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

सं.:उ.क्षे.वि.स./प्रचालन/106/01/2024/156-197 दिनांक: 12.04.2024

विषय: प्रचालन समन्वय उप-समिति की 218वीं बैठक की कार्यसूचीI

Subject: Agenda of the 218th OCC meeting.

प्रचालन समन्वय उप-समिति की 218वीं बैठक का आयोजन वीडियो कॉन्फ्रेंसिंग के माध्यम से दिनांक 18.04.2024 को 10:30 बजे से किया जायेगा I उक्त बैठक की कार्यसूची उत्तर क्षेत्रीय विद्युत् समिति की वेबसाइट http://164.100.60.165 पर उपलब्ध है I

बैठक में सम्मिलित होने के लिए लिंक व पासवर्ड सभी सदस्यों को ई-मेल द्वाराप्रदान किया जाएगा।

कृपया बैठक में उपस्थित होने की सुविधा प्रदान करें।

The **218th** meeting of the Operation Co-ordination sub-committee will be conducted through Video Conferencing on **18.04.2024** from **10:30 Hrs**. The agenda of this meeting has been uploaded on the NRPC web-site http://164.100.60.165.

The link and password for joining the meeting will be e-mailed to respective e-mail IDs in due course.

Kindly make it convenient to attend the meeting.

12/4/24

(डी. के. मीना)
अधीक्षण अभियंता (प्रचालन)

सेवा में : प्रचालन समन्वय उप समिति के सभी सदस्य।

To : All Members of OCC

18-ए, शहीदजीतसिंहमार्ग, कटवारियासराय, नईदिल्ली- 110016 फोन:011-26513265 ई-मेल: seo-nrpc@nic.inवेबसाइट: www.nrpc.gov.in
18-A, Shaheed Jeet Singh Marg, Katwaria Sarai, New Delhi-110016 Phone: 011-26513265 e- mail: seo-nrpc@nic.in Website: www.nrpc.gov.in

Contents

A.1. Confirmation of Minutes

217th OCC meeting was held on 15.03.2024. Minutes of the meeting were issued vide letter dt. 27.03.2024.

Decision required from Forum:

Forum may approve the minutes of 217th OCC meeting.

A.2. Review of Grid operations

A.2.1. Power Supply Position (Provisional) for March 2024

Anticipated Power Supply Position v/s Actual Power Supply Position (Provisional) of Northern Region during the month of March-2024 is as under:

State / UT	Req. / Avl.	Energy (MU)			Peak (MW)		
		Anticipated	Actual	% Variation	Anticipated	Actual	% Variation
CHANDIGARH	(Avl)	120	109	-9.3%	300	237	-21.0%
	(Req)	120	109	-9.3%	270	237	-12.2%
DELHI	(Avl)	3126	2216	-29.1%	4716	4482	-5.0%
	(Req)	2280	2216	-2.8%	4650	4482	-3.6%
HARYANA	(Avl)	5140	4290	-16.5%	8326	7747	-7.0%
	(Req)	4140	4291	3.6%	8428	7747	-8.1%
HIMACHAL PRADESH	(Avl)	1053	959	-9.0%	2055	1982	-3.6%
	(Req)	1068	962	-9.9%	2065	1982	-4.0%
J&K and LADAKH	(Avl)	1410	1707	21.1%	4190	2910	-30.5%
	(Req)	1910	1714	-10.3%	3810	2910	-23.6%
PUNJAB	(Avl)	5690	4693	-17.5%	11640	10214	-12.3%
	(Req)	4860	4693	-3.4%	9300	10214	9.8%
RAJASTHAN	(Avl)	8820	8935	1.3%	18480	17030	-7.8%
	(Req)	9610	8935	-7.0%	17000	17030	0.2%
UTTAR PRADESH	(Avl)	10540	10507	-0.3%	20500	21243	3.6%
	(Req)	10695	10538	-1.5%	20500	21243	3.6%
UTTARAKHAND	(Avl)	1188	1205	1.5%	2220	2260	1.8%
	(Req)	1221	1207	-1.2%	2275	2260	-0.7%
NORTHERN REGION	(Avl)	37088	34622	-6.6%	79400	60000	-24.4%
	(Req)	35904	34664	-3.5%	62500	60000	-4.0%

As per above, negative / significant variation (≥5%) in Actual Power Supply Position(Provisional) vis-à-vis Anticipated figures is observed for the month of March-2024 in terms of Energy Requirement for Chandigarh, Delhi, HP, UTs of J&K and Ladakh, Punjab, Rajasthan, UP, and Uttarakhand and in terms of Peak Demand similar variation is noted for Chandigarh, Delhi, Haryana, HP, UTs of J&K and Ladakh, Punjab, and Uttarakhand. These states/UTs are requested to submit reason for such variations so that the same can be deliberated in the meeting.

All SLDCs are requested to furnish provisional and revised power supply position in prescribed formats on NRPC website portal by 2nd and 15th day of the month respectively for the compliance of Central Electricity Authority (Furnishing of Statistics, Returns and Information) Regulations, 2007.

A.3. Maintenance Programme of Generating Units and Transmission Lines

A.3.1 Maintenance Programme for Generating Units

The meeting on proposed maintenance programme for Generating Units for the month of May-2024 is scheduled on 16-April-2024 via Video Conferencing

A.3.2 Outage Programme for Transmission Elements

The meeting on proposed outage programme of Transmission elements for the month of May-2024 is scheduled on 16-April-2024 via Video conferencing.

A.4. Planning of Grid Operation

A.4.1. Anticipated Power Supply Position in Northern Region for May 2024

The Anticipated Power Supply Position in Northern Region for May 2024 is as under:

State / UT	Availability / Requirement	Revised Energy (MU)	Revised Peak (MW)	Date of revision
CHANDIGARH	Availability	180	360	No Revision submitted
	Requirement	170	361	
	Surplus / Shortfall	10	-1	
	% Surplus / Shortfall	6.1%	-0.2%	
DELHI	Availability	4150	7700	No Revision submitted
	Requirement	3848	7344	
	Surplus / Shortfall	303	356	
	% Surplus / Shortfall	7.9%	4.8%	
HARYANA	Availability	7370	12240	No Revision submitted
	Requirement	5839	11388	
	Surplus / Shortfall	1531	852	
	% Surplus / Shortfall	26.2%	7.5%	
HIMACHAL PRADESH	Availability	1093	1885	09-Apr-24
	Requirement	1108	1780	
	Surplus / Shortfall	-16	105	
	% Surplus / Shortfall	-1.4%	5.9%	
J&K and LADAKH	Availability	1950	3300	No Revision submitted
	Requirement	1860	3069	
	Surplus / Shortfall	90	231	
	% Surplus / Shortfall	4.8%	7.5%	

State / UT	Availability / Requirement	Revised Energy (MU)	Revised Peak (MW)	Date of revision
PUNJAB	Availability	7220	11610	No Revision submitted
	Requirement	6373	12557	
	Surplus / Shortfall	847	-947	
	% Surplus / Shortfall	13.3%	-7.5%	
RAJASTHAN	Availability	9510	18280	No Revision submitted
	Requirement	9040	17952	
	Surplus / Shortfall	470	328	
	% Surplus / Shortfall	5.2%	1.8%	
UTTAR PRADESH	Availability	14570	27500	09-Apr-24
	Requirement	14260	27500	
	Surplus / Shortfall	310	0	
	% Surplus / Shortfall	2.2%	0.0%	
UTTARAKHAND	Availability	1418	2505	06-Apr-24
	Requirement	1442	2550	
	Surplus / Shortfall	-24	-45	
	% Surplus / Shortfall	-1.6%	-1.8%	
NORTHERN REGION	Availability	47461	78800	
	Requirement	43940	78000	
	Surplus / Shortfall	3521	800	
	% Surplus / Shortfall	8.0%	1.0%	

SLDCs are requested to update the anticipated power supply position of their respective state / UT for the month of May-2024 and submit the measures proposed to be taken to bridge the gap between demand & availability, as well to dispose-off the surplus, if any, in the prescribed format.

A.5. Follow-up of issues from previous OCC Meetings- Status update.

The updated status of agenda items is enclosed at ***Annexure-A.I***.

All utilities are requested to update the status.

A.6. NR Islanding scheme

Latest status of Islanding Scheme of NR is attached as **Annexure-A.II.**

Members may kindly deliberate.

A.7. Coal Supply Position of Thermal Plants in Northern Region

A.7.1. In 186th OCC meeting, it was agreed that coal stock position of generating stations in northern region may be reviewed in the OCC meetings on the monthly basis.

A.7.2. Accordingly, coal stock position of generating stations in northern region during current month (till 10th April 2024) is as follows:

Station	Capacity (MW)	PLF % (prev. months)	Normative Stock Reqd (Days)	Actual Stock (Days)
ANPARA C TPS	1200	0.92	17	5.8
ANPARA TPS	2630	0.81	17	19.6
BARKHERA TPS	90	0.21	26	63.0
DADRI (NCTPP)	1820	0.62	26	29.6
GH TPS (LEH.MOH.)	920	0.63	26	23.8
GOINDWAL SAHIB TPP	540	0.55	26	28.8
HARDUAGANJ TPS	1265	0.51	26	27.9
INDIRA GANDHI STPP	1500	0.75	26	36.3
KAWAI TPS	1320	0.71	26	10.2
KHAMBARKHERA TPS	90	0.44	26	62.0
KOTA TPS	1240	0.94	26	8.0
KUNDARKI TPS	90	0.34	26	34.8
LALITPUR TPS	1980	0.80	26	24.6
MAHATMA GANDHI TPS	1320	0.40	26	41.4
MAQSOODPUR TPS	90	0.35	26	55.0
MEJA STPP	1320	0.89	26	25.0
OBRA TPS	1094	0.60	26	18.5
PANIPAT TPS	710	0.54	26	47.3
PARICHHA TPS	1140	0.64	26	17.2
PRAYAGRAJ TPP	1980	0.86	26	33.1
RAJIV GANDHI TPS	1200	0.54	26	36.5
RAJPURA TPP	1400	0.92	26	24.8
RIHAND STPS	3000	0.82	17	26.5
ROPAR TPS	840	0.59	26	44.1
ROSA TPP Ph-I	1200	0.75	26	20.5
SINGRAULI STPS	2000	0.99	17	16.8
SURATGARH TPS	1500	0.61	26	7.6
TALWANDI SABO TPP	1980	0.78	26	9.9
TANDA TPS	1760	0.73	26	29.7
UNCHAHAR TPS	1550	0.79	26	23.8
UTRAULA TPS	90	0.30	26	39.0
YAMUNA NAGAR TPS	600	0.75	26	31.1
CHHABRA-I PH-1 TPP	500	0.85	26	2.1
KALISINDH TPS	1200	0.63	26	6.5
SURATGARH STPS	1320	0.62	26	6.7
CHHABRA-I PH-2 TPP	500	0.71	26	26.4
CHHABRA-II TPP	1320	0.81	26	6.5

A.8. Status of availability of ERS towers in Northern Region (Agenda by NRPC Sectt.)

A.8.1. In the 68th meeting of NRPC issues arising due to non-availability of sufficient ERS were discussed and it was decided that ERS availability monitoring shall be taken as rolling/follow-up agenda in OCC meetings for regular monitoring of ERS under different utilities in Northern region.

A.8.2. Subsequently matter was deliberated in 211th OCC meeting wherein NRLDC representative briefed about the Requirement of ERS, recent experience in Northern Region, CEA Regulation on ERS, Govt. Guidelines and Present situation on ERS.

A.8.3. NRPC Sectt. vide letter dated 26.09.2023 requested all transmission utilities of NR to furnish the length of transmission line (ckt-kms) and number of ERS towers available with them at different voltage levels (e.g. 220 kV, 400 KV 765 KV and + - 500 kV HVDC via email at **seo-nrpc@nic.in**.

A.8.4. In this regard, inputs received from utilities are attached as **Annexure-A.III.**

Transmission utilities of NR to update status.

A.9. Flexible Operation of Coal Based Thermal Power Plants (Agenda by CEA)

A.9.1. CEA has issued a gazette notification dated January 30, 2023 regarding flexible operation of coal-fired thermal generating units. As per CEA gazette notification extraordinary, part III, section 4, no. 61 (CG-DL-E-31012023-243299), the coal-based thermal power generating units shall have flexible operation capability with a minimum power level of 55%, along with a ramp rate of 2% between 55%-70% and a ramp rate of 3% above 70% within one year of the notification of the above-mentioned regulations, i.e., by Jan 2024.

A.9.2. In view of above CEA has also circulated SOP (copy attached as **Annexure-A.IV**) for operating at 55% load and recommended for training for plant operators/trainers on simulator at NPTI or training centre at major utility. Moreover, DO letters from PCE-II, CEA has been disseminated to the respective State Electricity Regulatory Commissions, as well as to the Principal Secretaries of the states, outlining the requisite measures for the enforcement and execution of CEA regulations.

A.9.3. As per above mentioned CEA (Flexible operation of Coal Based Thermal Power Generating Units) regulations, 2023, the coal-based thermal power generating units shall have flexible operation capability with minimum power level of 40%. The implementation of the flexible operation shall be as per the phasing plan specified by the authority from time to time. Consequently, the phasing plan for implementation measures for 40% minimum load operation in a phased manner (pilot+4 phases) prepared by CEA has been notified on Gazette of India (copy attached as **Annexure-A.V**).

A.9.4. In this regard CEA has also published a report on flexible operation of coal based thermal power plants and discussed various issues/challenges and mitigation plan for achieving 40% minimum technical load in March, 2023 (copy attached as **Annexure-A.VI**).

A.9.5. In this regard, CEA has requested following information:

i. Regarding 55% MTL(Minimum Technical Load)

a. Whether the target of achieving 55% Technical Minimum Load (TML) has been met and if not, the reasons for the same and tentative date for achieving the same.
b. Whether the specified ramp rates outlined in the regulations, I.e., 3% for 100-70% load and 2% for 70%-55% load, have been adhered to. If not, the reasons and tentative date for achieving the same.
c. How many operators have trained in your organization?
Generators are requested to submit Progress report (**Annexure-A.VII**) as per enclosed format on the date of the meeting.

ii. Regarding 40% MTL (Minimum Technical Load) and Status of units under Pilot phase

PILOT PHASE (May, 2023-March, 2024)

Phase	Sector	Organization	Name of Project	Unit No.	Capacity (MW)	Region
Pilot	Central	NTPC	MAUDA TPS	1	500	WR
Pilot	Central	NTPC	SIMHADRI	3	500	SR
Pilot	Central	NTPC	DADRI	6	490	NR
Pilot	Central	DVC	MEJIA TPS	8	500	ER
Pilot	Central	NEYVELI LIGNITE	NEYVELI NEW TPP	2	500	SR
Pilot	State	KPCL	YERMARUS TPS	1	800	SR
Pilot	State	GSECL	WANAKBORI TPP	6	800	WR
Pilot	State	RRVUNL	SURATGARH SCTPP	8	660	NR
Pilot	State	WBPDC	SAGARDIGHI TPS	3	500	ER
Pilot	Private	CEPL	MUTHIARA	2	600	SR
Pilot Phase Total				**10**	**5850**	

a. Whether the target of achieving 40% Technical Minimum Load (TML) has been met and if not, the reasons for the same and tentative date for achieving.

b. Whether the specified ramp rates outlined in the regulations, i.e., 3% for 100-70% load, 2% for 70%-55% load, 1% for 40%-55% have been adhered to. If not, the reasons for behind and tentative date for achieving the target.

