL CURRENT	
5	RØ TIE CB OPEN	
6	RØ TIE CB CLOSE	
7	YØ TIE CB OPEN	
8	YØ TIE CB CLOSE	
9	BØ TIE CB OPEN	
10	BØ TIE CB CLOSE	
11	ALL AR DIGITAL SIGNALS FOR TIE CB	
12	WAIT FOR MASTER	FOR AR LOGIC
13	86 OPERATED TIE CB	
14	STUB PROTECTION OPERATED	

TABLE 12: ANALOG AND DIGITAL SIGNALS IN ADDITION TO TABLE-10&11 FOR 400kV AND ABOVE

SL NO.	DIGITAL CHANNELS	REMARKS
1	DISTANCE PICKUP (RØ-EARTH)	
2	DISTANCE PICKUP (YØ-EARTH)	
3	DISTANCE PICKUP (BØ-EARTH)	
4	DISTANCE PICKUP (RØ-YØ)	
5	DISTANCE PICKUP (YØ-BØ)	
6	DISTANCE PICKUP (BØ-RØ)	
7	AR IN PROGRESS	
8	AR SUCCESSFUL	
9	CARRIER UNHEALTHY/FAIL CH-II	
10	CARRIER SWTICH OUT CH-II	
11	CARRIER SEND CH-II	

12	CARRIER RECEIVE CH-II	
13	DT SEND CH-II	
14	DT RECEIVE CH-II	
15	OVERVOLTAGE START	
16	OVERVOLTAGE STAGE-I OPEARTED	
17	OVERVOLTAGE STAGE-II OPEARTED	
18	UNDERFREQUENCY START	
19	UNDERFREQUENCY OPEARTED	
20	SPECIAL PROTECTION SCHEME	If Any
21	LBB INITIATION	
22	LBB RE-TRIP OPERATED	
23	LBB BUSBAR/BACKUP TRIP OPERATED	

TABLE 13: OTHER IMPORTANT DIGITAL CHANNELS

TRANSFORMER PROTECTION

C. The protection functions implemented for Transformers can be summarized as follows:

i) Differential Protection (and associated functions)

ii) HV Backup overcurrent and Earthfault Protection

iii) LV Backup overcurrent and Earthfault Protection

iv) REF Protection*and other protection functions*

SL NO.	ANALOG CHANNELS	REMARKS
1	HV CURRENT RØ	
2	HV CURRENT YØ	
3	HV CURRENT BØ	
4	HV NEUTRAL CURRENT	
5	LV CURRENT RØ	
6	LV CURRENT YØ	
7	LV CURRENT BØ	
8	LV NEUTRAL CURRENT	
9	DIFFERENTIAL CURRENT RØ	
10	DIFFERENTIAL CURRENT YØ	
11	DIFFERENTIAL CURRENT BØ	
12	DIFFERENTIAL BIAS CURRENT	
13	REF DIFFERENTIAL CURRENT	
14	REF BIAS CURRENT	
15	HIGH IMPEDANCE RESULTANT REF CURRENT	

TABLE 14: ANALOG CHANNELS FOR TRANSFORMERS

*Tie CT current channels should also be included in case of 1 and ½ CB scheme

SL NO.	DIGITAL CHANNELS	REMARKS
1	DIFFERENTIAL RØ START	

2	DIFFERENTIAL YØ START	
3	DIFFERENTIAL BØ START	
4	DIFFERENTIAL RØ TRIP	
5	DIFFERENTIAL YØ TRIP	
6	DIFFERENTIAL BØ TRIP	
7	DIFFERENTIAL TRIP (CURVE)	
8	DIFFERENTIAL UNRESTRAINED TRIP (HIGHSET)	
9	2^{ND} HARMONIC BLOCK OPERATED	
10	5^{TH} HARMONIC BLOCK OPERATED	
11	OVERFLUXING ALARM	
12	OVERFLUXING TRIP	DEFINE STAGES
13	OVERFLUXING HIGHSET TRIP	
14	REF START/ALARM	
15	REF TRIP	
16	BUCHHOLZ ALARM	
17	BUCHHOLZ TRIP	
18	MAIN TANK PRV TRIP	
19	OLTC PRV TRIP	
20	OSR TRIP	
21	HV WTI ALARM	
22	HV WTI TRIP	
23	LV WTI ALARM	
24	LV WTI TRIP	
25	OTI ALARM	
26	OTI TRIP	
27	MOG ALARM	
28	AIRCELL FAILURE	
29	86 OPEARTED HV	
30	96 OPERATED HV	
31	86 OPEARTED LV	
32	96 OPEARTED LV	
33	HV CB OPEN	
34	HV CB CLOSE	
35	LV CB OPEN	
36	LV CB CLOSE	
37	FIREFIGHTING ALARMS/TRIPS	
38	MAIN2/BCU FAULTY	
39	TIME SYNCHRONIZATION STATUS	
40	LAN NETWORK STATUS	

TABLE 15: DIGITAL CHANNELS FOR TRANSFORMERS

*Merged alarm/Trip signals of HV/LV WTI, a single “Differential Start” signals rather than differential start status of each phase etc. can be configured if the IED provides only 32 configurable DR digital channels.

SL NO.	DIGITAL CHANNELS	REMAKRS
1	OVERCURRENT RØ START	
2	OVERCURRENT YØ START	
3	OVERCURRENT BØ START	
4	OVERCURRENT RØ TRIP	
5	OVERCURRENT YØ TRIP	
6	OVERCURRENT BØ TRIP	
7	OVERCURRENT LOWSET TRIP	
8	OVERCURRENT HIGHSET TRIP	
9	EARTH FAULT START	
10	EARTH FAULT LOWSET TRIP	
11	EARTH FAULT HIGHSET TRIP	
12	LBB INITIATION	
13	LBB RETRIP AND BACKUP TRIP	
14	86 OPERATED	
15	96 OPERATED	
16	RELAY FAIL (MAIN/BACKUP/BCU)	
17	TIME SYNCHRONIZATION STATUS	
18	LAN NETWORK STATUS	

TABLE 16: OVERCURRENT AND EARTHFAULT PROTECTION FOR TRANSFORMERS

*The analog channels would comprise (V_R, V_Y, V_B, V_N, I_R, I_Y, I_B, I_N) with respect to HV or LV side in case separate OC & EF relay is provided as considered in the table above

REACTOR PROTECTION

D. The protection functions implemented for Reactors can be summarized as:

i) Differential Protection
ii) Restricted Earth fault Protection
iii) Backup Impedance, Overcurrent protection etc.

