

**Power System Operation Corporation Limited**  
**National Load Despatch Centre**  
**New Delhi**

30<sup>th</sup> Nov 2016

**Report on multiple trippings in Northern region during early morning hrs. of 30<sup>th</sup> Nov 2016**

**1.0 Introduction**

Between 01:09 to 06:30 hours of 30<sup>th</sup> Nov 2016 there were several trippings in the generation and transmission system creating insecure operating conditions in the grid. Corrective actions in the form of Reserves Regulation Ancillary Services (RRAS) despatch instructions to generators under RLDC's jurisdiction, reduction in Total Transfer Capability (TTC) between West and North region, curtailment of open access transactions were taken by NLDC/RLDCs and the situation was brought under control.

This report highlights the different tripping events and the measures taken.

**2.0 Sequence of trippings**

During midnight hours of 30.11.16, due to dense fog prevailing over northern India, several spikes were observed in PMU voltage plots of northern region. HVDC Mundra-Mahendargarh Pole-I was already under shutdown for maintenance work since 27<sup>th</sup> Nov 2016 and the Transfer Capability between WR and NR was already reduced since 27<sup>th</sup> Nov 2016. At 0109 hrs. of 30<sup>th</sup> Nov 2016, 765 kV Gwalior-Agra-I tripped due to Y-Phase to ground fault. The autoreclose was not successful and the line went under outage.

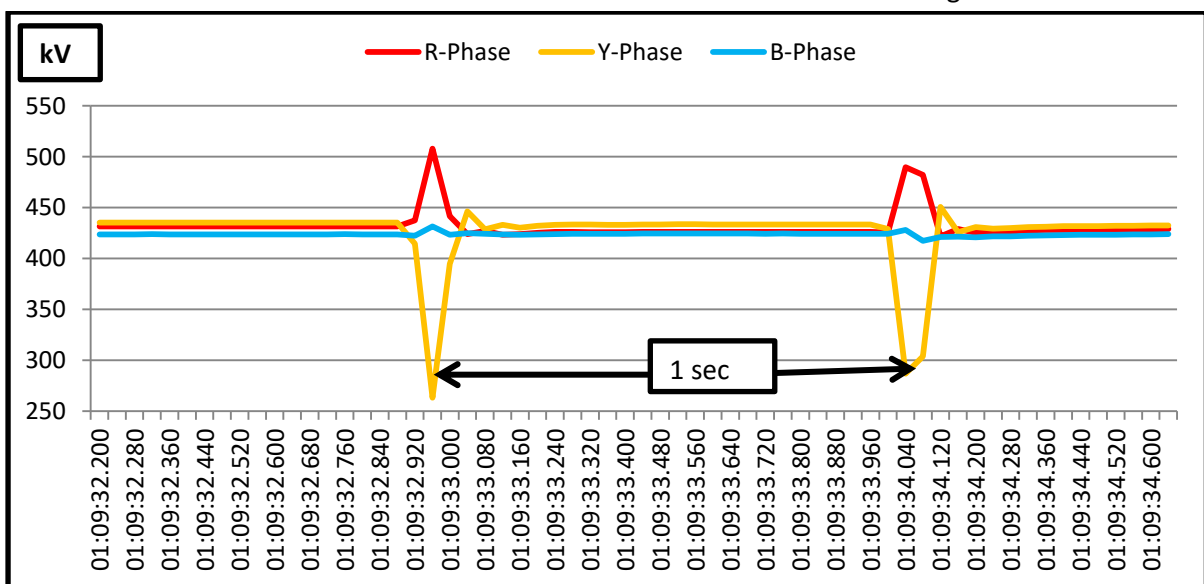


Fig1: PMU plot of 400 KV Agra station

The power flow on the lines prior to tripping was 1200 MW per circuit, post tripping of Line-I the flow on Line-II became 1800 MW.