Generators are requested to submit duly filled Progress report (**Annexure-A.VIII**) as per enclosed format on the date of the meeting.

Members may kindly deliberate.

A.10. Review of SPS at Jawaharpur TPS (Agenda by UPSLDC)

A.10.1 UPSLDC vide letter dated 08.04.2024 (copy attached as **Annexure-A.IX**) has intimated that 660MW unit – 01 of Jawaharpur TPS tripped on SPS at 09:49 hrs. on 07.04.2024. At present SPS is in disabled condition to avoid generation outage.

A.10.2 Therefore, UPSLDC has stated that system protection scheme needs to be reviewed on the basis of load flow study of sub-stations connected with Jawaharpur TPS.

A.10.3 Detailed load flow study would be put up by UPSLDC before the forum in the OCC meeting.

Members may kindly deliberate.

A.11. Review of SPS for safe evacuation of power from Anpara Complex in view of commissioning of 2X1000 MVA ICT at Obra C (Agenda by UPSLDC)

A.11.1. UPSLDC vide letter dated 10.04.2024 (copy attached as **Annexure-A.X**) have informed that the expected date of commissioning of 2X1000 MVA ICT at Obra C TPS i.e. ICT-I and ICT-II is April 2024 and September 2024 respectively.

A.11.2. UPSLDC has stated that in view of commissioning of 2X1000 MVA ICT at Obra C, SPS installed at Anpara DTPS for safe evaouation of power from Anpara Complex need to be reviewed. Detailed Basecase and proposed revised logic submitted by UPSLDC is attached as **Annexure-A.X**.

Members may kindly deliberate.

A.12. Commissioning work of Tehri PSP and its impact on operation of Tehri HPP and Koteshwar HEP (agenda by THDCIL)

A.12.1 The Civil, EM & HM works of Tehri PSP is in full swing and as per the present pace of work, the likely commissioning date of 1st Unit is July-2024. However, before commissioning of Tehri PSP, the following river joining works are required to be completed:

- Two nos baffle walls are required to be constructed to avoid the entry of debris etc in the water conductor system of PSP from TRT side during Pumping Mode of operation. The location of the proposed baffle wall is as below:
  - U/s of HPP TRT from EL.600.00m to El.607.00m.
  - U/s of PSP TRT from EL.597.00m to El.603.00m.

- During operation of HPP & KHEP, the water level is generally above El.603.00m. Hence, the above two nos Baffle wall cannot be constructed without complete shutdown of HPP & KHEP.
- The adjacent rock condition of river valley near U/s of PSP TRT area is filled with loose materials & required to be protected before operation of PSP. Further, the proposed approach road for the treatment (left & right bank) is required upto EL.597.00m. Hence, to take up the work of slope protection with construction of approach road for baffle wall & as well as for slope protection works, the proposed complete shutdown of HPP & KHEP is required.

- The existing Flood protection wall at PSP TRT outfall area (from El.616.00m to El.597.00m) is required to be removed before operation of PSP and subsequently raft at EL. 598.00m and U/s & D/s guide walls upto El.616.00m are required to be constructed.

A.12.2 In order to complete the above work, the following nature of shutdown of Tehri HPP & Koteshwer HEP is required:

a. **Partial Shutdown (THPP & KHEP): 1st April-24 to 14th May-24.**

b. **Complete Shutdown (THPP & KHEP): 15th May-24 to 30th Jun-24.**

A.12.3 The schedule of the activities from 1st April-24 to 30th Jun-2024 is placed at **Annexure-A.XI**.

Members may kindly deliberate.

A.13. In-Principle approval for diversion of old transmission lines due to change in soil and land profile in Singrauli / Rihand complex under ADD-CAP. (Agenda by Powergrid NR-3)

A.13.1. Powergrid NR-3 vide mail dated 08.04.2024 has intimated that some of the lines in Singrauli/Rihand complex have completed its useful life of 35 years or reaching to 35 years.Operation and maintenance of such old transmission lines is also very difficult and a big challenge. Total 18 no. of transmission lines are being maintained by POWERGRID under Singrauli/Rihand complex comprising 2003 no. of towers.

A.13.2. Out of 18 no. of Transmission lines, 07 no. of lines are aged more than 35 years & 02 lines are more than 32 years. Due to long period of time and change in profile of soil and land, leg of many towers got rusted /over soiled. Detail of such old Transmission lines are tabulated below-

Sr. No.	Name of Line	Total No. Of Tower	No of Over soiled / Rusted tower	DOCO	Age (years)
1	500KV HVDC Rihand-Dadari -I	371	175	10.01.92	32.18
2	500KV HVDC Rihand-Dadari -II			20.05.91	32.82
3	400KV Rihand-Singrauli - I	118	59	01.03.88	36.04
4	400KV Rihand-Singrauli -II			26.12.88	35.22
5	400KV Singrauli-Anpara Line	81	42	05.04.92	41.95
6	400KV Singrauli-Allahabad -I	180		01.06.83	40.80
7	400KV Singrauli-Allahabad - II	247	140	14.03.87	37.01
8	400KV Singrauli-Lucknow Line	244		01.06.86	37.79
9	400KV Singrauli-Fatehpur Line	253	90	26.12.88	35.22
Total		**1494**	**506**		

A.13.3. Further, Powergrid NR-3 has mentioned that as per technical specification, concrete level should be 225mm above the ground level but in most of the locations, concrete level is 1-2 mtr below from existing ground level due to change in soil / land profile. Dumping of coal ash from Generating station is also a big reason for over soiled towers under Singrauli/Rihand complex, which causes water logging and leads rusting in Tower legs. This type of over soiled /rusting problem may lead to breakdown of transmission lines at any time and endangering the overall safety and grid reliability. Hence, timely action is prudent to maintain the reliability and availability of the said Transmission Lines.

A.13.4. In view of the above, Powergrid NR-3 has requested that In-Principle approval may be consented for diversion of 09 no. of old transmission lines (as above) due to change in soil and land profile in Singrauli / Rihand complex under ADD-CAP to avoid breakdown of transmission lines and grid reliability.

Members may kindly deliberate.

खण्ड-ख: उ.क्षे.भा.प्रे.के.	**Part-B: NRLDC**

B.1. NR Grid Highlights for March 2024

Major grid highlights of Northern region grid for March 2024 is shown below:

Demand met details of NR

S.No.	Constituents	Max Demand met (in MW)	Date & Time of Max Demand met	Max Consumption (in MUs)	Date of Max Consumption	Average Demand met (in Mus)

1	Chandigarh	237	05.03.24 at 07:00	4.00	29.03.2024	3.51
2	Delhi	4482	08.03.24 at 09:43	84.82	30.03.2024	71.10
3	H.P.	1982	01.03.24 at 08:00	35.36	01.03.2024	30.63
4	Haryana	7747	18.03.24 at 12:30	152.27	19.03.2024	138.36
5	J&K	2910	05.03.24 at 07:00	60.01	05.03.2024	55.08
6	Punjab	10214	20.03.24 at 10:45	184.73	20.04.2024	151.56
7	Rajasthan	16773	01.03.24 at 10:00	307.59	12.03.2024	288.30
8	Uttarakhand	2260	01.03.24 at 08:00	43.18	29.03.2024	39.34
9	U.P.	21243	30.03.24 at 19:44	407.91	30.03.2024	336.74
10	**Northern Region**	**60002**	**19.03.24 at 10:00**	**1212.50**	**29.03.2024**	**1114.61**

***As per SCADA**

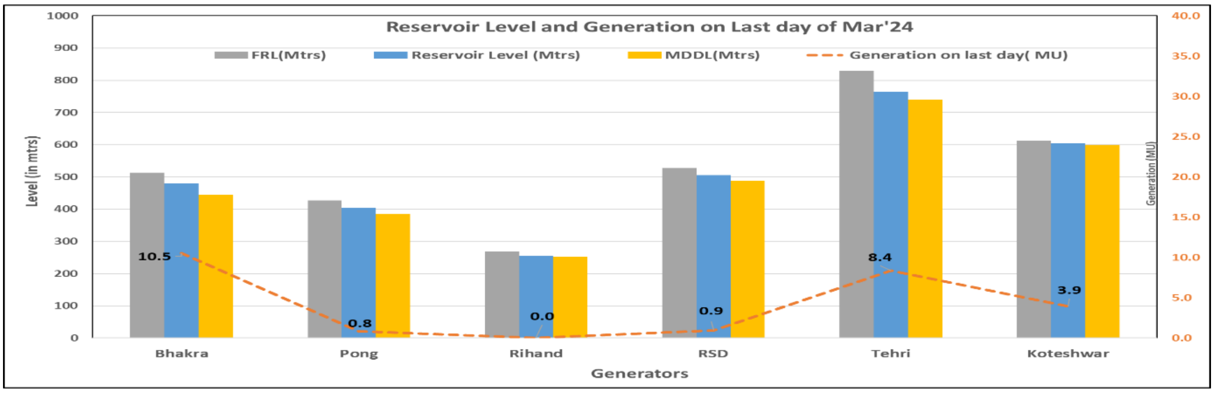
Northern Region all-time high value recorded in March'24:

Nil

Frequency profile

Month	Avg. Freq. (Hz)	Max. Freq. (Hz)	Min. Freq. (Hz)	<49.90 (% time)	49.90 – 50.05 (% time)	>50.05 (% time)
Mar'24	49.998	50.43 (17.03.24 at 06:03:00 hrs)	49.59 (28.03.24 at 22:23:10 hrs)	6.02	77.51	16.46
Mar'23	50.00	50.48	49.56	9.0	65.4	25.6

Reservoir Level and Generation on Last Day of Month

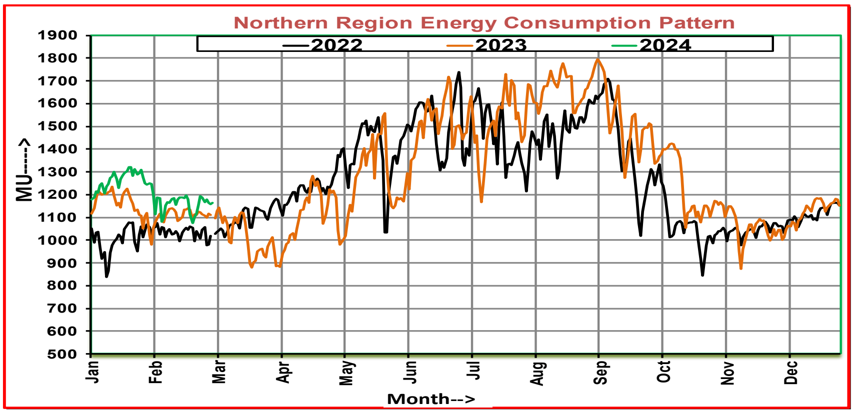


Detailed presentation on grid highlights of Mar'2024 will be shared by NRLDC in OCC meeting.

B.2. Summer Preparedness 2024

With the increase in temperature, demand of Northern Region starts increasing from March onwards every year. Summer of Northern region are typically hot and demand is also high during this time, therefore advance actions help in better grid operation.

Due to extreme weather conditions, high demand is observed during summer/monsoon months in Northern region. Along with high demand, high loadings of lines and transformers and low voltages especially at distribution level are big challenge to safe and secure grid operation. The energy consumption pattern of Northern region for last 3 years is shown below:



To overcome the commonly encountered challenges during summer months and ensuring smooth grid operation, following are some of the key actions that were agreed in last OCC meeting for ensuring safe and secure grid operation during summer 2024 are listed below:

- Apart from GNA/Market arrangements based on forecast, other short term arrangements should also be planned for real time imbalances. For example, ensuring adequate margin while scheduling own thermal generation, units on bar, maintenance of reserves, technical minimum operation of thermal units in case of load crash, tie up with neighbour states or hydro rich states and utilization of real-time market etc. to bridge the load-generation gap in real time.

- Regular monitoring of weather websites for weather forecast information and plan load generation balance accordingly. In case of forecasted thunderstorm or wind storm, generation may be timely backed down so as to avoid any under drawl, high frequency operation of the grid and wastage of precious fuel.
- In view of high/increasing demand & transmission constraints (if any) in importing the power or in case of any contingency in the system, states to maximize their internal generation to avoid low frequency/low voltage operation or other related issues.
- SLDCs to arrange for display window at their control centers so that system operators readily know quantum of reserve available and hence better real-time actions can be taken.
- Some states continue to connect/ disconnect large quantum of load at hourly boundaries resulting in frequency spikes and instantaneous over voltages. Such actions to be avoided especially during high demand season.
- States to take actions to ensure backing down of thermal generation as per latest regulations issued by CEA regarding thermal plants flexible operation.
- Utilities to update & share coal stock position of thermal plants at least a week in advance as agreed earlier in TCC/NRPC meeting, especially in case of anticipation of low coal stock.
- Each utility shall work on plan for tower repairing work before April. Extra precautions need to be taken care for important lines which have history of tripping during thunderstorm/windstorms.
- Latest status regarding availability of ERS to be submitted by all transmission utilities to NRPC/ NRLDC.
- Take all necessary precautions to avoid any issues arising due to low voltages during summer months.
- All state control area/Users shall ensure before start of summer that their protection and defence system are in working conditions and settings are as per the recommendations of NRPC. It is also suggested to carry out mock testing exercise of important SPS in Northern region including under state control area.
- All utilities to ensure the telemetry of all analog & digital points of all stations at respective control centers.