SL NO.	ANALOG CHANNELS	REMARKS
1	HV CURRENT RØ	
2	HV CURRENT YØ	
3	HV CURRENT BØ	
4	HV NEUTRAL CURRENT	
5	NCT CURRENT RØ	
6	NCT CURRENT YØ	
7	NCT CURRENT BØ	
8	NCT NEUTRAL CURRENT	
9	DIFFERENTIAL CURRENT RØ	
10	DIFFERENTIAL CURRENT YØ	
11	DIFFERENTIAL CURRENT BØ	
12	DIFFERENTIAL BIAS CURRENT	
13	REF DIFFERENTIAL CURRENT	
14	REF BIAS CURRENT	
15	HIGH IMPEDANCE RESULTANT REF CURRENT	

TABLE 17: ANALOG CHANNELS FOR REACTOR DIFFERENTIAL PROTECTION

SL NO.	DIGITAL CHANNELS	REMARKS
1	DIFFERENTIAL RØ START	
2	DIFFERENTIAL YØ START	
3	DIFFERENTIAL BØ START	
4	DIFFERENTIAL RØ TRIP	
5	DIFFERENTIAL YØ TRIP	
6	DIFFERENTIAL BØ TRIP	
7	DIFFERENTIAL TRIP (CURVE)	
8	DIFFERENTIAL UNRESTRAINED TRIP (HIGHSET)	
9	2^{ND} HARMONIC BLOCK OPERATED	
10	5^{TH} HARMONIC BLOCK OPERATED	
11	OVEREXCITATION START	
12	OVEREXCITATION TRIP	ADD STAGES
13	REF START/ALARM	
14	REF TRIP	
15	BUCHHOLZ ALARM	
16	BUCHHOLZ TRIP	
17	MAIN TANK PRV TRIP	
18	OLTC PRV TRIP	
19	OSR TRIP	
20	HV WTI ALARM	
21	HV WTI TRIP	
22	LV WTI ALARM	
23	LV WTI TRIP	
24	OTI ALARM	
25	OTI TRIP	
26	MOG ALARM	
27	AIRCELL FAILURE	
28	FIREFIGHTING ALARMS/TRIPS	
29	NGR BUCHHOLZ ALARM	
30	NGR BUCHHOLZ TRIP	
31	NGR PRV TRIP	
32	NGR OTI ALARM	
33	86 OPEARTED	
34	96 OPERATED	
35	CB OPEN	
36	CB CLOSE	
37	BACKUP_IMP RELAY FAIL	
38	TIME SYNCHRONIZATION STATUS	
39	LAN NETWORK STATUS	

TABLE 18: DIGITAL CHANNELS FOR REACTOR DIFFERENTIAL PROTECTION

*Inherent Protection signals can be utilized with Backup impedance or REF relay if constraint arises for number of configurable digital channels

SL NO.	ANALOG CHANNELS	REMARKS
1	VOLTAGE RØ	
2	VOLTAGE YØ	
3	VOLTAGE BØ	
4	VOLTAGE NEUTRAL	
5	CURRENT RØ	
6	CURRENT YØ	
7	CURRENT BØ	
8	CURRENT NEUTRAL	

TABLE 19: ANALOG CHANNELS FOR REACTOR BACKUP IMPEDANCE PROTECTION

SL NO.	DIGITAL CHANNELS	REMAKRS
1	ZONE START	
2	ZONE TRIP	
3	OVERCURRENT START	
4	OVERCURRENT TRIP	
5	DIFFERENTIAL RELAY FAIL	
6	CB OPEN	
7	CB CLOSE	
8	86 RELAY OPERATED	
9	96 RELAY OPERATED	
10	TIME SYNCHRONIZATION STATUS	
11	LAN NETWORK STATUS	

TABLE 20: DIGITAL CHANNELS FOR REACTOR BACKUP IMPEDANCE PROTECTION

BUSBAR PROTECTION

E. The protection functions available for bus bar relay are:

   i) Bus bar protection

   ii) LBB protection

SL NO.	ANALOG CHANNELS	REMARKS
1	BAY 01-CURRENT RØ	
2	BAY 01-CURRENT YØ	
3	BAY 01-CURRENT BØ	
4	BAY 02-CURRENT RØ	
5	BAY 02-CURRENT YØ	
6	BAY 02-CURRENT BØ	FOR ALL BAYS 1..2..3..
7	INCOMING RØ CURRENT IN ZONE A	
8	DIFFERENTIAL RØ CURRENT IN ZONE A	
9	INCOMING YØ CURRENT IN ZONE A	
10	DIFFERENTIAL YØ CURRENT IN ZONE A	
11	INCOMING BØ CURRENT IN ZONE A	
12	DIFFERENTIAL BØ CURRENT IN ZONE A	

TABLE 21: DIGITAL CHANNELS FOR REACTOR BACKUP IMPEDANCE PROTECTION

SL NO.	DIGITAL CHANNELS	REMARKS
1	BAY 01 CONNECTED TO BUS A	
2	BAY 01 CONNECTED TO BUS B	
3	BAY 02 CONNECTED TO BUS A	
4	BAY 02 CONNECTED TO BUS B	
5	BAY 03 CONNECTED TO BUS A	
6	BAY 03 CONNECTED TO BUS B	
7	DIFFERENTIAL TRIP OPERATED	
8	ZONE A COMMON TRIP	ZONE A and ZONE B refer to Main Bus 1 and Main Bus 2
9	ZONE A LBB BACKUP/EXTERNAL TRIP	
10	ZONE A OPEN CT ALARM	
11	ZONE A DIFFERENTIAL ALARM	
12	ZONE A INCOMING CURRENT ALARM	
13	ZONE B COMMON TRIP	
14	ZONE B LBB BACKUP/EXTERNAL TRIP	
15	ZONE B OPEN CT ALARM	
16	ZONE B DIFFERENTIAL ALARM	
17	ZONE B INCOMING CURRENT ALARM	
18	CHECKZONE TRIP	
19	ENDZONE PROTECTION OPERATED	
20	MAIN2/BCU ETC. RELAY FAIL (IF ANY)	
21	TIME SYNCHRONIZATION ERROR	
22	LAN NETWORK ERROR	

TABLE 22: DIGITAL CHANNELS FOR BUSBAR DIFFERENTIAL PROTECTION

LINE DIFFERENTIAL PROTECTION

F. Line differential Relay includes the following protection functions:

i) Line Differential Protection
ii) Backup Overcurrent and Earth fault protection
iii) Distance Protection (if Optical Link is in failed state. Function available as per site requirement)