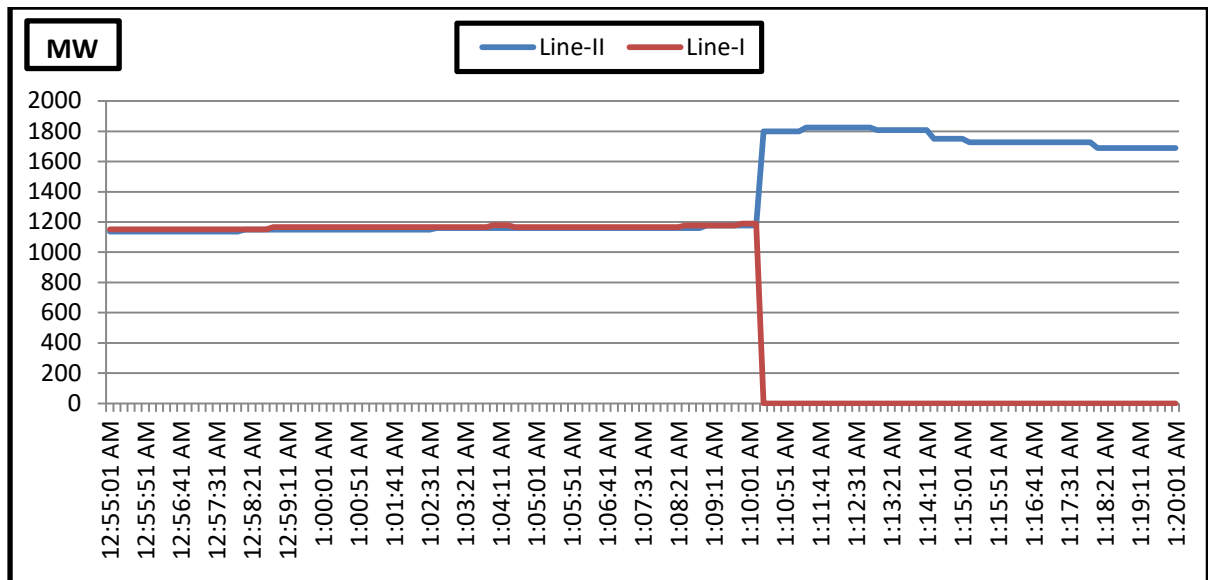


Fig 2: Power flow on 765 kV Gwalior-Agra-D/c

The voltage at Agra and Gwalior ends fell by small value due to the tripping. The plots for 765 kV and 400 kV buses are given separately for the incident.