Regarding feeders for physical regulation, list is attached as Annexure of 217 OCC meeting, SLDCs were requested to verify that

- list of feeders are actually radial in nature and are likely to provide the expected relief
- Such feeders are not part of any other scheme such as any SPS, UFR or df/dt actuated shedding
- Telemetry is to be ensured for all such feeders for monitoring in real time by SLDC/ NRLDC

In 217 OCC meeting, UP SLDC representative informed that there has been change in the list of feeders, as some of the feeders are not radial now. The details shared by UP SLDC representative is shown below:

Changes in the List of feeders for physical regulation in supply				
Uttar Pradesh				
Sl.No.	**Name of Feeder**	**Affected Area**	**Previous Status**	**Updated Status**

			Remarks	Remarks
1	220kV Meerut-Gajraula	Gajraula	Radial	Not Radial
2	220kV Baghat (PG)- Baghpat D/C	Baghpat	Radial	Radial
3	220kV Allahabad (PG)-Jhusi	Jhusi	Radial	Not Radial
4	220kV Sohawal (PG)-Barabanki D/C	Barabanki	Not Radial	Not Radial
5	220kV Mainpuri (PG)-Neemkarori D/C	Farukkhabad	Radial	Not Radial
6	220kV Gorakhpur (PG)- Gola D/C	Gorakhpur	Radial	Radial
7	132kV Ballia(PG)- Bansdeeh	Ballia	Radial	Radial
8	132kV Ballia (PG)- Sikandarpur	Ballia	Radial	Radial
50 no.s 132kV feeders can also be opened from SLDC snad testing was also carried out few days back at SLDC level				

NRLDC representative requested UP SLDC to check for other possible radial feeders in view that some of the feeders are not radial now.

The opening of feeders is generally an extreme step which shall be required in case of threat to grid security and non-adherence to RLDC instructions to manage overdrawl by SLDCs/ DISCOMs. In such a case, every utility needs to take actions to support RLDC by following their instructions including opening of feeders.

All SLDCs are once again requested to verify that

- list of feeders are actually radial in nature and are likely to provide the expected relief
- such feeders are not part of any other scheme such as any SPS, UFR or df/dt actuated shedding

Telemetry is to be ensured for all such feeders for monitoring in real time by SLDC/ NRLDC. States are also advised to take remedial measures for minimizing sustained over drawal at low frequencies as per the IEGC.

Members may like to discuss.

B.3. Sharing of ATC/TTC assessment and basecase with NRLDC

All NR states Chandigarh U/Ts are sharing basecase and ATC/TTC assessment with NRLDC. OCC has advised all states to timely declare TTC/ATC for prospective months and revise the figures as per requirement.

CERC vide their order dated 29.09.2023 has granted approval of "'Detailed Procedure for Allocation of Transmission Corridor for Scheduling of General Network Access and Temporary General Network Access under Central Electricity Regulatory Commission (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022".

Detailed roles and responsibilities for State Load Dispatch Centers in various timelines of the approved procedure are provided in the table below.

Purpose	***Sl No***	***Action of Stakeholder***	***Responsibility***	***Submission to***	***Data/ Information Submission Time line***
1. Revision 0 TTC/ATC Declaration for Month 'M'	*1(a)*	*Submission of node wise Load and generation data along with envisaged*	*SLD*	*RLDC*	*10th Day of 'M-12' month*
		scenarios for assessment of transfer capability			
		Assessment of TTC/ATC of the import/export capability of the state and intra-state system and sharing of updated network simulation models			
	1(b)	*Declaration of TTC/ATC of the intra- state system by SLDC in consultation with RLDC*			*26th Day of 'M-12' month*
2. Interconnection Studies for elements to be integrated in the month 'M'	*2(a)*	*Submission of node-wise load and generation data & sharing of network simulation models for intra-state elements coming in the next six months*	*SLD*	*RLDC*	*8th Day of 'M- 6' month*
	2(b)	*Sharing of inter-connection study results*			*21st Day of 'M-6' month*
3. Month Ahead TTC/ATC Declaration & Base case for Operational Studies for Month 'M'	*3(a)*	*Submission of node wise Load and generation data along with envisaged scenarios for assessment of transfer capability*	*SLD*	*RLDC*	*8th Day of 'M- 1' month*
		Assessment of TTC/ATC of the intra- state system and sharing of updated network simulation models			
	3(b)	*Declaration of TTC/ATC of the intra- state system in consultation with RLDC*	*SLDC*	*RL*	*22nd Day of 'M-1' month*

To encourage participation from SLDCs with regard to basecase preparation and ATC/TTC assessment, two workshops have been conducted from Grid-India/NRLDC side. One workshop was conducted 31.08.2023 before the finalization of the procedure and another on 10.01.2024 recently to involve further participation from SLDCs.

Although all SLDCs are now involved in preparation of basecase & ATC/TTC assessment, it is seen that the timelines as per CERC approved procedure are

not being followed and number of times basecases are not received from SLDC side.

B.3.1 ATC/TTC assessment sharing 11 months in advance

The procedure mentions that:

"SLDCs in consultation with RLDCs shall declare the import and export TTC, ATC, and TRM of the individual control/bid areas within the region in accordance with Regulation 44 (3) of the Grid Code 2023. RLDCs shall assess the import and export TTC, TRM and ATC for the group of control/bid areas within the region (if required). The computed TTC, TRM and ATC figures shall be published on the website of respective SLDCs and RLDCs, along with the details of the basis of calculations, including assumptions, if any, **at least eleven (11) months in advance**. The specific constraints indicated in the system study shall also be published on the website."

Accordingly, SLDCs are requested to send the PSSE cases for four scenarios for April'25 i.e. Morning Peak, Solar Peak, Evening Peak & Off-Peak hours as given below

S. No.	Scenario	Time of Scenario
1	Off-Peak	03:00 Hrs
2	Morning Peak	10:30 Hrs
3	Evening Peak	18:45 Hrs
4	Solar Peak	12:00 Hrs

It is requested that the basecases as well as ATC/TTC assessments may be shared with NRLDC as per CERC approved procedure. Further, above exercise needs to be carried out regularly on monthly basis.

Basecase & ATC/TTC assessment was received from only Haryana, UP and J&K SLDC for M-12 scenarios.

It was discussed in last several OCC meetings & all states were requested to share basecase as well as ATC/TTC assessments for M-11 scenarios on monthly basis with NRLDC as per CERC approved procedure. Accordingly, it is requested to submit the basecase as well as ATC/TTC assessments.

Members may please discuss.

B.3.2 Sharing of Data and study results for interconnection studies

As per **Regulation 33 of IEGC 2023,**

(9) Each SLDC shall undertake a study on the impact of new elements to be commissioned in the intra-state system in the next six (6) months on the TTC and ATC for the State and share the results of the studies with RLDC.
(10) Each RLDC shall undertake a study on the impact of new elements to be commissioned in the next six (6) months in (a) the ISTS of the region and (b) the intra-state system on the inter-state system and share the results of the studies with NLDC.

(11) NLDC shall undertake study on the impact of new elements to be commissioned in the next six (6) months in (a) inter-regional system, (b) cross-border link and (c) intra-regional system on the inter-regional system.

In line with above, utilities are requested to share the list of **elements/LGB data/interconnection study results** etc as per the approved procedure which are expected to be commissioned up to **October 2024, before 08.04.2024. Above was also requested vide mails dated 27.03.2024 by NRLDC. This needs to be practised as monthly exercise on regular basis.**

It was discussed in last several OCC meetings & all utilities were requested to share list of elements/LGB data/interconnection study results etc as per the approved procedure on monthly basis.

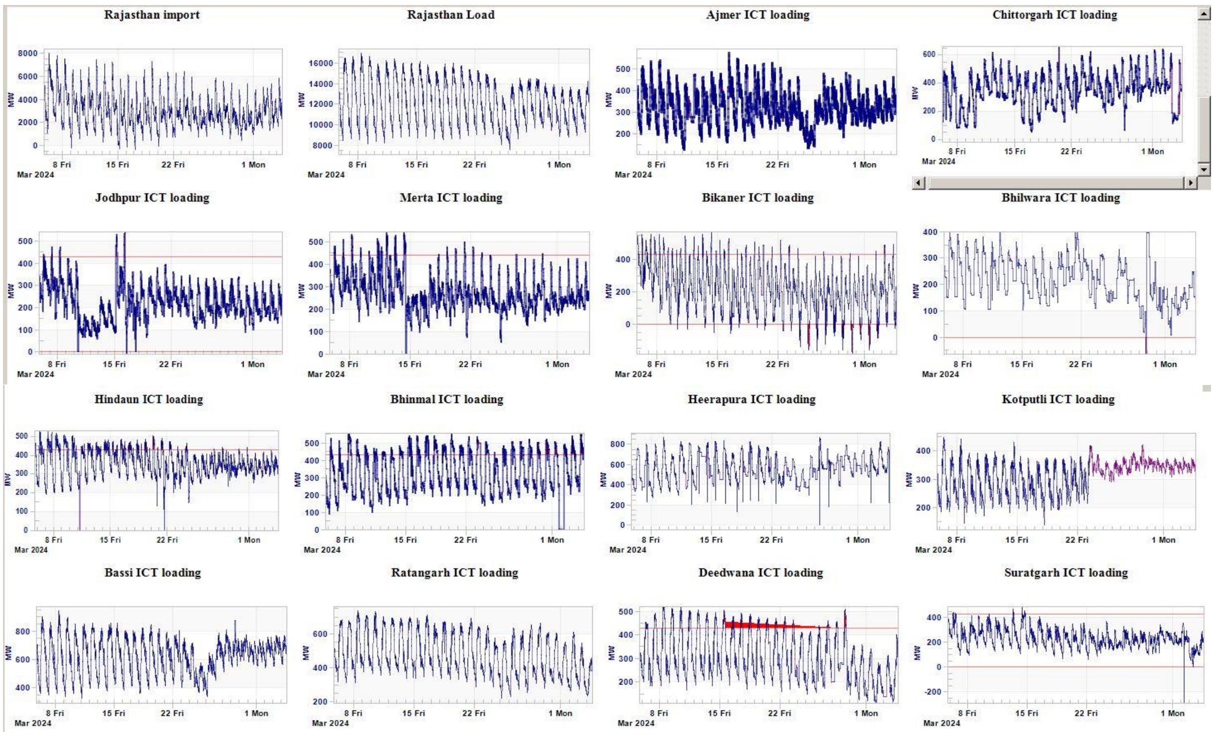
B.3.3 ATC/TTC of states for summer 2024 (M-1)

Latest ATC/TTC figures as available with NRLDC for the month of May 2024 is attached as Annexure-B.I of agenda. States are requested to go through these figures and provide any comments.

ATC/TTC assessment for summer 2024 is yet to be received from the states.

B.3.4 Constraints observed during last month

It is being observed that loading of 400/220kV ICTs at number of RVPN substations continue to be on the higher side. Some of the such stations are shown below along with loading of 400/220kV ICTs for last 30 days:



From the data available at NRLDC, it is being observed that the loading of almost all 400/220kV substations (intrastate as well as interstate) in Rajasthan is beyond their N-1 contingency limit during day-time. Such situation may always cause load loss in particular area of N-1 non-compliance apart from possibilities of major grid disturbance in Rajasthan control area.

As discussed in last two OCC meeting, it is requested that,

- All SLDCs assess and share ATC/TTC assessment for Summer 2024 at the earliest. ATC/TTC assessment has been received from UP SLDC which is being examined at NRLDC end.
- All states to share data and base case for M-6 & M-11 timelines as discussed in the agenda.
- SLDCs to take actions to ensure that loading of ICTs and lines under their jurisdiction are below their N-1 contingency limits.
- Maximize internal generation in case of drawl near to the transfer capability limits.
- Forum agreed that in case no assessments for eleven months in advance are shared by SLDC, the existing ATC/TTC assessment could be published on website and considered for the said month.

Members may please discuss.

B.4. Grid Operation related issues in Northern region

a) Long outage of transmission elements

It is requested to expedite restoration of the Grid elements under long outage at the earliest and also provide an update regarding their expected restoration date/time in the meeting/ NRLDC outage portal.

Some of the key elements that need to be revived at the earliest:

S. No.	Element Name	Outage Date
1	400/220 kV 315 MVA ICT 2 at Mundka(DV)	20-09-2019
2	400/220 kV 315 MVA ICT 4 at Mundka(DV)	19-03-2024
3	400/220 kV 315 MVA ICT 1 at Muradnagar_1(UP)	13-03-2020
4	50 MVAR Bus Reactor No 1 at 400KV Moradabad(UP)	03-12-2021
5	400/220 kV 240 MVA ICT 3 at Moradabad(UP)	13-12-2021
6	220 KV Gazipur(DTL)-Noida Sec62(UP) (UP) Ckt-1	30-04-2022
7	220 KV Gazipur(DTL)-Shahibabad(UP) (UP) Ckt-2	30-04-2022
8	125 MVAR Bus Reactor NO 1 AT 400KV PARICHA(UPUN)	03-03-2023
9	400 KV Noida Sec 148-Noida Sec 123 (UP) Ckt-2	09-03-2023
10	400/220 KV 500 MVA ICT 1 AT RAMGARH(RS)	26-04-2023
11	400/220 kV 240 MVA ICT 1 at Muradnagar_2(UP)	05-06-2023
12	400KV Bus 2 at Parbati_3(NH)	21-08-2023
13	400/220 kV 500 MVA ICT 1 at Rasra (UP)	26-10-2023
14	400/220 kV 240 MVA ICT 3 at Gorakhpur(UP)	11-11-2023
15	400 KV DULHASTI(NH)-KISHENPUR(PG) (PG) CKT-2	09-01-2024

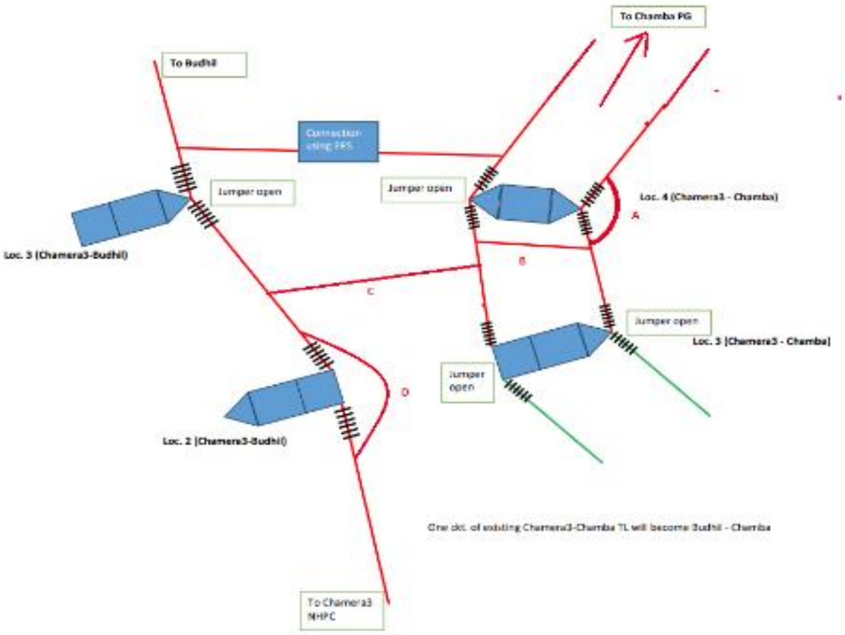
16	400/220 KV 315 MVA ICT 2 AT UNNAO(UP)	11-01-2024
17	225 MVAR Bus Series Reactor No 1 at 400 KV Ballabhgarh(PG)	02-02-2024
18	63 MVAR Bus Reactor No 1 at 400KV Unnao(UP)	21-02-2024
19	400/220 kV 450 MVA ICT 1 at Panipat(BB)	28-03-2024

List of generating units under long outage is attached as **Annexure-B.II**. It can be seen that number of thermal generating units are under outage. It is requested to provide update regarding the likely revival date for these generating units in the meeting/ NRLDC outage portal and expedite revival of these transmission elements.