SL NO.	ANALOG CHANNELS	REMARKS
1	CURRENT RØ	
2	CURRENT YØ	
3	CURRENT BØ	
4	CURRENT NEUTRAL	
5	REMOTE END CURRENT RØ	
6	REMOTE END CURRENT YØ	
7	REMOTE END CURRENT BØ	
8	REMOTE END CURRENT NEUTRAL	
9	DIFFERENTIAL CURRENT RØ	
10	DIFFERENTIAL CURRENT YØ	
11	DIFFERENTIAL CURRENT BØ	
12	BIAS CURRENT	

TABLE 23: ANALOG CHANNELS FOR LINE DIFFERENTIAL PROTECTION

SL NO.	DIGITAL CHANNELS	REMARKS
1	DIFFERENTIAL RØ TRIP	
2	DIFFERENTIAL YØ TRIP	
3	DIFFERENTIAL BØ TRIP	
4	DIFFERENTIAL RESTRAINED TRIP	
5	DIFFERENTIAL UNRESTRAINED TRIP	
6	2^{ND} HARMONIC BLOCK OPERATED	
7	5^{TH} HARMONIC BLOCK OPERATED	
8	RECEIVE SIGNAL 01	
9	RECEIVE SIGNAL 02	
10	SEND SIGNAL 01	
11	SEND SIGNAL 02	
12	REMOTE RELAY ERROR	
13	MAIN2/BACKUP RELAY FAIL	
14	CB OPEN	
15	CB CLOSE	
16	86 OPERATED	
17	96 OPERATED	
18	BACKUP RELAY/BCU FAIL	
19	TIME SYNCHRONIZATION ERROR	
20	LAN NETWORK FAIL	

TABLE 24: DIGITAL CHANNELS FOR LINE DIFFERENTIAL PROTECTION

*AR signals, Distance Protection, OC and EF protection signals, single pole CB status to be included as per scheme implemented for the short line.

If separate OC and EF relay is present, the DR list as inTABLE 7 & 8** are also applicable

CHAPTER 11

DISTURBANCE RECORDER PARAMETERS FOR GENERATING STATIONS

The presently implemented Disturbance Recorder channels were collected from the following generating stations: NEEPCO, NHPC, NTPC, ADANI, KMPCL, OPTC and AGTCPP. With respect to the protection functions kept for Generators, the DR channel list was compiled.

The following compilation of DR analog and digital channels is a summarized list of analog and digital channels comprising all available protections kept for generators. The list is to be segregated with respect to the protection functions available at site.

SN	ANALOG CHANNELS	REMARKS
1	RØ VOLTAGE	
2	YØ VOLTAGE	
3	BØ VOLTAGE	
4	NEUTRAL VOLTAGE	
5	RØ CURRENT (LOAD SIDE)	
6	YØ CURRENT (LOAD SIDE)	
7	BØ CURRENT (LOAD SIDE)	
8	NEUTRAL CURRENT	
9	NEUTRAL CURRENT SENSITIVE)	
10	RØ CURRENT (NEUTRAL SIDE)	
11	YØ CURRENT (NEUTRAL SIDE)	
12	BØ CURRENT (NEUTRAL SIDE)	
13	FREQUENCY	
14	EXCITATION TRAFO HV CURRENT	
15	1ST STAGE RESIDUAL OVERVOLTAGE	
16	2ND STAGE RESIDUAL OVERVOLTAGE	
17	100% STATOR EARTH FAULT VOLTAGE	
18	100% STATOR EARTH FAULT CURRENT	
19	OPEN DELTA VOLTAGE	
20	NGT VOLTAGE	
21	REF CURRENT/VOLTAGE	(Depending on HZ or LZ REF implementation)
22	NEGATIVE SEQUENCE CURRENTS	(If Applicable)
23	STATOR FAULT 20HZ INJ. VOLTAGE	
24	STATOR FAULT 20HZ INJ. CURRENT	

TABLE 25: ANALOG CHANNELS FOR GENERATOR PROTECTION

SN	DIGITAL CHANNELS	REMARKS
1	GENERATOR DIFFERENTIAL START	
2	GENERATOR DIFFERENTIAL RØ TRIP	
3	GENERATOR DIFFERENTIAL YØ TRIP	
4	GENERATOR DIFFERENTIAL BØ TRIP	
5	GENERATOR DIFFERNTIAL TRIP	
6	POWER 1 TRIP	
7	POWER 2 TRIP	
8	OVERCURRENT STAGE-I TRIP	
9	OVERCURRENT STAGE-II TRIP	
10	EARTHFAULT TRIP	
11	UNDER EXCITATION START	
12	UNDER EXCITATION OPERATED	DEFINE STAGES
13	OVER EXCITATION START	
14	OVER EXCITATION OPEATED	DEFINE STAGES
15	OVERVOLTAGE START	
16	OVERVOLTAGE TRIP	DEFINE STAGES
17	UNDERVOLTAGE START	
18	UNDERVOLTAGE TRIP	DEFINE STAGES
19	UNDERFREQUENCY ALARM	
20	UNDERFREQUENCY TRIP	DEFINE STAGES
21	OVERFREQUENCY ALARM	
22	OVERFREQUENCY TRIP	DEFINE STAGES
23	TURBINE TRIP	
24	TURBINE EMERGENCY TRIP	
25	GENERATOR ELECTRICAL FAULT	
26	STATOR EARTH FAULT ALARM	
27	STATOR EARTH FAULT TRIP	
28	NEG. PHASE SEQ THERMAL ALARM	
29	NEG. PHASE SEQ THERMAL TRIP	
30	GENERATOR THERMAL OVERLOAD TRIP	
31	UNDER IMPEDANCE PROTECTION OPERATED	DEFINE STAGES
32	NEUTRAL VOLT. DISPLACEMENT PROT. OPERATED	
33	RESIDUAL OVERVOLTAGE TRIP	DEFINE STAGES
34	RØ CB OPEN	DEFINE FOR GENERATOR CB, FIELD CB ETC. (AS PER APPLICABLE SCHEME) AND AS PER (GANG OPERATED OR SINGLE POLE CB)
35	RØ CB CLOSE	
36	YØ CB OPEN	
37	YØ CB CLOSE	
38	BØ CB OPEN	
39	BØ CB CLOSE	
40	FIELD FAIL ALARM	
41	FIELD FAIL-1 TRIP	
42	FIELD FAIL-2 TRIP	
43	VT FUSE FAIL ALARM	
44	REVERSE POWER TRIP (32G)	DEFINE STAGES
45	SENSITIVE EARTH FAULT TRIP	
46	ANY START	
47	ANY TRIP	
48	ROTOR EARTH FAULT START	
49	ROTOR EARTH FAULT TRIP	DEFINE STAGES