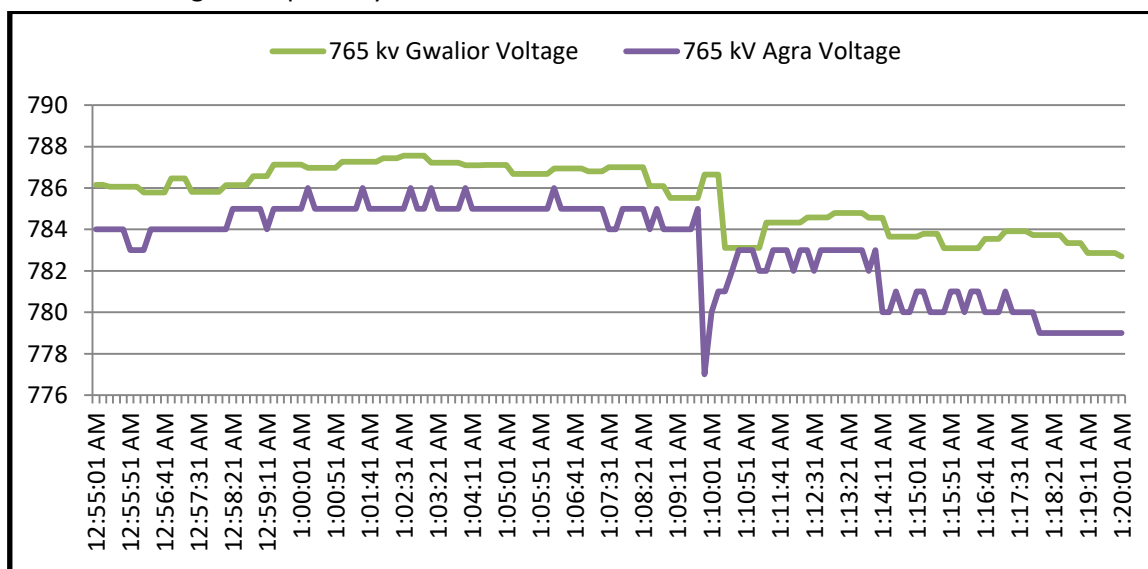


Fig 3: Voltage at 765 kV buses of Gwalior and Agra

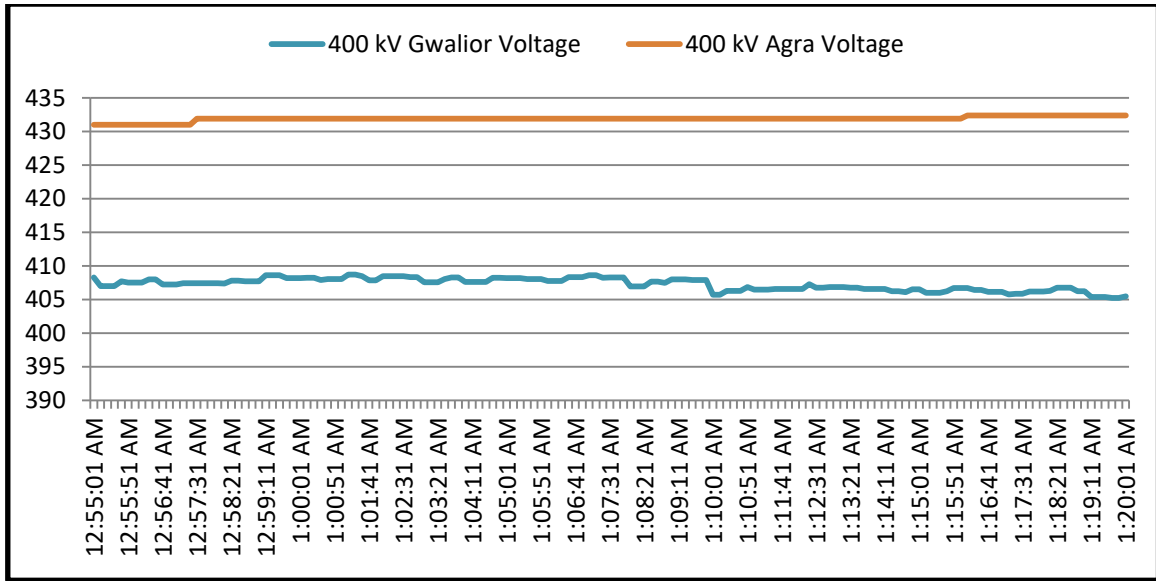


Fig 4 : 400 kV bus voltages of Agra and Gwalior

After the tripping, the line was restored at 01:45 hrs.; however it tripped at 0200 hours and line could not hold on subsequent charging attempts.

Power flow on the 765 kV Solapur-Raichur D/C lines increased from 650 MW/circuit to 1000 MW/circuit. This heavy flow caused the angular separation to increase with southern region which is reflected in angle difference between Agartala and Thrissur. This aspect needs to be examined separately.