Member may like to discuss.

b) Long outage of 220kV Chamera2-Chamba D/C line

220 KV Chamera_3(NH)-Chamba(PG) (PG) Ckt-1 and ckt-2 were out due to tower collapse on 09-07-2023. Tower collapse was reported at Loc no. 1 from Chamera-3 end and subsequently an interim arrangement was worked out in separate meeting between NRPC, PGCIL(NR2), Chamera3(NHPC), Budhil(Grenko), HPPTCL and NRLDC.



New circuits after installation of the alternative mechanism are in service as:

a) 220 kV Budhil-Chamba transmission line
b) 220 kV Chamera III-Chamba line

As the interim arrangement was done to facilitate safe evacuation of hydropower during the peak hydro season, it is requested that the works on collapsed tower may be expedited and the line may be restored to its normal configuration.

In 215 OCC meeting, NHPC representative stated that tower has been damaged and washed away, accordingly proposal is being worked out to directly string the conductor to gantry. Proposal is being taken up between NHPC and POWERGRID and it is expected that the line would be charged before monsoon season. Work from NHPC side is expected to be completed by Apr 2024.

NHPC/POWERGRID to provide update. Members may please discuss.

c) Update of Important grid element document in line with IEGC:

In line with Chapter 6 section 29.2.(b) of IEGC, list of important grid elements in Northern region has to be compiled by NRLDC. Such elements shall be opened/closed only on instructions from NRLDC. It is requested to submit the list of all elements with details charged under their jurisdiction from 1.4.2023 till date including those expected to be commissioned till May 2024 so that the same could be included in the list.

However, response from most of the utilities is still pending. It is requested to provide details before 30th April 2024. Last updated document is available at following link. Any other feedback related to inclusion/deletion of elements may also be provided.

Utilities may provide update.

d) Synchronisation issue of 765kV Bhadla2-Ajmer ckt 1 during high solar generation

EHV lines are generally being manually opened during evening time to control high voltages in the RE complex of Western Rajasthan owing to no solar generation. As a practice, in case of two ckts, the ckts are kept open on alternate basis everyday.

Recently, 765kV Bhadla2-Ajmer ckt 1 was opened to control high voltages in the RE complex as routine activity. The line was opened on 30-03-2024 at 18:04. The next day, given the rising trend in solar generation and as per normal practice, code was issued from NRLDC control room to charge the line at 08:39 on 31-03-2024. However, it was observed that there was delay in charging of line from POWERGRID side and the line was charged at 11:10 hrs, when the solar generation had already increased and oscillations to the tune of 15-20kV were being observed in the grid.

On enquiry, it was informed that there was some issue at Bhadla-2 end and the angular difference between 765kV Ajmer and Bhadla-2 substations was higher than 15degrees. Logic has been implemented in Bay Control Unit that incase angular difference between two adjacent substations is higher than 15 degrees, then line can not be closed. This led to delay in charging of important line in the RE complex.

It is to be noted that the angular difference considered as 15 degrees, is on the lower side in case of N-1 contingency. CEA manual on transmission planning criteria also specifies that angular difference of upto 30 degrees may be allowed in case of N-1 contingency.

Further, reservations have also been observed on loading limit of 765kV lines in RE complex. In the mail it is being mentioned that the safe loading limit of line is as per SIL i.e. 2200MW. This is different from the understanding at NRLDC level. It is understood that the transmission lines could be loaded to their thermal limits in case of N-1 contingency for short duration. The thermal limit for 765kV lines comes out as nearly 4200MW, however, considering high power flow and issues related to angular differences, limit of 3500MW is being considered while performing simulation studies. The issue was recently observed while studies were being done for shutdown of 765kV Bikaner-Moga D/C line for NHAI related works.

In view of the above issues, it is requested that:

- POWERGRID may provide reasons for keeping limit of 15 degrees in angular difference between buses for closing of 765kV line
- POWERGRID/BKTL/CTUIL may confirm the maximum loading limit of 765kV lines to be considered for simulation studies as well as real-time grid operation.

Members may please discuss.

B.5. Frequent forced outages of transmission elements in the month of March'24:

The following transmission elements were frequently under forced outages during the month of **March'24**:

S. NO.	Element Name	No. of forced outages	Utility/SLDC
1	132 KV Mahendra Nagar(PG)-Tanakpur(NH) (PG) Ckt-1	3	POWERGRID/NHPC
2	220 KV Agra(PG)-Tundla (UP) (UP) Ckt-1	4	POWERGRID/UP
3	220 KV RAPS_A(NP)-Sakatpura(RS) (RS) Ckt-1	4	Rajasthan/RAPS
4	220 KV RAPS_A(NP)-Sakatpura(RS) (RS) Ckt-2	4	Rajasthan/RAPS
5	220 KV RAPS_B(NP)-Sakatpura(RS) (RS) Ckt-1	3	Rajasthan/RAPS
6	220 KV Sitarganj(PG)-CBGanj(UP) (PG) Ckt-1	3	POWERGRID/UP
7	400 KV Ajmer-Bhilwara (RS) Ckt-2	4	Rajasthan
8	400 KV Akal-Jodhpur (RS) Ckt-1	3	Rajasthan
9	400 KV Bareilly-Unnao (UP) Ckt-2	3	UP
10	400 KV Bikaner-Bhadla (RS) Ckt-2	3	Rajasthan
11	400 KV Dehar(BB)-Panchkula(PG) (PG) Ckt-1	3	POWERGRID/BBMB

The complete details are attached at **Annexure-B.III**.

It may be noted that frequent outages of such elements affect the reliability and security of the grid. Hence, utilities are requested to analyze the root cause of the tripping and share the remedial measures taken/being taken in this respect.

Members may like to discuss.

B.6. Multiple element tripping events in Northern region in the month of March '24:

A total of 20 grid events occurred in the month of March'24 of which **11** are of GD-1 category, **02** are of GI-1 Category and **07** are of GI-2 Category. The tripping report of all the events have been issued from NRLDC. A list of all these events is attached at **Annexure-B.IV.**

Maximum delayed clearance of fault observed in event of multiple elements tripping at 400/220kV Merta(RS) on 14th March, 2024 (As per PMU at Merta(RS), R-N phase to earth fault is observed with delayed fault clearance time of 880 ms).

Delayed clearance of fault (more than 100ms for 400kV and 160ms for 220kV system) observed in total **06** events out of **20** grid events occurred in the month. In 06 (no.) of grid events, there was no fault in the grid.

Remedial actions taken by constituents to avoid such multiple elements tripping may be shared.

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.

DR/EL of the following grid events not received till date:

a) 800 KV HVDC Kurukshetra(PG) on 2nd , 29th March'24
b) 220kV Hissar(BBMB) on 23rd March'24 (partial data received)
c) 220kV Upper Nangal(HP) on 19th March'24

Detail report of majority of the grid events not received yet.

Members may take necessary preventive measures to avoid such grid incidents / disturbances in future and report actions taken by respective utilities in OCC & PSC forum. Moreover, utilities may impress upon all concerned for providing the Preliminary Report, DR/EL & Detailed Report of the events to RLDC in line with the regulations.

Members may like to discuss.

B.7. Details of tripping of Inter-Regional lines from Northern Region for March' 24:

A total of 17 inter-regional lines tripping occurred in the month of March'24. The list is attached at **Annexure-B.V.** The status of receipt of preliminary reports, DR/EL within 24hrs of the event and fault clearing time as per PMU data has also been mentioned in the table. The non-receipt of DR/EL & preliminary report within 24hrs of the event from SLDCs / ISTS licensees / ISGSs is in violation of regulation 37.2(c) of IEGC and regulation 15(3) of CEA Grid Standards. As per regulations, all the utilities shall furnish the DR/EL, flag details & preliminary report to RLDC/RPC within 24hrs of the event. They shall also furnish the detailed investigation report within 7 days of the event if fault clearance time is higher than that mandated by CEA (Grid Standard) Regulations.

Members may please note and advise the concerned for taking corrective action to avoid such tripping as well as timely submission of the information.

Members may like to discuss.

B.8. Status of submission of DR/EL and tripping report of utilities for the month of March'24.

The status of receipt of DR/EL and tripping report of utilities for the month of March'24 is attached at **Annexure-B.VI**. It is to be noted that as per the IEGC provision under clause 37.2 (c), tripping report along with DR/EL has to be furnished within 24 hrs of the occurrence of the event. However, it is evident from the submitted data that reporting status is not satisfactory and needs improvement. Also, it is observed that reporting status has improved however, reporting status from BBMB, Punjab, Delhi, HP, Rajasthan & J&K need further improvement.

Members may please note and advise the concerned for timely submission of the information. It is requested that DR/EL of all the trippings shall be **uploaded on Web Based Tripping Monitoring System "http://103.7.128.184/Account/Login.aspx"** within 24 hours of the events as per IEGC clause 37.2(c) and clause 15.3 of CEA grid standard. Apart from prints of DR outputs, the corresponding COMTRADE files may please also be submitted in tripping portal / through email.

Members may like to discuss.

B.9. Frequency response characteristic:

The FRC based event occurred in the month of **March-2024**. Description of the event is as given below:

Table:

S. No.	Event Date	Time (In hrs.)	Event Description	Starting Frequency (in Hz)	Nadir Frequency (in Hz)	End Frequency (in Hz)	*Δf*	NR FRC during the event (%)
1	03-Mar-24	14:01hrs	On 03rd March, 2024, at 14:01 hrs, 400 KV Kankani-Jaisalmer (RS) Ckt-2 tripped on R-Y phase to phase fault. As per PMU at Bhadla2(PG), R-Y phase to phase observed, which cleared within 100msec. At the same time, drop in RE generation of approximately 2510 MW is observed as per SCADA data. Hence, generation loss considered for Frequency Restoration	50.30	50.055	50.128	0.17	51

			Capability (FRC) computation is 2510 MW.					

Details received from Haryana, Rajasthan, UP, Rosa(relaiance), kawai TPS, Koteshwar, Rihand TPS, Tehri HEP and TSPL TPS only.

Memebers are requested to share the data and analysis of FRC of their control area.

Members may like to discuss.

B.10. Grid Disturbance in RAPS, KTPS generation complex on 29th March 2024:

On 29th March at 20:22hrs, multiple elements tripping occurred un RAPS, KTPS generation complex. KTPS, RAPS-A, RAPS-B & RAPS-C generation station got blackout during this incident. Initiating incident was blast of R-ph CT at 220kV side of 220/132kV 160MVA ICT-1 at Kota Sakatpura(Raj). As bus bar protection is not available at Kota Sakatpura S/s, few of the 220kV lines tripped on Z-4 protection operation and Z-2 protection operation at Kota Sakatpura & KTPS respectively. Simultaneously, the remaining 220kV lines got significantly overloaded and tripped on distance protection operation during power swing. Thereafter due to lack of evacuation path, over frequency occurred in systems and KTPS units tripped on over frequency. SUTs at RAPS-B tripped for initiation of house load operation but it failed. SUTs of RAPS-C also tripped for switching of auxiliary supply to UTs but it also failed due to mismatch in frequency. It resulted in the tripping of RAPS-B & C units. Island formed with RAPS-A unit with the load of Debari and Chittorgarh which operated till 20:47hrs and later collapsed due to tripping of turbine generator on over fluxing. Brief f details are attached as **Annexure B. VII**.

Similar events of blackout in KTSP, RAPS generation complex occurred on 05th Jaunuary'24. Frequent disturbance in this complex having significant quantum of nuclear generation is serious issue. Necessary remedial actions at RAPS, KTPS and RVPN end need to be expedited to avoid any such event in future.

Deliberation on 05th January'24 event was done during 216 OCC meeting. KTPS, RAPS & Rajasthan are requested to share the details of remedial actions taken as agreed during discussion in 216 OCC meeting. Further, an online meeting was conducted on 05th April 2024, RAPS, KTPS & SLDC-Rajasthan agreed to take following remedial actions:

RAPS:

i) To review the ATS scheme design at RAPS-B to ensure successful auto transfer of auxiliary supply during desired condition.
ii) To strengthen the reliability of auxiliary supply of RAPS-C & D, explore the possibility of having complete auxiliary supply requirement from 400kV side.
iii) Healthiness and availability of SCADA data need to be ensured at RAPS-A, B & C.

Rajasthan:

i) To expedite the bus bar protection at 220/132kV Kota Sakatpura S/s.
ii) To explore the possibility of connecting 220kV Chittorgarh & Debari with the grid which are being operated in radial mode. It will increase the evacuation path for the generation in this complex and ensure the availability of sufficient load as per island scheme of RAPS.

iii) Dedicated SCADA display of the KTPS, RAPS generation complex need to be made for effective monitoring and decision making in this complex.
iv) 220kV KTPS-Kota(PG) D/C need to be kept in close condition to have sufficient evacuation path. A SOP may be prepared by SLDC-Rajasthan for monitoring of loading of 220kV KTPS-Kota(PG) D/C and to initiate necessary actions if desired in real time.

Members may like to discuss.