SN	DIGITAL CHANNELS	REMARKS
50	STATOR EARTH FAULT START	
51	STATOR EARTH FAULT 95% TRIP	DEFINE STAGES
52	STATOR EARTH FAULT 100% TRIP	
53	STANDBY EARTH FAULT TRIP	
54	OVERCURRENT START	
55	OVERCURRENT TRIP	DEFINE STAGES
56	EXCITER TRIP	
57	POLE SLIPPING OPERATED	
58	DEAD MACHING TRIP	
59	LOW FORWARD POWER PROTECTION OPERATE	
60	OUT OF STEP TRIP	
61	UNBALANCE LOAD CURRENT OPERATED	
62	100% STATOR EARTH FAULT START (3^{RD} HARM.)	
63	100% STATOR EARTH FAULT TRIP (3^{RD} HARM.)	
64	LBB INITIATION	
65	LBB OPERATED	
66	UNIT MANUAL EMERGENCY TRIP	
67	LOSS OF EXCITATION OPERATED (40G)	
68	NEG. SEQ. CURRENT PROTECTION ALARM	
69	NEG. SEQ. CURRENT PROTECTION TRIP (46G)	
70	86 RELAY OPERATED	86X/Y/Z as per scheme
71	POLE SLIP Z1 TRIP	
72	POLE SLIP Z2 TRIP	
73	ACCIDENTAL ENERGIZATION PROTECTION	
74	CO2 RELEASE	
75	AVR FAULTY	
76	TIME SYNCHRONIZATION ERROR	
77	LAN NETWORK ERROR	
78	MAIN 2/BCU FAIL	

TABLE 26: DIGITAL CHANNELS FOR GENERATOR PROTECTION

The above mentioned DR analog and digital channels are summarized in general for thermal, hydro generating plants. The segregation of protection functions for generators among respective IEDs is based on scheme of C&R Panel (Control and Relay panel) followed at site. The DR channels are to be configured as per protection functions implemented in the relays or nos. of relays. The above **TABLE 25 & 26** may be segregated as such.

ANNEXURE – I

Standardization of Disturbance Recorder Channels is also dependent on additional factors such as: Protection Philosophy followed by the Utilities, Substation level C&R Panel architecture, IED communication network, Switchyard Equipment, Station auxiliaries etc.

A field study was carried out with the participating utilities for visualization of the current state of DR parameters and system architectures on a wide area perspective.

The following points were considered for the conducted questionnaire based data collection:

i) Modern IEDs support communication over local area network (Ethernet) via optical fibre/RJ45/LAN cable, time synchronization over SNTP, GOOSE messaging system. Centralized DRPC is present within the same network for monitoring and operations.
ii) Redundancy in power supply for IEDs and station auxiliaries and monitoring the same via recorded DR data
iii) Status of switchyard equipment and tripping relays (inherent protection, master trip etc.)
iv) Carrier Communication Status
v) Triggering criteria adopted by the utilities and the DR recording window parameters.

As per inputs received from utilities, transmission companies and generation companies from North-Eastern, Eastern, Western, Southern Grid viz. AEGCL, AEML-T, AP TRANSCO, HVPNL, MEPTCL, KMTL, MSPCL, TRIPURA TRANSCO, TPCL, MSETCL, DHARIWAL, ESSAR, INDIGRID, JP NIGRIE, KMPCL, DIKCHU, DVC, JORETHAND, JUSNL, WBSETCL, OPTCL, MPPTCL, MPPGCL, NTPC, NEEPCO, NHPC, OTPC, ADANI, KORBA NTPS, VSTPS, AgTCPP the following status were observed for various grid substations.

TABLE 27: FIELD STATUS WITH RESPECT TO TOR POINTS

SL No.	PARTICULARS	STATUS
1	Are the IED's in the Substation connected using fibre optic/LAN cable into a local Ethernet network?	62% are equipped with optical fibre/LAN cable into a local Ethernet network
2	DR downloading facility at the substation a. Centralized DRPC b. Laptop/PC is manually connected using the front port of the relay for DR files extraction only when a grid disturbance has taken place	57% are equipped with Centralized DRPC whereas front port extraction is carried out for others
3	Is there any standard list of DR analog and digital channel configuration followed by the utility?	Standard list available: 52%
4	Are the IED's in the substation time synchronized with the GPS system?	76% are GPS Synchronized
5	Is redundancy maintained for AC supply (in form of inverters) in the substation for AC appliances (SAS PC, DRPC and Metering PC)?	76%
6	Is redundancy maintained for DC supply for IED's, GPS modules, Ethernet switches etc.?	76%
7	Mode of DR trigger available in the IEDs for protection functions a. DR trigger "only with trip" b. DR trigger with both "Start and trip"	76% have adopted "Start and Trip"
8	Is pre-fault time of 500ms and overall DR capturing time window of 3 sec followed?	73% with minor variations in pre-fault and post trigger timings
9	Is the status of the auxiliary tripping relays and switchgear elements included in the DR digital channels? a. Master trip relays (86), LBB Trip relay (96) b. CB Open/Close Status	90%
10	Is the "setting philosophy" followed as per RK setting Guidelines?	85%
11	Is "Time Synch error" recorded in the DR if an IED is out of time synchronization during a fault event?	41%
12	Is "LAN Error" recorded in the DR if an IED is out of LAN during a fault event?	33%
13	Is the status of all the inherent protection of transformers /reactors/NGRs included in the DR digital channels?	72%
14	Are the signals associated with carrier protection schemes implemented in the DR? a. Carrier Healthy b. Carrier Switch In/Out	A: 86% B: 76%
15	Are "Watchdog contacts/Life contacts" of IEDs used for monitoring the healthiness as a digital channel in the DR?	59%

ANNEXURE – II

The most common cases of tripping events for grid elements occur for transmission lines. As transmission lines travel through various terrains (hilly, half/fully submerged, jungle, lightning prone, vegetation growth along the corridor) it may be practically impossible to maintain absolute healthiness of the transmission line equipments and its corridor clearance throughout the year. However, the utmost motive is to restrict the number of disturbances in transmission lines under acceptable limits and to take measures so that such disturbance can be avoided in future.

It has been observed around the world that, the most common cases of transmission line fault is "Single phase to Earth (1Ø-E)" and transient in nature. Auto-reclosure function plays an important role in saving the grid elements from unnecessary outages during transient single phase to earth faults. From Power System Protection field of view, modern IEDs are equipped with programmable logics which greatly enhances the scope of design of important protection philosophies which otherwise has extensive use of hard wirings and auxiliary relays.

The non-operation/failed operation of Auto-reclosure may be due to various reasons (programmed logic is not fulfilled; nature of fault has changed during dead time). To absolutely pin point the reason for the above, it is necessary that the extracted Disturbance Recorder file should comprise of all the Analog values of voltages and current along with the Digital statuses of all equipments and protection functions (PLCC, CB, auxiliary relays etc., relay internal protection signals). This can only be achieved if the DR parameters and channels are configured to its full capability to capture the sequence of events during the faults.