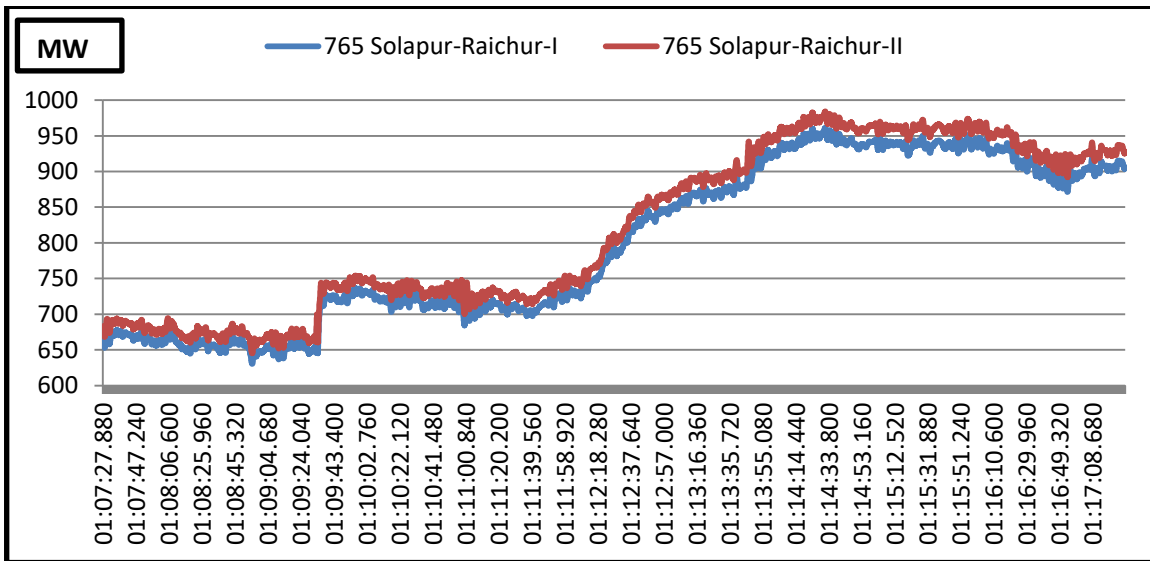


Fig 5: Increase in power flow towards Southern region

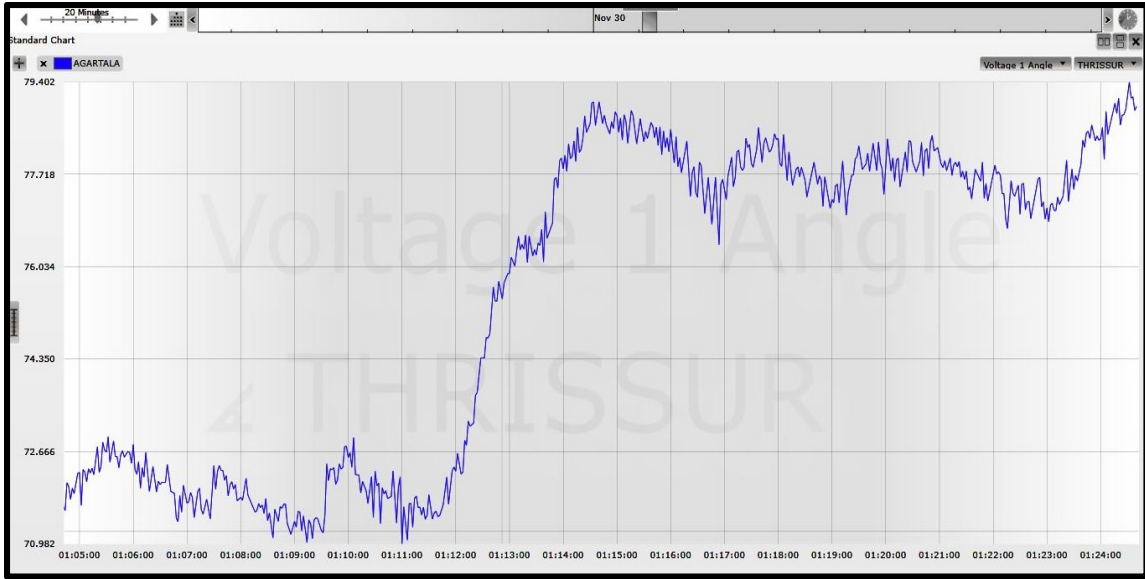


Fig 6 Angular separation between Agartala and Thrissur increased from 70 degrees to 79 degrees.

There was sudden rise in the frequency due to this tripping the frequency rose from 49.92 Hz to 50.02 Hz indicating sudden load loss. There were two periods of low frequency oscillations after the tripping; one continuing from 01:09:56:220 to 01:10:11:480. The other one started at 01:10:24:360 and ended at 01:10:36:560. The voltage versus Frequency plot for the Agra station is given below.