Follow up issues from previous OCC meetings Annexure-A.I

1	Down Stream network by State utilities from ISTS Station	Augmentation of transformation capacity in various existing substations, addition of new substations along with line bays as well as requirement of line bays by STUs for downstream network are under implementation at various locations in Northern Region. Further, 220kV bays have already been commissioned at various substations in NR. For its utilization, downstream 220kV system needs to be commissioned.	List of downstream networks is enclosed in **Annexure-A.I.I**.
2	Progress of installing new capacitors and repair of defective capacitors	Information regarding installation of new capacitors and repair of defective capacitors is to be submitted to NRPC Secretariat.	Data upto following months, received from various states / UTs: ◎ CHANDIGARH: Sep-2019 ◎ DELHI: Jan-2024 ◎ HARYANA: Dec-2023 ◎ HP: Feb-2024 ◎ J&K and LADAKH: Not Available ◎ PUNJAB: Dec-2023 ◎ RAJASTHAN: Jan-2024 ◎ UP: Feb-2024 ◎ UTTARAKHAND: Mar-2024 All States/UTs are requested to update status on monthly basis.
3	Healthiness of defence mechanism: Self-certification	Report of mock exercise for healthiness of UFRs carried out by utilities themselves on quarterly basis is to be submitted to NRPC Secretariat and NRLDC. All utilities were advised to certify specifically, in the report that "All the UFRs are checked and found functional".	Data upto following months, received from various states / UTs: ◎ CHANDIGARH: Not Available ◎ DELHI: Dec-2023 ◎ HARYANA: Dec-2023 ◎ HP: Feb-2024 ◎ J&K and LADAKH: Not Available ◎ PUNJAB: Dec-2023 ◎ RAJASTHAN: Dec-2023 ◎ UP: Dec-2023 ◎ UTTARAKHAND: Dec-2023 ◎ BBMB: Dec-2023 All States/UTs are requested to update status for healthiness of UFRs on monthly basis for islanding schemes and on quartely basis for the rest .
		In compliance of NPC decision, NR states/constituents agreed to raise the AUFR settings by 0.2 Hz in 47th TCC/49th NRPC meetings.	Status: ◎ CHANDIGARH: Not Available ◎ DELHI: Increased ◎ HARYANA: Increased ◎ HP: Increased ◎ J&K and LADAKH: Increased ◎ PUNJAB: Increased ◎ RAJASTHAN: Increased ◎ UP: Increased ◎ UTTARAKHAND: Increased ◎ BBMB: Increased

4	Status of FGD installation vis-à-vis installation plan at identified TPS	List of FGDs to be installed in NR was finalized in the 36th TCC (special) meeting dt. 14.09.2017. All SLDCs were regularly requested since 144th OCC meeting to take up with the concerned generators where FGD was required to be installed. Further, progress of FGD installation work on monthly basis is monitored in OCC meetings.	Status of the information submission (month) from states / utilities is as under: ◎ HARYANA – Sep-2023 ◎ PUNJAB – Feb-2024 ◎ RAJASTHAN – Jul-2023 ◎ UP – Jan-2024 ◎ NTPC – Feb-2023 FGD status details are enclosed as **Annexure-A.I.II.** All States/utilities are requested to update status of FGD installation progress on monthly basis.
5	Submission of breakup of Energy Consumption by the states	All states/UTs are requested to submit the requisite data as per the billed data information in the format given as under: Category→ | Consumption by Domestic Loads | Consumption by Commercial Loads | Consumption by Agricultural Loads | Consumption by Industrial Loads | Traction supply load | Miscellaneous / Others <Month> | | | | | |	Status of the information submission (month) from states / utilities is as under: State / UT – Upto ◎ CHANDIGARH – Not Submitted ◎ DELHI – Jan-24 ◎ HARYANA – Dec-23 ◎ HP – Feb-24 ◎ J&K and LADAKH – Not Submitted ◎ PUNJAB – Dec-23 ◎ RAJASTHAN – Jan-24 ◎ UP – Dec-23 ◎ UTTARAKHAND – Dec-23 J&K and Ladakh and Chandigarh are requested to submit the requisite data w.e.f. April 2018 as per the billed data information in the given format
6	Information about variable charges of all generating units in the Region	The variable charges detail for different generating units are available on the MERIT Order Portal.	All states/UTs are requested to submit daily data on MERIT Order Portal timely.
7	Status of Automatic Demand Management Sysytem in NR states/UT's	The status of ADMS implementation in NR, which is mandated in clause 5.4.2 (d) of IEGC by SLDC/SEB/DISCOMs is presented in the following table:	Status: ◎ DELHI – Scheme Implemented but operated in manual mode. ◎ HARYANA – Scheme not implemented ◎ HP – Scheme not implemented ◎ PUNJAB – Scheme not implemented ◎ RAJASTHAN – Under implementation. Likely completion schedule is 31.03.2024 ◎ UP – Scheme implemented by NPCIL only ◎ UTTARAKHAND – Scheme not implemented

8	Reactive compensation at 220 kV/ 400 kV level at 15 substations			
	State / Utility	Substation	Reactor	Status
i	POWERGRID	Kurukshetra	500 MVAr TCR	500 MVAr TCR at Kurukshetra has been commissioned on dated 15th December 2023
ii	DTL	Peeragarhi	1x50 MVAr at 220 kV	1x50 MVAr Reactor at Peeragarhi has been commissioned on dated 18.09.2023
iii	DTL	Harsh Vihar	2x50 MVAr at 220 kV	2x50 MVAR Reactor at Harsh Vihar has been commissioned on dated 31th March 2023.
iv	DTL	Mundka	1x125 MVAr at 400 kV & 1x25 MVAr at 220 kV	Bay work completed on 25.03.2023. Reactor part tender is dropped and at present same is under revision.
v	DTL	Bamnauli	2x25 MVAr at 220 kV	Bay work completed on 25.03.2023. Reactor part tender is dropped and at present same is under revision.
vi	DTL	Indraprastha	2x25 MVAr at 220 kV	Bay work completed on 07.11.2023. Reactor part tender is dropped and at present same is under revision.
vii	DTL	Electric Lane	1x50 MVAr at 220 kV	Under Re-tendering due to Single Bid
viii	PUNJAB	Dhuri	1x125 MVAr at 400 kV & 1x25 MVAr at 220 kV	400kV Reactors - 1x125 MVAR Reactor at Dhuri has been commissioned on dated 30th March 2023. 220kV Reactors - 1x25 MVAR Reactor at Dhuri has been commissioned on dated 27th January 2023.
ix	PUNJAB	Nakodar	1x25 MVAr at 220 kV	1x25 MVAR Reactor at Nakodar has been commissioned on dated 13th February 2023.
x	PTCUL	Kashipur	1x125 MVAR at 400 kV	SLDC informed that PTCUL has intimated that tender has been scrapped. Retendering will be done after confirmation of PSDF funding
xi	RAJASTHAN	Akal	1x25 MVAr	1x25 MVAR Reactor at Akal has been commissioned on dated 25th July’ 2022.

xii	RAJASTHAN	Bikaner	1x25 MVAr	1x25 MVAR Reactor at Bikaner has been commissioned on dated 24th June 2023.
xiii	RAJASTHAN	Suratgarh	1x25 MVAr	1x25 MVAR Reactor at Suratgarh has been commissioned on dated 25th November 2022.
xiv	RAJASTHAN	Barmer & others	13x25 MVAr	Agreement signed on dt. 22.06.2020. Grant of Ist Instalment received on dt.19.02.21 & work order placed on dt. 7.04.2022 to M/s Kanohar Electricals Ltd. Schedule time is 18 months. Out of 13 Nos. of reactors, 10 Nos. have been erected and three are under erection. Tentative charging plan is
xv	RAJASTHAN	Jodhpur	1x125 MVAr	Agreement signed on dt. 22.06.2020. Grant of Ist Instalment received on dt.19.02.21 & work order placed on dt. 7.04.2022 to M/s Kanohar Electricals Ltd. Schedule time is 18 months. 01 No. of 125 MVAR reactor is under final inspection. Tentaive charging plan is 31.03.2024.

Annexure-A-I.I

1. Down Stream network by State utilities from ISTS Station:

Sl. No.	Substation	Downstream network bays	Status of bays	Planned 220 kV system and Implementation status	Revised Target	Remarks
1	400/220kV, 3x315 MVA Samba	Commissioned: 8 Total: 8	Utilized: 6 Unutilized: 2	• Network to be planned for 2 bays.	Mar'24	02 No. of bays shall be utilized for LILO-II of 220kV Jatwal-Bishnah Transmission Line, the work of which is delayed due to severe ROW problem at Location No. 1 near Grid Substation Jatwal where the Land owner is not allowing erection of Tower. The Deputy Commissioner Samba has been approached for intervention and facilitating the erection of Tower. He is persuading the Land owner to get the work completed. Updated in 210th OCC by JKPTCL.
2	400/220kV, 2x315 MVA New Wanpoh	Commissioned: 6 Total: 6	Utilized: 2 Unutilized: 4	• 220 kV New Wanpoh - Alusteng D/c Line	Mar'25	02 No. of bays are to be utilized for connecting 220kV New Wanpoh-Alusteng D/c Line. RoW issues persisting; At present new-wampoh-mirbazar 5km and harwan-alstung 16km have been completed, expected date of completion is Mar 2025 subject to availability of funds and resolving of RoW issues), Updated in 214th OCC by JKPTCL.
				• 220 kV New Wanpoh - Mattan D/c Line	End of 2024	02 No. of bays are to be utilized for connecting 220kV New Wanpoh-Mattan D/c Line. The funding source for the project is being identified and the project is expected to be completed by ending 2024. Updated in 204th OCC by JKPTCL.
3	400/220kV, 2x315 MVA Amargarh	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• 220kV D/C line from 400/220kV Kunzar - 220/33kV Sheeri	End of 2024	02 No. of bays are proposed to be utilized for connecting 220/132 kV GSS Loolipora. The funding source for the project is being identified and the project is expected to be completed by ending 2024. Updated in 204th OCC by JKPTCL.
4	400/220kV, 2x500 MVA Kurukshetra (GIS)	Commissioned: 8 Total: 8	Utilized: 6 Unutilized: 2	• 220kV Bhadson (Kurukshetra) – Ramana Ramani D/c line	Jul'24	Updated in 205th OCC by HVPNL
5	400/220 kV, 2x315 MVA Dehradun	Commissioned: 6 Total: 6	Utilized: 2 Unutilized: 4	• Network to be planned for 4 bays	-	PTCUL to update the status.
6	Shahjahanpur, 2x315 MVA 400/220 kV	Commissioned: 6 Approved/Under Implementation:1 Total: 7	Utilized: 7	• 220 kV D/C Shahajahanpur (PG) - Gola line	Commissioned	Energization date: 26.10.2023 updated by UPPTCL in 215th OCC
				• LILO of Sitapur – Shahjahanpur 220 kV SC line at Shahjahanpur (PG)	Commissioned	Energization date: 25.02.2022 updated by UPPTCL in 196th OCC
7	Hamirpur 400/220 kV Sub-station	Commissioned: 8 Total: 8	Utilized: 4 Unutilized: 4	• 220 kV Hamirpur-Dehan D/c line	Commissioned	HPPTCL has commissioned the Planned 220kV Dehan-Hamirpur TL utilizing 2 No. 220kV Bays.Commisioned date: 09.06.2022. Updated in 198th OCC by HPPTCL
				• Network to be planned for 4 bays	-	HPPTCL to update the status.
8	Sikar 400/220kV, 1x 315 MVA S/s	Commissioned: 8 Total: 8	Utilized: 6 Unutilized: 2	• LILO of 220 kV Sikar (220 kV GSS)-Dhod S/c line at Sikar (PG)	Commissioned	LILO of 220 kV S/C Sikar-Dhod line at 400 kV GSS PGCIL, Sikar has been charged on dt. 31.03.2022
				• Network to be planned for 2 bays.	-	Against the 3rd ICT at 400 kV GSS Sikar, only 2 bays were constructed and same has been utilized by RVPN by constructing LILO of 220 kV S/C Sikar – Dhod line as updated by RVPNL in 195th OCC
				• 220 kV D/C line Bhiwani (PG) – Bhiwani (HVPNL) line	Commissioned	Updated in 202nd OCC by HVPNL

Sl. No.	Substation	Downstream network bays	Status of bays	Planned 220 kV system and Implementation status	Revised Target	Remarks
9	Bhiwani 400/220kV S/s	Commissioned: 6 Total: 6	Utilized: 2 Unutilized: 4	• 220 kV Bhiwani (PG) - Isherwal (HVPNL) D/c line.	Apr'24	Issue related to ROW as intimated in 215th OCC by HVPNL.
				• 220 kV Bhiwani (PG) - Dadhibana (HVPNL) D/c line.	Apr'24	Issue related to ROW as intimated in 192nd OCC by HVPNL.
10	Jind 400/220kV S/s	Commissioned: 4 Approved:4 Total: 8	Utilized: 4 Unutilized: 0	• LILO of both circuits of 220 kV Jind HVPNL to PTPS D/C line at 400 kV substation PGCIL Khatkar (Jind) with 0.5 sq inch ACSR conductor	May'24	Tender is under process Updated in 205th OCC by HVPNL.
11	400/220kV Tughlakabad GIS	Commissioned: 6 Under Implementation: 4 Total: 10	Utilized: 6 Unutilized: 0 Under Implementation:4	• RK Puram – Tughlakabad (UG Cable) 220kV D/c line – March 2023.	Commissioned	Updated in 216th OCC by DTL
				• Masjid Mor – Tughlakabad 220kV D/c line.	Commissioned	Updated in 216th OCC by DTL
12	400/220kV Kala Amb GIS (TBCB)	Commissioned: 6 Total: 6	Utilized: 2 Unutilized: 2 Under Implementation:2	• HPPTCL has planned one no. of 220kV D/c line from Kala Amb 400/220kV S/s to 220/132kV Kala Amb S/s	Mar'24	Work completed and the line is ready for charging however connection agreement with CTU and PKATL is under process thereafter line shall be charged.Updated in 217th OCC by HPPTCL
				• HPPTCL has planned one no. of 220kV D/c line from Kala Amb 400/220kV S/s to 220/132kV Giri S/s	-	HPPTCL to update the status.
				• Network to be planned for 2 bays	-	HPPTCL to update the status.
13	400/220kV Kadarpur Sub-station	Commissioned: 8 Total: 8	Utilized: 0 Unutilized: 8	• LILO of both circuits of 220 KV Pali - Sector 56 D/C line at Kadarpur along with augmentation of existing conductor from 220 KV Sector-56 to LILO point with 0.4 sq inch AL-59 conductor.	Mar'24	Forest approval is pending for 220 KV Pali - Sector 56 D/C line. Updated in 215th OCC by HVPNL
				• LILO of both circuits of 220KV Sector 65 - Pali D/C line at Kadarpur along with augmentation of balance 0.4 sq. inch ACSR conductor of 220 kV Kadarpur - Sector 65 D/C line with 0.4sq inch AL-59 conductor	Mar'24	Updated in 205th OCC by HVPNL
14	400/220kV Sohna Road Sub-station	Commissioned: 8 Total: 8	Utilized: 4 Unutilized: 4	• LILO of both circuits of 220kV D/c Sohna-Rangla Rajpur at Roj Ka Meo line at 400kV Sohna Road	Dec'24	Updated in 216th OCC by HVPNL
				• LILO of both circuits of 220kV D/c Badshahpur-Sec77 line at 400kV Sohna Road	-	The matter is subjudice in Hon'ble Punjab & Haryana High court, Chandigarh Updated in 205th OCC by HVPNL. **Status:-** Earlier 02 nos 220 kV line bays were to be utilized for the 220 kV GIS S/Stn. Sec-77, Gurugram but due to denotification of land of the 220 kV GIS S/Stn. Sec-77 the said substation is now going to be dismantled and a new substation is proposed at Sec-75A, Gurugram. Now, these 02 no. 220 kV line bays may be utilized at 220 kV GIS S/Stn Sec-75A, Gurugram.
15	400/220kV Prithla Sub-station	Commissioned: 8 Aprroved: 2 Total: 10	Utilized: 4 Unutilized: 4 Under Implementation:2	• 220kV D/C line from Prithla to Harfali with LILO of one circuit at 220kV Meerpur Kurali	31.03.2024	Updated in 205th OCC by HVPNL
				• LILO of both ckt of 220kV D/c Ranga Rajpur – Palwal line	Commissioned	Commisioned date: 31.12.2021. Updated in 198th OCC by HVPNL
				• 220kV D/C for Sector78, Faridabad	31.03.2024	Issue related to ROW and Pending crossing approval from Northern Railways and DFCCIL. as intimated in 205th OCC by HVPNL.
				• Prithla - Sector 89 Faridabad 220kV D/c line	31.03.2024	Updated in 205th OCC by HVPNL