As such, a list of probable grid disturbances that utilities face were drafted in the form of questionnaire and shared with participating TRANSCO's for sharing the ideas and philosophies they adopt for DR configuration to study fault events.

TABLE 28: CASES OF UNSUCCESSFUL AUTO-RECLOSURE OPERATIONS

Sl No.	Case Description	Probable Explanation	DR channels required for analyzing the event
1.	A single pole (RØ pole) trip is issued by the relay and dead time of AR is started. The relay issues a three pole trip during the dead time and AR is unsuccessful	A three pole trip in dead time is issued if there is an evolving fault in the other two healthy phases.	▪ AR Start ▪ AR in progress ▪ AR Unsuccessful ▪ Protection Status of the other healthy phases
2.	The relay issues a three pole trip in spite of the AR functions being kept ON	AR BLOCK logic may be high in the relay. AR Block may be linked with CB healthy status, CB spring charge, Gas pressure, Carrier Faulty etc.	▪ AR Block Status ▪ CB Ready Status ▪ Carrier Healthy
3.	For an 1 and ½ CB scheme, AR is successful in the Main CB but unsuccessful in the Tie CB	AR Block logic may be high in the Tie CB. "Wait for master" setting for Tie CB might be incorrect	▪ Wait for Master in Tie Bay CB ▪ AR Block Status ▪ CB Ready Status
4.	The relay issues a RØ pole trip to the CB. Thereafter, the whole bus is tripped on LBB Operation	Failure of opening or delay opening of RØ pole CB. Trip wirings for R-pole might be linked with Y or B phase pole	▪ LBB Initiation ▪ CB Open/Close status per pole ▪ Analog values of current ▪ 86R status
5.	For 132kV Level, relay issues a three pole trip and AR dead time is started. However, AR operation is not achieved after elapse of the dead time	Synchro check function might have blocked the AR	▪ Vsynch analog channel

TABLE 29: UNDER/OVER REACHING BY DISTANCE RELAY

Sl No.	Case Description	Probable Explanation	DR channels required for analyzing the event
1.	During a single phase to earth fault, the distance protection is not picked at the local end relay, whereas the upstream relay operated in Zone 3	Dir. EF protection might have picked up for the local end relay due to high resistive nature of the fault. If the upstream end relay belongs to a very long line, the Zone 3 reach may be large enough to sense the fault. The EF setting at local end should be revised	▪ Earth fault start ▪ Zone 3 pickup ▪ Zone 3 Optd ▪ VT Fuse Fail ▪ Time Synch Status
2.	The upstream relay trips on IDMT Earth fault before the local end relay which sensed the fault in Zone 3 reach	The EF ROT for upstream relay is not set with respect to Zone 3-time delay. TMS should be verified	▪ Earth fault Start ▪ Earth fault Operated ▪ Zone 3 pickup ▪ Time Synch Status
3.	For a fault in the mid-portion of a transmission line, the relay at local end trips on Zone 1 protection instantaneously. But the remote end relay fails to sense the fault at the inception, whereas later trips on Zone 2 protection.	The local end source is stronger than the remote end source which might be comparatively very weak. Probable implementation of weak infeed with echo can be studied, Zone settings may be revised and Carrier healthiness be verified	▪ Zone 2, Zone 3 pickups ▪ Carrier Healthy ▪ Earth fault Start ▪ Time Synch Status
4.	"Carrier Send" signal was high in the relay during operation of PUTT scheme. However, the remote end relay failed to receive the carrier input and PUTT was not successful	"Carrier Fail" may be persistent in the PLCC link which may be due to faulty "Rx level" or other associated issues	▪ Carrier Healthy ▪ Zone 2 pickup ▪ Time Synch Status
5.	The relay at local end issues a trip on Zone 1 instantaneously. But the upstream CB is tripped on EF at the same time	EF High set may be enabled for the upstream relay. Transmission lines should not have EF High set protection enabled.	▪ Earth Fault Start ▪ Earth Fault Operate ▪ Time Synch Status
6.	During a fault, the line is tripped on Zone 2 protection but the upstream adjacent transformer is also tripped either on Earth fault of Overcurrent protection instantaneously	The EF and OC High set settings of the transformer are to be re-evaluated. High set should be kept based on %Imp with a delay of 50ms	▪ OC and EF Start ▪ OC and EF Trip ▪ OC and EF HS Optd
7.	Frequent loss of the double circuit line in spite of corridor clearance not being an issue	Lightning faults, poor tower footing earthing	▪ Analog values of current and voltages ▪ Mutual compensation current channel ▪ Time Synch Status

Sl No.	Case Description	Probable Explanation	DR channels required for analyzing the event
8.	A relay in a radial of the line issued a Zone 2 or Zone 3 trip during a single phase to earth fault in spite of the fact that no power source is available for a radial feeder to feed the fault	The substation might be a LILO point along a long radial line. The line might trip due to capacitive current effect during phase to earth faults.	▪ Current and voltage channels ▪ Pre-fault duration of 500ms
9.	A transmission line trips and later when it is charged, it is found healthy. The issue is repeated on many instances in spite of no corridor clearance issues.	Insulator Disc Puncture, Disc Crack, Spurious DT receive signal etc.	▪ Pre-fault duration of 500ms ▪ Current and voltage channels ▪ Carrier and DT signal channels
10.	An important 132kV Line is tripped due to a fault. There is subsequent cascading tripping of associated feeders resulting in a partial blackout.	During peak load conditions, (n-1) contingency may not be maintained which resulted in overcurrent operation of other feeders. The overcurrent settings for the feeders are to be re-evaluated.	▪ Pre-fault duration of 500ms ▪ Overcurrent Start ▪ Overcurrent Trip ▪ Zone pickups and trips ▪ Time Synch Status
11.	Spurious SOTF operation when Zone 2 or Zone 3 was picked up in the relay	"Manual CB close contact" may be false latched. "Auto-initiation" settings might be enabled, initial pre-fault loading of the line might be below the "pole open detect settings" of the relay	▪ Pre-fault duration of 500ms ▪ SOTF initiation ▪ Current and voltage phasors
12.	A radial transmission line trips due to fault. On the first and second charging attempt it trips on SOTF. The line is surveyed but no physical fault is found	If the HV and LV CBs of downstream transformers at remote end substation are kept closed, heavy charging current is down during charging of line and relay senses it as an SOTF	▪ Pre-fault duration of 500ms ▪ SOTF initiation ▪ Current and voltage phasors Harmonic Table
13.	Spurious DT signal which led to the tripping of CB at remote end	Issue of hard wiring in the PLCC Panel	▪ DT Send ▪ Carrier Send ▪ Manual CB Trip