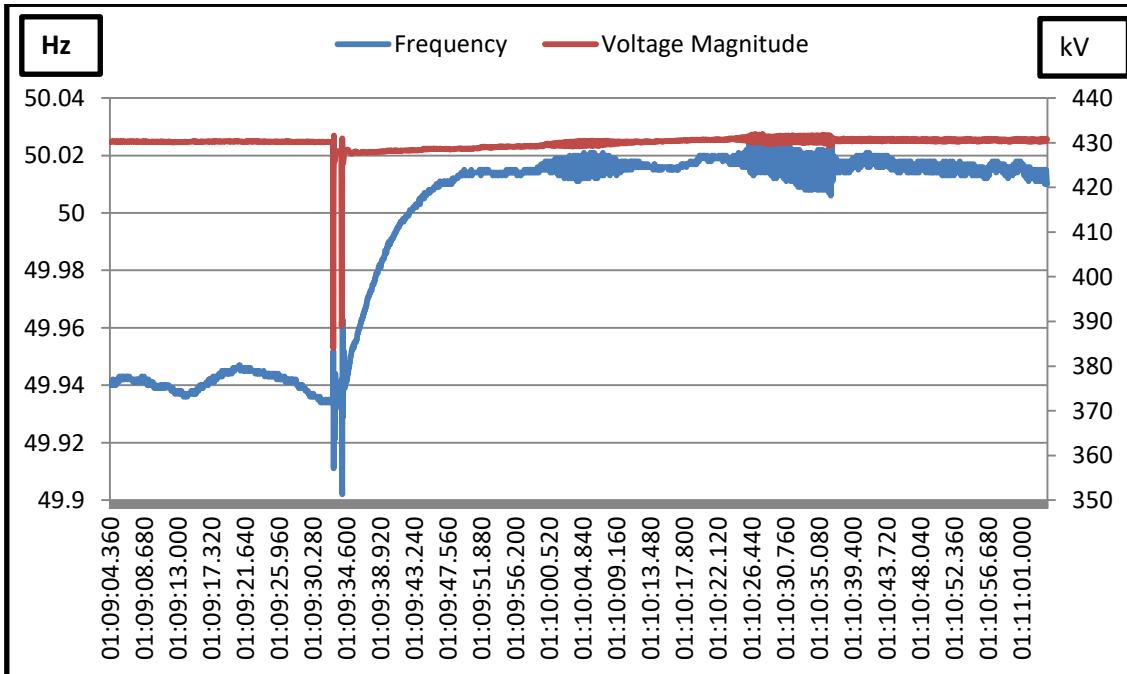


Fig 7: Rise in frequency post tripping of 765 kV Gwalior-Agra-I

Due to the above tripping, several actions were taken by control room personnel; available UnRequisitioned Surplus (URS) generation was dispatched in NR while 500 MW generation in WR was backed down for decongesting the WR-NR Corridor. Power flow in HVDC Agra-BNC was

reversed from 700 MW(NR-NER) to 500 MW(NER-NR with only pole-II in service) to decongest the WR-NR corridor. TTC/ATC of WR-NR corridor was curtailed by 1200 MW and further to restrict the line loadings from 0430 hrs to 2400 hrs of 30.11.2016. 765 kV Gwalior-Agra-I was revived at 1715 hrs. of 30<sup>th</sup> Nov 2016.