Sl. No.	Substation	Downstream network bays	Status of bays	Planned 220 kV system and Implementation status	Revised Target	Remarks
16	400/220kV Sonepat Sub-station	Commissioned: 6 Under Implementation:2 Total: 8	Utilized: 2 Unutilized: 4 Under Implementation:2	• LILO of both circuits of 220kV Samalkha - Mohana line at Sonepat	Mar'24	Updated in 216th OCC by HVPNL. **Status:** Work was held up due to ROW at T.L. No. 7,8,11,12 & 13 by the farmers of Jajji villagers during July'23 and now the matter has been resolve and work under progress from 01.08.2023. The erection work of T.no. 1 is pending due to non availability of shut down at 220KV Mohana-Smk line and 220KV Jajji-Mohana line. • PLCC protection coupler and Forest approval is also pending.
				• Sonepat - HSIISC Rai 220kV D/c line	Mar'24	Updated in 212th OCC by HVPNL. **Status:** Due to non-performance of work of 220KV GIS Rai S/Stn, the Contract has been terminated & blacklisted by O/o XEN/WB O/o CE/PD&C, HVPNL, Panchkula vide Ch-100/HDP-2418/REC-254/Xen(WB) Dated 24.02.2023. Now pending work will be caried out by HVPNL/ Departmentely. Now, the matter is under approval from competent authority of Nigam.,
				• Sonepat - Kharkhoda Pocket A 220kV D/c line	31.07.2024	Updated in 212th OCC by HVPNL. **Status:** Work order has been issued to M/s R.S Infra on dated 09.08.2023 by O/o CE/PD&C, Panchkula for construction of line. The Survey work has been completed.
17	400/220kV Neemrana Sub-station	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• LILO of Bhiwadi - Neemrana 220kV S/c line at Neemrana (PG)	-	Work is under progres. Stub Setting: 02/2017. Permission for forest, Highway & pipeline crossing is awaited from concerned department as updated in 215th OCC by RVPNL.
18	400/220kV Kotputli Sub-station	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• Kotputli - Pathreda 220kV D/c line	-	Date of bid opening has been extended up to 28.02.2024 as updated in 216th OCC by RVPNL.
19	400/220kV Jallandhar Sub-station	Commissioned: 10 Total: 10	Utilized: 8 Unutilized: 2	• Network to be planned for 2 bays	May'24	LILO of 220 kV BBMB Jalandhar - Butari line at 400 kV PGCIL Jalandhar being planned. Work expected to be completed by May 2024. Updated in 198th OCC by PSTCL.
20	400/220kV Roorkee Sub-station	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• Roorkee (PG)-Pirankaliyar 220kV D/c line	Commissioned	Roorkee (PG)-Pirankaliyar 220kV D/c line commissioned in 2020 as intimated by PTCUL in 197th OCC
21	400/220kV Lucknow Sub-station	Commissioned: 8 Total: 8	Utilized: 4 Unutilized: 4	• Network to be planned for 2 bays	Commissioned	• Lucknow -Kanduni, 220 kV D/C line work energized on 05.10.2023. Updated in 212th OCC by UPPTCL. • No planning for 2 no. of bays upated by UPPTCL in 196th OCC. The same has been communicated to Powergrid.
22	400/220kV Gorakhpur Sub-station	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• Network to be planned for 2 bays	Commissioned	• Gorakhpur(PG)- Maharajganj, 220 kV D/C line energized on 27.09.2023 updated by UPPTCL in 212th OCC

Sl. No.	Substation	Downstream network bays	Status of bays	Planned 220 kV system and Implementation status	Revised Target	Remarks
23	400/220kV Fatehpur Sub-station	Commissioned: 8 Under Implementation:2 Total: 10	Utilized: 6 Unutilized: 2 Under Implementation:2	• Network to be planned for 2 bays	-	• UPPTCL intimated that 02 no. of bays under finalization stage. In 201st OCC, UPPTCL intimated that it is finalized that Khaga s/s will be connected (tentative time 1.5 years). • No planning for 2 no. of bays updated by UPPTCL in 196th OCC. The same has been communicated to Powergrid.
24	400/220kV Abdullapur Sub-station	Commissioned: 10 Under Implementation:2 Total: 12	Utilized: 10 Unutilized: 0 Under Implementation:2	• Abdullapur – Rajokheri 220kV D/c line	Mar'24	SCDA System & PLCC work pending at 220 KV S/stn. Rajokheri Updated in 215th OCC by HVPNL
25	400/220kV Pachkula Sub-station	Commissioned: 8 Under tender:2 Total: 10 Out of these 10 nos. 220kV Line Bays, 2 bays would be used by the lines being constructed by POWERGRID (Chandigarh-2) and balance 8 nos. bays would be used by HVPNL	Utilized: 2 Unutilized: 4 Under Implementation:2	• Panchkula – Pinjore 220kV D/c line	Mar'24	Updated in 217th OCC by HVPNL
				• Panchkula – Sector-32 220kV D/c line	Mar'24	Updated in 217th OCC by HVPNL
				• Panchkula – Raiwali 220kV D/c line	Commissioned	Updated in 194th OCC by HVPNL
				• Panchkula – Sadhaura 220kV D/c line: Sep'23	Jul'24	Updated in 205th OCC by HVPNL
26	400/220kV Amritsar S/s	Commissioned:7 Approved in 50th NRPC- 1 no. Total: 8	Utilized: 6 Under Implementation:2	• Amritsar – Patti 220kV S/c line	Mar'24	Work is completed, agreement is expected to be signed by March 2024. Updated in 216th OCC by PSTCL.
				• Amritsar – Rashiana 220kV S/c line (2 bays shall be required for above lines. However, 1 unutilized bay shall be used for Patti and requirement of one additional bay approved for Rashiana by NRPC)	Mar'24	Work is completed, agreement is expected to be signed by March 2024. Updated in 216th OCC by PSTCL.
27	400/220kV Bagpat S/s	Commissioned: 8 Total: 8	Utilized:6 Unutilized: 2	• Bagpat - Modipuram 220kV D/c line	Commissioned	Updated in 201st OCC by UPPTCL
28	400/220kV Bahardurgarh S/s	Commissioned: 4 Approved: 4 Total: 8	Utilized:2 Unutilized: 2	• LILO of 220 kV Nunamajra-Daultabad S/c line at 400 kV Bahadurgarh PGCIL	Mar'25	Updated in 205th OCC by HVPNL. **Status:** Under Tendering process
				• Bahadurgarh - METL 220kV D/c line (Deposit work of M/s METL)	Mar'25	Updated in 216th OCC by HVPNL. **Status:** Tendering under progress.
				• Bahadurgarh - Kharkhoda Pocket B 220kV D/c line	Jul'24	Updated in 212th OCC by HVPNL. **Status:** Work order has been issued to M/s R.S Infra on dated 09.08.2023 by O/o CE/PD&C, Panchkula for construction of line. The Survey work has been completed.
29	400/220kV Jaipur (South) S/s	Commissioned: 4 Total: 4	Utilized:2 Unutilized: 2	• LILO of 220 kV S/C Dausa – Sawai Madhopur line at 400 kV GSS Jaipur South (PG)	06.10.2025	Work order has been issued on 06.10.2023, work under progress as updated by RVPNL in 215th OCC
30	400/220kV Sohawal S/s	Commissioned: 8 Total: 8	Utilized: 8	• Sohawal - Barabanki 220kV D/c line	Commissioned	Energization date: 14.04.2018 updated by UPPTCL in 196th OCC
				• Sohawal - New Tanda 220kV D/c line	Commissioned	Energization date: 28.05.2019 updated by UPPTCL in 196th OCC
				• Network to be planned for 2 bays	Commissioned	• Sohawal - Gonda 220kV S/c line (Energization date: 27.04.2020) updated by UPPTCL in 196th OCC • Sohawal - Bahraich 220kV S/c line (Energization date: 15.02.2021) updated by UPPTCL in 196th OCC

Sl. No.	Substation	Downstream network bays	Status of bays	Planned 220 kV system and Implementation status	Revised Target	Remarks
31	400/220kV, Kankroli	Commissioned: 6 Total: 6	Utilized: 4 Unutilized: 2	• 220 kV D/C Kankroli(PG) - Nathdwara line	Mar'24	Price bid opened on 29.01.2024 as updated bu RVPN in 216th OCC.
32	400/220kV, Manesar	Commissioned: 8 Total: 8	Utilized: 4 Unutilized: 4	• Network to be planned for 2 bays	-	Status:- 2nos bays are being utilised for 220 kV D/C Panchgaon (PGCIL)-Panchgaon Ckt-I & 220 kV D/C Panchagon (PGCIL)-Panchgaon Ckt-II, charged on dated 05.09.2022 & 20.10.2022 respectively. The 2nos bays may be utilised by HVPNL in future.
33	400/220kV, Saharanpur	Commissioned: 6 Under Implementation:2 Total: 8	Utilized: 6 Unutilized: 0 Under Implementation:2	• Network to be planned for 2 bays	Commissioned	Saharanpur(PG)-Devband D/c line (Energization date: 20.04.2023) updated by UPPTCL in 207th OCC
34	400/220kV, Wagoora	Commissioned: 10 Total: 10	Utilized: 6 Unutilized: 4	• Network to be planned for 4 bays	-	PDD, J&K to update the status.
35	400/220kV, Ludhiana	Commissioned: 9 Total: 9	Utilized: 8 Unutilized: 1	• Network to be planned for 1 bay	Mar'24	Direct circuit from 220 kV Lalton Kalan to Dhandari Kalan to be diverted to 400 kV PGCIL Ludhiana. Work completed , final agrrement is expected to be signed by Mar'24. Updated in 216th OCC by PSTCL.
36	400/220kV, Chamba (Chamera Pool)	Commissioned: 3 Under tender:1 Total: 4	Utilized:3 Unutilized: 0 Under tender:1	• Stringing of 2nd ckt of Chamera Pool – Karian 220kV D/c line	Commissioned	Stringing of 2nd Circuit of Chamera Pool-Karian Tansmission line has been completed & terminal bay at 400/220 kV chamera pooling substation (PGCIL) is commissioned on 20.01.2024. Updated in 217th OCC by HPPTCL.
37	400/220kV, Mainpuri	Commissioned: 6 Under Implementation:2 Total: 8	Utilized: 6 Unutilized: 0 Under Implementation:2	• Network to be planned for 2 bays	-	• 02 no. of bays under finalization stage updated by UPPTCL in 196th OCC. Mainpuri S/s planned. Land is not finalized, therefore timeline not available as intimated by UPPTCL in 201st OCC.
38	400/220kV, Patiala	Commissioned: 8 Total: 8	Utilized: 6 Unutilized: 2	• Network to be planned for 2 bays	May'24	2 Nos. bays for 400 kV PGCIL Patiala - 220 kV Bhadson (D/C) line being planned. Work expected to be completed by May 2024. Updated in 198th OCC by PSTCL.

FGD Status

Updated status of FGD related data submission

NTPC (27.02.2023)	
	MEJA Stage-I
	RIHAND STPS
	SINGRAULI STPS
	TANDA Stage-I
	TANDA Stage-II
	UNCHAHAR TPS
UPRVUNL (18.07.2023)	
	ANPARA TPS
	HARDUAGANJ TPS
	OBRA TPS
	PARICHHA TPS

PSPCL (18.07.2023)	
	GGSSTP, Ropar
	GH TPS (LEH.MOH.)
RRVUNL (09.07.2023)	
	CHHABRA SCPP
	CHHABRA TPP
	KALISINDH TPS
	KOTA TPS
	SURATGARH SCTPS
	SURATGARH TPS

Updated status of FGD related data submission

Lalitpur Power Gen. Co. Ltd. (17.10.2022)	
	Lalitpur TPS
Lanco Anpara Power Ltd. (18.06.2022)	
	ANPARA-C TPS

HGPCL (14.09.2022)	
	PANIPAT TPS
	RAJIV GANDHI TPS
	YAMUNA NAGAR TPS

Adani Power Ltd. (18.02.2022)	
	KAWAI TPS

Rosa Power Supply Company (18.06.2022)	
	Rosa TPP Phase-I
Prayagraj Power Generation Company Ltd. (17.10.2022)	
	Prayagraj TPP
APCPL (25.02.2022)	
	INDIRA GANDHI STPP

Pending submissions

GVK Power Ltd.
GOINDWAL SAHIB

NTPC
DADRI (NCTPP)
Talwandi Sabo Power Ltd.
TALWANDI SABO TPP
L&T Power Development Ltd.
Nabha TPP (Rajpura TPP)

Target Dates for FGD Commissioning (Utility-wise)

Adani Power Ltd.	KAWAI TPS U#1 (Target: 31-12-2024), KAWAI TPS U#2 (Target: 31-12-2024)
APCPL	INDIRA GANDHI STPP U#1 (Target: 31-01-2022), INDIRA GANDHI STPP U#2 (Target: 30-09-2023), INDIRA GANDHI STPP U#3 (Target: 30-06-2023)
GVK Power Ltd.	GOINDWAL SAHIB U#1 (Target: 30-04-2020), GOINDWAL SAHIB U#2 (Target: 29-02-2020)
HGPCL	PANIPAT TPS U#6 (Target: 31-12-2022), PANIPAT TPS U#7 (Target: 31-12-2022), PANIPAT TPS U#8 (Target: 31-12-2022), RAJIV GANDHI TPS U#1 (Target: 31-12-2024), RAJIV GANDHI TPS U#2 (Target: 31-12-2024), YAMUNA NAGAR TPS U#1 (Target: 31-12-2024), YAMUNA NAGAR TPS U#2 (Target: 31-12-2024)