TABLE 30: CASES OF TRANSFORMER DIFFERENTIAL TRIPPINGS

Sl No.	Case Description	Probable Explanation	DR channels required for analyzing the event
1.	During an out of zone fault, the differential protection of the transformer is operated	CT saturation, Loose CT connection	▪ Pre-fault data of 500ms ▪ Idiff and Irest current ▪ HV and LV current values
2.	During an out of zone fault, the restricted earth fault protection is operated	NCT Polarity mismatch, loose connection in CT path	▪ Pre-fault data of 500ms ▪ NCT current value ▪ HZREF resultant current/voltage (if applicable)
3.	Spurious operation of PRD, Buchholz relay	Due to moisture ingress during rainy season, mechanical jerk	▪ Inherent protection operate status ▪ All analog channels ▪ Pre-fault data of 500ms
4.	Tripping of the transformer in differential protection during charging operation	2nd harmonic blocking value should be checked along with fault current (if any)	▪ 2nd harmonic blocking ▪ All analog channels
5.	Mal-operation of the NIFPS system	The status inputs of the NIFPS control box might have mal-operated	▪ Inherent protection operate status ▪ 86 relay status ▪ Analog value of current
6.	Transformer has tripped on Over fluxing. When the voltages are near nominal limit, the first attempt of charging is carried out but it trips again on V/f protection	The V/f pickup should be checked. Whether tailor made curve or IEEE curve is followed and the cooling down period set in the relay	▪ V/f pickup ▪ V/f Alarm ▪ V/f trip operated ▪ Pre-fault values ▪ All voltage channels
7.	Buchholz relay operation during an earthquake	Due to mechanical jerk and improper slant of the pipe connecting conservator with main tank	▪ Buchholz operate status ▪ Pre-fault data of 500ms ▪ Time synch status
8.	Differential protection operated during stormy weather	Damaged lightning arrester	▪ Pre-fault data of 500ms ▪ Analog values of current and voltages

TABLE 31: OPERATION OF BUSBAR PROTECTION

Sl No.	Case Description	Probable Explanation	DR channels required for analyzing the event
1.	During a fault in Bus 1, the busbar relay failed to discriminate the faulty bus and the total system (Bus 1 and Bus 2) were tripped	The inputs of bus isolator status, CB status for feeders are not properly reported to the busbar relay	▪ Analog current values of all the bays ▪ Busbar differential current ▪ Busbar restraint current ▪ Isolator and CB status ▪ Busbar operate Zone status ▪ Busbar trip status
2.	Spurious LBB operation from the busbar relay	Spurious initiation of external protection operated to the busbar relay, double DC earth fault leading to false LBB initiation	▪ 86 status of each bay ▪ LBB initiation ▪ LBB trip ▪ Pre-fault data of 500ms
3.	Busbar mal-operation due to external fault	CT saturation, CT loose connection, CT polarity issue	▪ Pre-fault data of 500ms ▪ Analog current values of all the bays ▪ Busbar differential and restraint current ▪ Bus Zone status ▪ Check Zone status (if any) ▪ Busbar Trip status

CHAPTER 12

EXPLORING THE STANDARDS AND POSSIBILITIES FOR DISTURBANCE RECORDER PARAMETERS FOR RENEWABLE ENERGY (RE) GENERATING STATIONS

A REVIEW OF STANDARDS ADOPTED AT RE GENERATION SITE

The Amguri Solar Plant of North Eastern Region has been considered for understanding the protection philosophy followed at RE Generation Plants and likewise the DR standardization Parameters have been forwarded.

The "Amguri Solar Plant" located at the district of Sivasagar, Assam has a generation capacity of 70MWp. The project was executed by M/s Jackson Power Private Limited and commissioned in the year 2022.

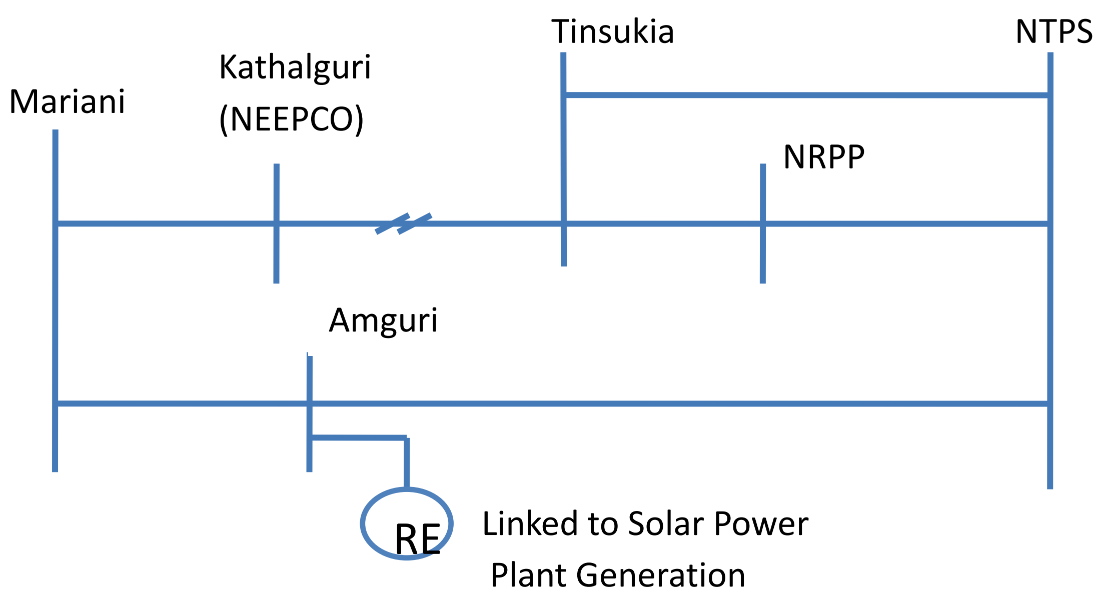


FIG 8: CONNECTIVITY OF AMGURI SOLAR PLANT

The previous 220kV transmission line between 220kV NTPS Grid Substation and 220kV Mariani Grid Substation has been included with 220kV Amguri Power Plant and the new connectivity has been formed as 220kV NTPS – Amguri and 220kV Amguri – Mariani Line.

PROTECTION FUNCTIONS (INVERTERS)

The protection and sustainable operation functions for a RE Generating plant is divided into three categories viz.