In the early morning hours at 0603 hrs, major tripping occurred at Sarnath complex in Northern Region. All the lines from 400/220 KV Sarnath got tripped . The details of trippings are given below:

S.No.	Name of Element	Tripping Time	Normalisation time
1	400 kV Sarnath-Anpara-I & II	06:02	09:35,15:51
2	400 kV Sarnath-Varanasi-I & II	06:02	
3	400 kV Anpara-Obra	06:02	
4	400 kV Anpara-Mau	06:03	08:10
5	400 kV Obra-Rewa Road	06:02	08:10
6	400 kV Anpara-Singrauli	06:04	06:53
7	400kV Anpara-Anpara C 1&2	06:02	11:18
8	400kV Anpara-Anpara D 1&2	06:02	
9	400kV Azamgarh-Sarnath	06:02	07:32
10	765 kV Anapara-Unnao	02:39	18:08
11	Anpara C(Unit-II,640 MW)	06:02	15:40
12	Anpara A	06:02	14:10
13	Vindhyachal HVDC Block-I	06:02	17:13

It was intimated by UPPTCL that tripping occurred on 400 kV Sarnath-Varanasi D/C lines due to wiring problem for protection of 400 KV 400 kV Sarnath-Varanasi-I & II. Circuit Breaker (CB) of 400 kV Sarnath-Varanasi-I line did not open at Sarnath end. All lines connected with Sarnath tripped from remote end. Due to evacuation problem, all running units of Anapara A,B,C,D tripped on high frequency. Load loss in the tripping was 485 MW and the generation loss in the tripping was 2200 MW.

The fault appears to be in all the Y & B phases and clearance appears to be more than the desired 100 milliseconds fault clearance time as per CEA Standards. The PMU plot for Ballia in Fig shows the fault.

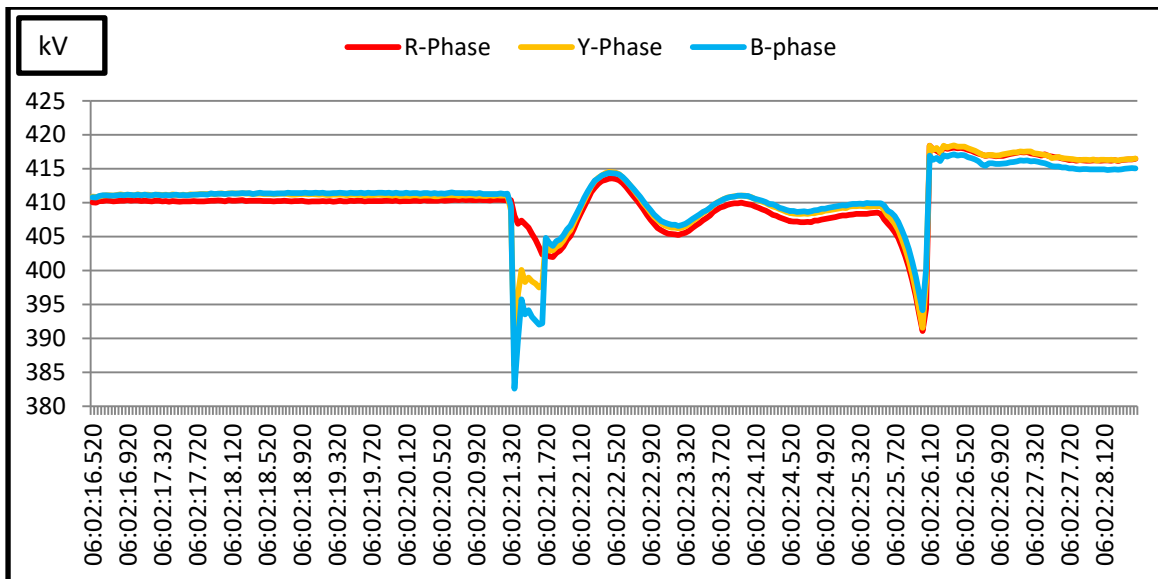


Fig 8: 400 kV Ballia PMU three phase voltage

At the same time of incident, Vindhychal HVDC Back to Back Block-1 of 250 MW capacity tripped due to DC Over current protection thereby depleting the West to North corridor further.

This tripping caused the frequency to fall and frequency fell from 50.14 Hz to 49.90 Hz.