NTPC	DADRI (NCTPP) U#1 (Target: 31-12-2020), DADRI (NCTPP) U#2 (Target: 31-10-2020), DADRI (NCTPP) U#3 (Target: 31-08-2020), DADRI (NCTPP) U#4 (Target: 30-06-2020), DADRI (NCTPP) U#5 (Target: 30-06-2022), DADRI (NCTPP) U#6 (Target: 31-03-2023), RIHAND STPS U#1 (Target: 31-10-2025), RIHAND STPS U#2 (Target: 30-06-2026), RIHAND STPS U#3 (Target: 31-12-2024), RIHAND STPS U#4 (Target: 31-03-2025), RIHAND STPS U#5 (Target: 30-06-2025), RIHAND STPS U#6 (Target: 31-10-2025), SINGRAULI STPS U#1 (Target: 31-12-2024), SINGRAULI STPS U#2 (Target: 31-12-2024), SINGRAULI STPS U#3 (Target: 31-12-2024), SINGRAULI STPS U#4 (Target: 31-12-2024), SINGRAULI STPS U#5 (Target: 31-03-2025), SINGRAULI STPS U#6 (Target: 31-06-2024), SINGRAULI STPS U#7 (Target: 31-03-2024), UNCHAHAR TPS U#1 (Target: 31-12-2023), UNCHAHAR TPS U#2 (Target: 31-12-2023), UNCHAHAR TPS U#3 (Target: 30-09-2023), UNCHAHAR TPS U#4 (Target: 30-09-2023), UNCHAHAR TPS U#5 (Target: 30-09-2023), UNCHAHAR TPS U#6 (Target: 31-08-2022), MEJA Stage-I U#1 (Target: 31-10-2023), MEJA Stage-I U#2 (Target: 30-06-2023), TANDA Stage-I U#3 (Target:), TANDA Stage-I U#4 (Target:), TANDA Stage-II U#3 (Target: 31-03-2023), TANDA Stage-II U#4 (Target: 30-09-2023)

L&T Power Development Ltd (Nabha)	Nabha TPP (Rajpura TPP) U#1 (Target: 30-04-2021), Nabha TPP (Rajpura TPP) U#2 (Target: 28-02-2021)
Lalitpur Power Gen. Company Ltd.	LALITPUR TPS U#1 (Target: 31-12-2026), LALITPUR TPS U#2 (Target: 30-09-2026), LALITPUR TPS U#3 (Target: 30-06-2026)
Lanco Anpara Power Ltd.	ANPARA C TPS U#1 (Target: 31-12-2023), ANPARA C TPS U#2 (Target: 31-12-2023)
Prayagraj Power Generation Company Ltd.	PRAYAGRAJ TPP U#1 (Target: 31-12-2024), PRAYAGRAJ TPP U#2 (Target: 31-12-2024), PRAYAGRAJ TPP U#3 (Target: 31-12-2024)
PSPCL	GH TPS (LEH.MOH.) U#1 (Target: 31-12-2026), GH TPS (LEH.MOH.) U#2 (Target: 31-12-2026), GH TPS (LEH.MOH.) U#3 (Target: 31-12-2026), GH TPS (LEH.MOH.) U#4 (Target: 31-12-2026), GGSSTP, Ropar U#3 (Target: 31-12-2026), GGSSTP, Ropar U#4 (Target: 31-12-2026), GGSSTP, Ropar U#5 (Target: 31-12-2026), GGSSTP, Ropar U#6 (Target: 30-12-2026)

Rosa Power Supply Company	ROSA TPP Ph-I U#1 (Target: 31-12-2026), ROSA TPP Ph-I U#2 (Target: 31-12-2026), ROSA TPP Ph-I U#3 (Target: 31-12-2026), ROSA TPP Ph-I U#4 (Target: 31-12-2026)
RRVUNL	KOTA TPS U#5 (Target: 31-08-2024), KOTA TPS U#6 (Target: 31-08-2024), KOTA TPS U#7 (Target: 31-08-2024), SURATGARH TPS U#1 (Target: 31-12-2026), SURATGARH TPS U#2 (Target: 31-12-2026), SURATGARH TPS U#3 (Target: 31-12-2026), SURATGARH TPS U#4 (Target: 31-12-2026), SURATGARH TPS U#5 (Target: 31-12-2026), SURATGARH TPS U#6 (Target: 31-12-2026), SURATGARH SCTPS U#7 (Target: 28-02-2025), SURATGARH SCTPS U#8 (Target: 28-02-2025), CHHABRA TPP U#1 (Target: 31-12-2026), CHHABRA TPP U#2 (Target: 31-12-2026), CHHABRA TPP U#3 (Target: 31-12-2026), CHHABRA TPP U#4 (Target: 31-12-2026), CHHABRA SCPP U#5 (Target: 28-02-2025), CHHABRA SCPP U#6 (Target: 28-02-2025), KALISINDH TPS U#1 (Target: 28-02-2025), KALISINDH TPS U#2 (Target: 28-02-2025)
Talwandi Sabo Power Ltd.	TALWANDI SABO TPP U#1 (Target: 28-02-2021), TALWANDI SABO TPP U#2 (Target: 31-12-2020), TALWANDI SABO TPP U#3 (Target: 31-10-2020)
UPRVUNL	ANPARA TPS U#1 (Target: 31-12-2023), ANPARA TPS U#2 (Target: 31-12-2023), ANPARA TPS U#3 (Target: 31-12-2023), ANPARA TPS U#4 (Target: 31-12-2023), ANPARA TPS U#5 (Target: 31-12-2023), ANPARA TPS U#6 (Target: 31-12-2023), ANPARA TPS U#7 (Target: 31-12-2023), HARDUAGANJ TPS U#8 (Target: 31-12-2024), HARDUAGANJ TPS U#9 (Target: 31-12-2024), OBRA TPS U#9 (Target: 31-12-2024), OBRA TPS U#10 (Target: 31-12-2024), OBRA TPS U#11 (Target: 31-12-2024), OBRA TPS U#12 (Target: 31-12-2024), OBRA TPS U#13 (Target: 31-12-2024), PARICHHA TPS U#3 (Target: 30-04-2022), PARICHHA TPS U#4 (Target: 31-12-2024), PARICHHA TPS U#5 (Target: 31-12-2024), PARICHHA TPS U#6 (Target: 31-12-2024)

MIS Report for Status of Islanding Schemes

Implemented Schemes

Sl. No.	Islanding Scheme	SLDC	Status	Submission of Self Certification of Healitheness	SOP	SCADA Display Page	Remarks
1	NAPS IS	UP	Implemented	Yes (08-10-2021)	Yes	Yes	-
2	RAPS IS	Rajasthan	Implemented	16-Aug-21	Yes	Yes	List of officials in-charge, format for generation, islanding scheme sld and relays in RAPP IS submitted by RVPN on 04.12.2021.
3	Delhi IS	Delhi	Implemented				
4	Pathankot-RSD IS	Punjab	Implemented				

Under Implementation/ Newly Proposed/Under Discussion

Sl. No.	Islanding Scheme	SLDC	Status	Details of progress	DPR for PSDF funding (Required / Not Required)	Timelines Status - Proposed/Actual									
						Study		Design		Approval		Procurement		Commissioning	
						Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual	Proposed	Actual
1	Lucknow-Unchahar IS	UP	Under Implementation	Scheme has been approved in 59th NRPC meeting held on 31.10.2022. Installation of Ufrs is completed as informed by NTPC.		-		-	-	-	-	-	-	-	-
2	Agra IS	UP	Under Implementation	Scheme has been approved in 71th NRPC meeting held on 29.01.2024. UPSLDC is in discussion with STU regarding list of locations where UFRs are to be installed.		-		-	-	-	-	-	-	-	-
3	Jodhpur-Barmer-Rajwest IS	Rajasthan	Under Implementation	Scheme has been approved in 60th NRPC meeting held on 30.11.2022. DPR for Jodhpur-Barmer-Rajwest IS is still awaited.	-	-		-	-	-	-	-	-	-	-
4	Suratgarh IS	Rajasthan	Under Implementation	Scheme has been approved in 60th NRPC meeting held on 30.11.2022. DPR for Suratgarh IS is still awaited.	-	-		-	-	-	-	-	-	-	-
5	Patiala-Nabha Power Rajpura IS	Punjab	Under Implementation	Scheme has been approved in 60th NRPC meeting held on 30.11.2022. Punjab SLDC informed that DPR for PSDF funding has been approved from their management and it will be submitted within one week. Implementation timeline: March,2025		-		-	-	-	-	-	-	-	-
6	Kullu-Manali-Mandi IS	HP	Under Implementation	Scheme has been approved in 60th NRPC meeting held on 30.11.2022. HPSEB representative informed that the proposal for procurement of UFR is submitted to Chief Engineer (System Planning) for approval on 29th December 2023.Purchasing and installation of UFRs is pending. Approval in this regard is still awaited from higher management of HPSEB. Timeline to be intimated by HPSLDC		-		-	-	-	-	-	-	-	-
7	Shimla-Solan IS	HP	Under Implementation	Scheme has been approved in 60th NRPC meeting held on 30.11.2022. GE Officials to visit Bhabha HEP by 20th March 2024 to inspect the changes if required in the Contro System. Timeline to be intimated by HPSLDC.											

Status of availability of ERS towers in NR

Sl. No.	Transmission Utility	Voltage Level (220kV/400kV/765kV/ 500 kV HVDC etc.)	Length of the transmission lines owned by the Utility (Ckt. Kms.)	Number of ERS Sets (towers) available (Nos.)	ERS Set (towers) required as per the Govt. norms.	Location	Remarks
1	PTCUL	400kV	418.394	NIL	1		DPR Under preparation.
		220kV	1045.135	NIL	1		DPR Under preparation.
2	Powergrid NR-1	220 KV	1842.88	NIL	1		
		400 KV	11074.26	12 Towers	3	All 400kV ERS at Ballabhgarh	make-Lindsey
		765 KV	4721.85	15 Towers	1	All 765kV ERS at Meerut	Make-SBB
		500 KV HVDC	653.88	NIL	1		
		800 KV HVDC	416.58	NIL	1		
3	Powergrid NR-2	66 KV	37.56	Nil	1		ERS tower available for 400KV rating can be used in place of lower as well as higher voltage Towers. In case used for 765KV Line, No of towers can be erected will reduce due to increase in Tower Hight.
		132 KV	262.7	Nil	1		
		220 KV	2152	Nil	1		
		400 KV	8097.3	02 Set (32 Towers)	2	Kishenpur & Jalandhar	
		765 KV	337.5	Nil	1		
4	Powergrid NR-3	800KV HVDC	2205	NIL	1		400KV ERS will be also be used in other voltage level lines
		500KV HVDC	2566	NIL	1		
		765KV	4396	NIL	1		
		400KV	12254	26 Towers	3	Kanpur	
		220KV	1541	NIL	1		
		132KV	207	NIL	1		
5	PARBATI KOLDAM TRANSMISSION COMPANY LIMITED	400kV	457	NIL	1		Procurement under process.
6	PATRAN TRANSMISSION COMPANY LTD	400kV	0.4	NIL	1	It is kept in Bhopal and on need basis is moved across region	Not available, will tie up based on the requirements in future. However the parent company IndiGrid owns one set of ERS for all five regions.
7	NRSS-XXIX TRANSMISSION LTD	400kV	853	NIL	1		
8	GURGAON PALWAL TRANSMISSION LTD	400kV	272	NIL	1		
9	RAPP Transmission Company Limited.	400kV	402	NIL	1		
10	NRSS XXXVI Transmission Limited	400kV	301.924	NIL	1		Element I - Operational comprising of 3 kms. Element II - Work Under Progress comprising of 221.924 kms. Element II - Work Under Progress comprising of 77 kms.
11	HPPTCL	220 kV	659	NIL	1		
		400 kV	75.7	NIL	1		
12	RVPN	132 kV	18969.958	1	4	01 No. ERS available at 220 kV GSS Heerapura, Jaipur	ERS proposed : 01 Set at 400 kV GSS, Jodhpur. 01 set at 400 kV GSS Bikaner
		220 kV	16227.979		3		
		400 kV	6899.386		2		
		765 kV	425.498		1		
13	DTL	220kV	915.498	NIL	1	400kV Bamnauli Sub station	ERS tower available for 400KV rating can also be used for lower voltage lines as well
		400kV	249.19	02 Sets (32 towers)	1		

Sl. No.	Transmission Utility	Voltage Level (220kV/400kV/765kV/ 500 kV HVDC etc.)	Length of the transmission lines owned by the Utility (Ckt. Kms.)	Number of ERS Sets (towers) available (Nos.)	ERS Set (towers) required as per the Govt. norms.	Location	Remarks
14	JKPTCL			10			JKPTCL, Kashmir:10 procured (out of which 3 on loan to JKPTCL, Jammu)
15	HVPN						HVPN does not have ERS Set. Technical Specifications have been finalized
16	PSTCL	400 kV	1666.43	2	2		
		220 kV	7921.991				
17	UPPTCL 1- Meerut	132KV	27508.321	24 Nos(15 Running+9 Angle)		400 kV S/s Gr. Noida	ERS will be also be used in other voltage level lines.
		220KV	14973.453				
		400KV	6922.828				
	UPPTCL 2-Prayagraj	765KV	839.37	24 Towers		220 kv S/s phulpur	ERS will also be used in other voltage lines.
		400KV	1804.257				
		220KV	2578.932				
		132KV	4714.768				
18	POWERLINK						
19	POWERGRID HIMACHAL TRANSMISSION LTD						
20	Powergrid Ajmer Phagi Transmission Limited						
21	Powergrid Fatehgarh Transmission Limited						
22	POWERGRID KALA AMB TRANSMISSION LTD						
23	Powergrid Unchahar Transmission Ltd						
24	Powergrid Khetri Transmission Limited						
25	POWERGRID VARANASI TRANSMISSION SYSTEM LTD						
26	ADANI TRANSMISSION INDIA LIMITED		2090	1 Set (12 towers)	1 set (12 towers)	Sami (Gujarat)	Make-Lindsey ERS set available for 400KV & 500KV rating can be used for lower as well as higher voltage Towers. In case used for 765KV Line, No of towers can reduce due to increase in Tower Height & nos of conductors.
27	BIKANER KHETRI TRANSMISSION LIMITED		482				
28	FATEHGARH BHADLA TRANSMISSION LIMITED	500 kV HVDC 400 kV HVAC	291				
29	NRSS-XXXI(B) TRANSMISSION LTD	400 kV	577.74	Not Available	Not Available		In the advance stage of process of finalising arrangement for providing ERS on need basis with other transmission utility (M/s INDIGRID).
30	ARAVALI POWER COMPANY PVT LTD	765 kv HVAC					

*The transmission Utility with line length less than 500 ckt kms (of 400 KV lines) may be given option either to procure ERS or have agreement with other transmission utilities for providing ERS on mutually agreed terms, when need arises. (As per MoP directions)

Government of India
Ministry of Power
Central Electricity Authority

Operating Procedure and Training Curriculum at 55% Minimum Technical Load of Thermal Generating Units

March 2023

Sewa Bhawan , Sector 1 , R K Puram , New Delhi -110066

Central Electricity Authority

Thermal Project Renovation and Modernization Division

घनश्याम प्रसाद
अध्यक्ष तथा पदेन सचिव भारत सरकार
GHANSHYAM PRASAD
Chairperson & Ex-officio Secretary
To the Government Of India

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

केन्द्रीय विद्युत प्राधिकरण
भारत सरकार
विद्युत मंत्रालय
सेवा भवन, आर.के. पुरम
नई दिल्ली–110066
Central Electricity Authority
Ministry of Power
Sewa Bhawan, R. K. Puram
New Delhi-110066

FOREWORD

Availability of flexible power is essential for integration of increasingly renewables into the grid to achieve the goal of energy transition. Flexible operation of coal fired units are one of the cheapest source of flexible power presently in the country. Hence, it will be crucial to operate the existing thermal units in the new operating regime for integrating the renewables in the grid.