A. DC Side Protection
    a. Overvoltage Protection
    b. Overcurrent Protection
    c. Reverse Polarity
    d. Anti PID
    e. Ground Fault Monitoring
    f. Insulation Monitoring
    g. Over heat Protection
    h. Surge Protection
    i. Fan Protection

B. AC Side Protection
    a. Over/Under Voltage Protection
    b. Over Current Protection
    c. Current Balance
    d. Over/Under Frequency Protection
    e. Short Circuit Protection
    f. Surge Protection
    g. Earthfault Protection

C. Grid Support Features
    a. Low Voltage Ride Through (LVRT)
    b. High Voltage Ride Through (HVRT)
    c. Anti-Islanding
    d. Active & Reactive Power Regulation
    e. PF Control
    f. Soft Shutdown

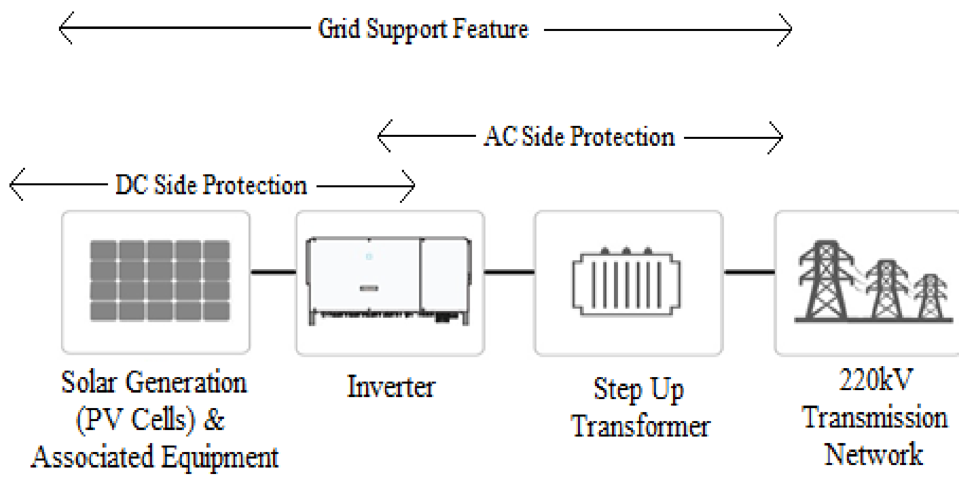


FIG 9: DC SIDE, AC SIDE AND GRID SUPPORT FEATURES IN A RE GENERATION PLANT

The above list has been compiled based on the inputs received from M/s Jackson. As per the inputs received from site, the logics and settings for the above protection functions and Grid Support Features are configured as per CEA Guidelines and IEC 62109, IEC 62116 standards.

CONTROL AND MONITORING SYSTEM

Two different models of PV Grid Connected Inverters are used at Amguri viz. **SG110CX and SG250HZ**

- The PV Grid-Connected String Inverters (Make: Sungrow) communicate with Computers (equipped with monitoring software) using Modbus RTU Protocol. This protocol can read the real-time operating data and fault states of the inverter.
- The analog values of current, voltages, Power, fault states are reported to the monitoring workstation with the help of pre-defined addresses (as per the Inverter Communication Manual) which is linked with the monitoring software.
- All protection functions are inbuilt in the inverter, the status of which is registered in the "event log" present in the inverter which can be extracted using local vendor provided application software. The status of each protection function can be reported to the SCADA system using "Addresses" as per the inverter manual.

No.	Name	Address	Data Type	Unit	Note
22	A-B line voltage/phase A voltage	5019	U16	0.1 V	Output type (address: 5002) is 1: upload phase voltage; 2: upload line voltage
23	B-C line Voltage/phase B Voltage	5020	U16	0.1 V	Output type (address: 5002) is 1: upload phase voltage; 2: upload line voltage
24	C-A line Voltage/phase C Voltage	5021	U16	0.1 V	Output type (address: 5002) is 1: upload phase voltage; 2: upload line voltage
25	Phase A current	5022	U16	0.1 A	
26	Phase B current	5023	U16	0.1 A	
27	Phase C current	5024	U16	0.1 A	
28	Reserved	5025～5026	U32	W	
29	Reserved	5027～5028	U32	W	
30	Reserved	5029～5030	U32	W	
31	Total active power	5031～5032	U32	W	
32	Total reactive power	5033–5034	S32	var	
33	Power factor	5035	S16	0.001	>0 means leading <0 means lagging

FIG 10: SCREENSHOT OF MODBUS ADDRESSES FOR ANALOG VALUES IN INVERTER OPERATION (FROM INVERTER MANUAL)

LCD or APP display (decimal)	Communication send data (hexadecimal)	Description	Classification
011	0x000B	Device abnormal	Fault
012	0x000C	Excessive leakage current	Fault
013	0x000D	Grid abnormal	Fault
014	0x000E	10-minute grid overvoltage	Fault
015	0x000F	Grid high voltage	Fault
016	0x0010	Output overload	Fault
017	0x0011	Grid voltage unbalance	Fault
019	0x0013	Device abnormal	Fault
020	0x0014	Device abnormal	Fault
021	0x0015	Device abnormal	Fault
022	0x0016	Device abnormal	Fault
023	0x0017	PV connection fault	Fault
024	0x0018	Device abnormal	Fault
025	0x0019	Device abnormal	Fault
030	0x001E	Device abnormal	Fault
031	0x001F	Device abnormal	Fault
032	0x0020	Device abnormal	Fault
033	0x0021	Device abnormal	Fault
034	0x0022	Device abnormal	Fault
036	0x0024	Excessively high module temperature	Fault
037	0x0025	Excessively high ambient temperature	Fault
038	0x0026	Device abnormal	Fault

FIG 11: SCRENSHOT OF MODBUS ADDRESSES FOR CONDITION MONITORING OF INVERTER FUNCTIONS (FROM INVERTER MANUAL)

TABLE 32: REMARKS AGAINST TOR POINTS FOR AMGURI RE PLANT

Sl. No	Terms of Reference	Remarks
1	Triggering criteria for DR	At inverter level, the various operations are monitored through the Local SAS HMI. The status of analog and digital values from the inverters is reported to the SAS via Modbus protocol. "Event log" can be viewed from the SAS after any disturbance has occurred. Comtrade DR facility (.cfg, .dat) etc. is not available for the inverter.
2	Sampling rate to be adopted	Not Applicable for Inverters
3	Data format for raw data files of DR	Not Applicable for Inverters
4	Power supply arrangement for DR and associated equipments	2KVA UPS for redundancy in AC supply. Two manually selectable DC sources are present. Automatic DC changeover is absent.
5	Protocol for monitoring healthiness of DR	Not Applicable