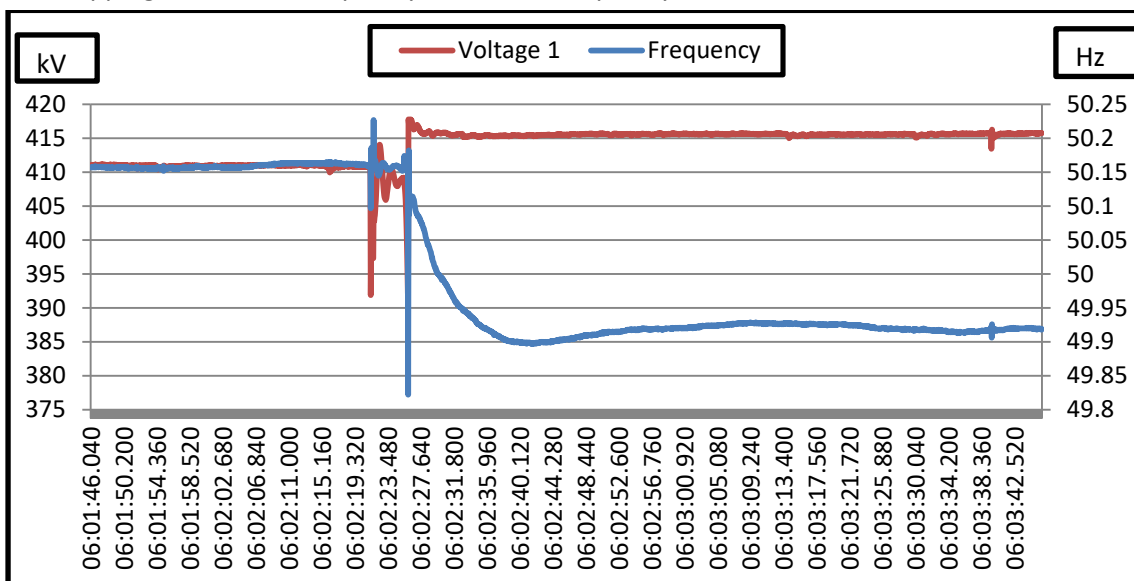


Fig 9: Fall in frequency with tripping at Sarnath and Anpara

Later, there was multiple tripping in Punjab network due to foggy weather, several lines tripped which are given below:

1. 400kV T.Sabo – Dhuri ckt-I (6:33) & ckt-II (6:24)
2. 400kV T.Sabo – Muktsar Ckt-I (7.37) & ckt-II (7.24)
3. 400kV T.Sabo – Nakodar (6:42)
4. 400kV T.Sabo – Moga (6:48)

Talwandi Saboo Unit-I & II (0724 hours) and III (0648 hours) tripped which caused the generation loss of approx. 1000 MW. Instructions were issued for revival of tripped elements in Punjab.

NLDC/NRLDC also advised for revival of a 500 MW unit at Jhajjar and a 210 MW at Dadri Thermal Stage-I which was on cold reserve. The Jhajjar unit has been synchronized at 18:16 hours.

### **3.0 Remedial actions being taken by RLDCs/NLDC:**

RLDCs/NLDC are closely monitoring the fog forecast being issued by IMD (the forecasts for this season have commenced from today only on the IMD website) and alerting all the Load Despatch Centres (LDCs) accordingly. Adverse weather warnings on account of depression has also been indicated by IMD for Tamilnadu/Puducherry coastal areas for 1<sup>st</sup> and 2<sup>nd</sup> Dec 2016.

In view of the likely adverse weather conditions on account of fog in Northern Region leading to faults in the transmission system and their outages, NLDC/RLDCs have curtailed the West to North transfer capability from 6200 MW to 5000 MW (a reduction of 1200 MW) and simultaneous import of NR from 8850 MW to 7200 MW (a reduction of 1650 MW). Power Exchange transactions were curtailed from 1100-2400 hours of 30<sup>th</sup> Nov 2016. The reduction in TTC/ATC is being done for the next few days till the fog situation eases and tripping in the transmission system is kept under control by the various transmission utilities.

The above actions necessitate a close control of drawals by the constituent states of Northern Region. Frequency has gone down to 49.53 Hz during the daytime and RLDCs are advising SLDCs to restrict the overdrawals through harnessing of generation resources within the state.

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