Observations and suggestions forwarded by FOLD Working Group 3

1. As per conversation with M/s Jackson, the status of protection functions, grid support features for the inverters etc. are inbuilt within the same inverter module. There is no provision of separate IEDs to monitor the protection functions. Hence, the DR recording facility (in comtrade format as applicable at Generating Stations and Transmission substations) is not applicable to the solar plant inverters at Amguri.
2. The protection at stepped up voltage at 220kV Level at Amguri Plant is as per the protection philosophies followed by other transmission utilities. Hence, the main area of concern is post-fault monitoring of analog values and digital status at inverter level (DC side and AC Side)

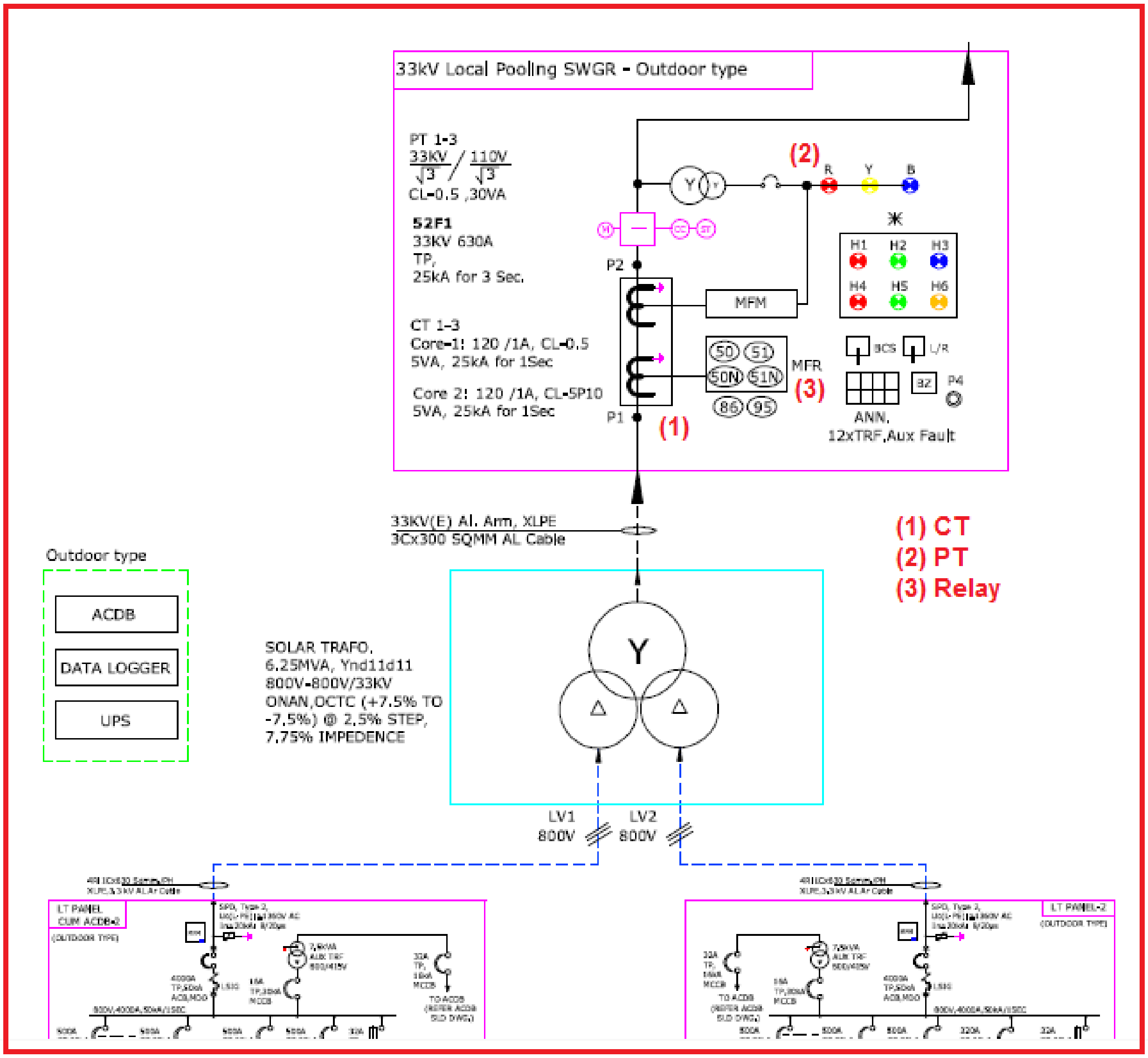


FIG 12: 800V-800V/33kV STEP UP TRANSFORMER CONNECTED TO INVERTER STRINGS

3. The inverters support event logger facility. The status of various protection and control signals can be extracted through the display interface connected to the inverters (The HMI of SAS or via application softwares of the concerned model of inverters.) The status of the inverters is represented by "numerical codes" in the event logger; each code corresponds to a definite status as described in the inverter manual.

4. The polling frequency of inverter data to the SAS at Amguri was reported to be 250ms resolution. The GPS date/time stamp(synchronized to common reference (e.g. Coordinated Universal time(UTC)) of generated inverter event data is not available (or the feature is absent).

5. However, the stepped up 33kV HV Side of the transformer (e.g. 800V/33kV in case of Amguri solar plant) has installed protection relays (refer fig. 11). The response of the inverter can be studied by configuring the DR parameters at the HV side of step up transformer. An idea of the inverter response can be achieved through analysis of the DR data extracted from HV side during grid disturbances.

6. The numerical relays to be installed at Solar plant (Amguri) support MODBUS communication. It is proposed that all numerical relays installed at RE generation plant should be IEC 61850 complaint.

7. It may be proposed that, future RE generation plants should have instrument transformers installed at each voltage level to facilitate installation of numerical relays to record grid disturbance data. The possibility of Digital Fault Recording (DFR)data (such as bus voltage phase quantities, Bus frequency, Current phase quantities, calculated active &reactive power output, dynamic reactive element voltage, frequency, current and power output) equippedwith inverters should also be explored.

8. Installation of stand-alone Disturbance recorder devices, Event logger (with GPS time synch and standard sampling frequency) should be explored.

9. Installation of Phasor measurement units(PMUs) at station bus of RE generation plants can also be explored.

10. Active/Reactive power and voltage oscillation detection feature is generally not available at relays procured for line feeders (33kV and above). DR channels associated with these functions would enable more efficient monitoring of RE Generation at Grid substation

level. The availability of the features for such RE Generation connected features may be explored (discussion and OEM support)

The basic criteria of DR parameter standards for RE Generation plants should be such that, the response of the inverter to grid disturbances and status of the protection functions of the inverters (AC side and DC side) should be recorded in analog and digital form with adequate sampling frequency rate (>=1000Hz) with settable pre and post fault time window.

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