TPRM Division, CEA has brought out a comprehensive report on Standard Operating Procedure at 55% Technical Minimum Load of Thermal Generating Units. The report has highlighted prerequisites for reducing minimum stable load, operational issues of Ball and Tube mill based units and Long Term Concerns/Measures of low (55%) load operation. This document has listed in details the various standard operating procedure for the operation of coal fired power plants at 55% load. Training of Operators is another important aspects of low load operation which has also been discussed in the report. The committee with members from various organizations have put in their valuable efforts and time to bring out a comprehensive document covering important topics.

I would like to express my sincere appreciation to the chairman of the committee, Sh. B.C.Mallick, Chief Engineer and all committee members for bringing out the report which shall be useful in achieving country wide operation of thermal units at 55% minimum load.

(Ghanshyam Prasad)

दूरभाष / Telephone : 011-26732201, 26732222, ईमेल / Email : chair@nic.in, वेबसाईट / Website : www.cea.nic.in

सत्यमेव जयते

PRAVEEN GUPTA

दूरभाष (का०)
TELEPHONE (O)
TELEFAX (O)
011-26732901

सदस्य
तथा पदेन अपर सचिव भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सेवा भवन, रामाकृष्णा पुरम्
MEMBER (THERMAL)
& EX-OFFICIO ADDL. SECRETARY TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R.K. PURAM

नई दिल्ली - 110066
NEW DELHI-110066

PREFACE

Presently more than 70% of energy demand is being met from thermal generation. Flexible operation of coal-fired power plants is required to maximize absorption of generation from renewable energy sources into the grid. In this regard, CEA has recently notified a regulation on "Flexible Operation of Coal based Thermal Power Generating Units".

To facilitate power generating utilities, Central Electricity Authority has prepared Standard Operating Procedure/ manual for attaining / operating coal-based power plants at 55% technical minimum load including a training curriculum for technical personnel. A committee under chairmanship of Chief Engineer, TPRM Division, was constituted under the aegis of CEA with members from NTPC, DVC, BHEL, SEIMENS, L&T, STEAG, TATA Power, NPTI and CPRI for preparation of the Standard operating procedure (SOP) and training curriculum for power plants operators. The report also discusses the prerequisites for reducing minimum operating stable load and also suggested close monitoring of unit operational parameters like combustion, flame stability, turbine casing top bottom differential temperature etc.

I would like to appreciate the efforts of team of officers under able guidance of Shri B.C. Mallick for timely preparing the SOPs and training curriculum. I am confident that the document shall help the utilities to prepare themselves for 55% load operation and impart required training to the operating personnel for safe 55% load operation.

Gupta

(Praveen Gupta)

फैक्स/Fax : 011-26197267

Bikash Chandra Mallick
Chief Engineer

भारत सरकार
GOVERNMENT OF INDIA
केन्द्रीय विद्युत प्राधिकरण
CENTRAL ELECTRICITY AUTHORITY
विद्युत मंत्रालय
MINISTRY OF POWER
सेवा भवन, रामकृष्ण पुरम्
SEWA BHAWAN, RAMAKRISHNA PURAM

नई दिल्ली-110066, दिनांक :
NEW DELHI-110066, Dated :

ACKNOWLEDGEMENT

The flexible power can be made available from various resources like Hydro Power Plants, Pump Storage System, Gas Power Plants, Coal based Power Plant and Battery Storage System. Our first preference should be to utilize cheapest flexible power available in the system like Hydro Power Plants and Pump Storage System. Coal based plants have the capability to operate at lower loads, provide more than one percent ramp rate and it has also been found to be cheaper flexible resource.

Many coal fired generating units have been operating at 55% load as and when need arises in the grid. However, many other units are yet to achieve this operating milestone to support the grid. Reasons cited are the concerns regarding safety, security, availability and lack of support from original equipment suppliers. To tackle the issue, a committee was constituted by CEA to prepare a **Standard Operating Procedures (SOPs)** for operating coal fired generating unit at 55% load. A comprehensive SOP has been prepared which includes prerequisites of Boilers and Turbine parameters. Also discussed various issues which may be faced by generating utilities in long term. A training curriculum for developing trained power plant personnel is also included in the report for safe and efficient plant operation at 55% load. The SOPs prepared shall help coal based generating utilities in understanding the issues/ the up gradations required in the plants, if any and in the skills of the operators.

I express my sincere thanks to all the committee members from NTPC, DVC, MAHAGENCO, TANGEDCO, BHEL, Tata Power, L&T, Siemens, STEAG, NPTI, CPRI for their active participation during deliberations and providing valuable inputs. I am thankful to Chairperson, CEA and Member (Thermal), CEA for valuable guidance. Finally, I appreciate the efforts of TPRM Division and their support in bringing out the SOP.

(B.C.Mallick)
Chief Engineer and
Chairman of the Committee

CONTENTS

ABBREVIATIONS

MOP	Ministry of Power
CEA	Central Electricity Authority
NTPC	National Thermal Power Corporation
DVC	Damodar Valley Corporation
BHEL	Bharat Heavy Electricals Limited
L&T	Larson & Toubro
CPRI	Central Power Research Institute
NPTI	National Power Training Institute
NDC	Nationally determined contribution
RES	Renewable Energy Sources
NRE	New & Renewable Energy
MTL	Minimum Technical Load
SOP	Standard Operating Procedures
TML	Technical Minimum Load
TPP	Thermal Power Plant
MS	Main Steam
HRH	Hot Reheat Line
TG	Turbine Governor
SH	Superheat
RH	Reheat
VM	Volatile Matter
PA	Primary Air
TDBFP	Turbine Driven Boiler Feed Pump
MDBFP	Motor Driven Boiler Feed Pump
CRH	Cold Reheat
SCAPH	Steam Coil Air Preheater
TMCR	Turbine Maximum Continuous Rating
DP	Differential Pressure
BFP	Boiler Feed Pump

ID	Induced Draught
FD	Forced Draught
SWAS	Steam & water Analysis
mmWCL	Millimetres per Water Column Length
SADC	Secondary Air Damper Control
HP	High Pressure
HPT	High Pressure Turbine
IPT	Intermediate Pressure Turbine
LPT	Low Pressure Turbine
MW	Megawatts
OEM	Original Equipment Manufacturer
O&M	Operation and Maintenance
PM	Preventive Maintenance
APC	Auxiliary Power Consumption
FG	Flue Gas
AVT	All volatile treatment
PF	Pulverised Flow
SPM	Suspended Particulate Matter
APH	Air Preheater
FEGT	Furnace Exit Gas Temperature
DCS	Distributed Control Systems
FDS	Functional Design Specification
P&ID	Piping and instrumentation Diagram
ESV	Emergency Shutdown Valve
IVSV	Idle Vacuuming Switching Valve
HHV	Higher Heating Value
EHTC	Electro Hydraulic Turbine Control
CMC	Coordinated Master Control
HFO	Heavy fuel Oil
LFO	Light Fuel Oil
EBD	Emergency Blow Down

FRS	Feed Regulating Station
WW	Water Wall
DMCW	De Mineralized Cooling Water
GSC	Gland Steam Condenser
HPCV	High Pressure Check Valve
ECO	Economiser
RGMO	Restrictive Governor mode operation

1. BACKGROUND

1.1 Flexibilisation of Thermal Power Plant

India is moving ahead to achieve nationally determined contribution (NDC) of 40% of installed renewable capacity by 2030. The introduction of large scale renewable generation in the grid is bringing a new set of challenges in the power sector.
The inconsistency and intermittency of solar & wind power has to be managed by other sources of generation in order to ensure the grid stability. Flexible operation of existing coal-fired power plants is very much required to ensure security, reliability of power supply and stability of electricity grids while maximizing generation from renewable energy sources (RES) & integration of the same into grid, because thermal generation capacity of 209 GW constituting 54% of total installed capacity is the dominant part of power generation in the country and more than 70% of country's energy demand is being met from thermal generation. Thus, Flexible operation of thermal power plant is essential for handling the instability & intermittency of renewable generation.

1.2 Committee Formation

A meeting was held under the chairmanship of Hon'ble Minister of Power and NRE on 06.05.2022 to discuss the technical issues related to flexible operation/Technical Minimum of Thermal Power Plant for smooth integration of renewable generation. In the meeting it was decided that a operating manual for attaining/operating at 55% technical minimum load (TML) of thermal power plant and a training curriculum for technical personnel for the same was to be prepared by CEA.

In this regard a committee was constituted under the aegis of CEA with member from NTPC , DVC , BHEL , SEIMENS , L&T , STEAG , TATA Power for preparation of the operating manual and training curriculum .The composition of committee is as under :-

1. Sh. B.C. Mallick , Chief Engineer	CEA	Chairman of committee
2. Sh. Pravir Kumar , Director	CEA	Convener
3. Sh. Om Kant Shukla, Director	CEA	Member
4. Sh. Rohit Yadav, Deputy Director	CEA	Member
5. Sh, Vikalp Saini, Assistant Director	CEA	Member
6. Sh. Srinivasa Rao Gaddamanugu, GM	NTPC	Member
7. Sh. Dipankar Biswas, GM	NTPC	Member
8. Sh. Vijaya Nand Sharma, DCE	DVC	Member
9. Sh. Vijay V Namjoshi, Chief (Generation)	Tata Power	Member
10. Sh. P S Kumar, CEO	Steag	Member
11. Sh. Ian Rebello	Siemens	Member

12. Sh. Dhiman Chattopadhyay, GM	BHEL	Member
13. Sh. Akram Ansari, Sr. Manager	BHEL	Member
14. Sh. Rajneesh Kumar, Head	L&T	Member
15. Sh. Durgasankar Sahu	NPTI	Member
16. Sh. N. Rajkumar, Joint Director	CPRI	Member

Following officers were also invited as Special Invitees in the subsequent meetings of the committee:

1. Sh. Eknath Moze , CE	Mahagenco	Member
2. Sh. S. Parmeswaran , SE	Tangedco	Member

The main objective of this committee are as under:

i. To prepare the Standard Operating Procedures (SOPs) to address the challenges of Flexibilisation and achieve the target of TML (Technical Minimum Load).

ii. To prepare a training curriculum for technical personnel of TPPs(Thermal Power Plants) for the above purpose.

2. STANDARD OPERATING PROCEDURE FOR 55% MINIMUM TECHNICAL LOAD OPERATION

2.1. Objective

To enable coal based thermal Generating Units to run at a Technical Minimum Load of 55% of Rated capacity.

2.2. Scope

This document covers the operating procedure for reducing Unit load from peak load to the current Technical Minimum Load i.e. 55% of Unit rating and for sustaining at 55% Load for coal based Thermal Power Plants.

2.3. Introduction

With rapid rise in renewable energy addition, operation regime of coal-based power plants in India, which is primarily designed as base load power plants has changed over the past few years. This has warranted higher load ramp rates, lower minimum loads, and frequent unit start-ups. Minimum load operation is crucial for coal-based plants during the periods of low demand and high renewable energy injection into the grid, as they are expected to operate in follow up mode.

As coal-based power plants were not designed for prolonged operation at minimum load, reducing to minimum sustainable load imposes many challenges with respect to reliability, efficiency, and equipment health.

Currently Indian coal based thermal Units are being operated at a Technical Minimum Load of 55% to 70% of their rated capacity. If all the Units operate at the lowest possible Technical Minimum Load, then the excessive load cycling, start-ups and shutdowns can be reduced. The target TML of 55% can be reached in a single step (from 70% to 55%) or in two steps (70% to 60% and then to 55%). In each of the steps, ensure that all the Combustion equipment, monitoring equipment and control loops are healthy before starting to reduce the Unit load. Slowly reduce the load watching for any stumbling blocks and address them. Closely monitor Unit operation with respect to the required operational parameters and evolve the practices to be followed at 55% TML for safe and efficiency Unit operation.

2.4. Prerequisites for reducing minimum operating stable load to 55%:

2.4.1 Boiler

(i) Ensure that basic auto control loops such as feed water flow, airflow, and steam (MS/HRH) temp control, furnace draft control, etc. are healthy and in operation.

(ii) Ensure Fuel Air Dampers, Auxiliary Air dampers, Over Fire Air dampers, Burner tilt, Flame scanners and Pulveriser controls are in proper working condition.

(iii) The healthiness of Flame Scanner is to be checked regularly and necessary action to be taken as required to capture flame at TML. Ensure Furnace Cameras, if available, are in place and showing clear picture of Furnace.

(iv) Spray control for SH and RH should be re-tuned for meeting the requirement during load changes in the entire load range. Generally, auto loops are tuned for response in the range of 60% to 100% load range.

(v) Burner Tilt is to be in Synchronism in all the corners and elevations.

(vi) Requirement of Minimum Volatile Matter content and moisture content in coal being fired is to be ensured nearer to the design value. In case of low VM, blending may be considered.

(vii) Review Boiler Load Index Vs Oxygen curve for maintaining sufficient wind box to furnace differential pressure at low loads as low differential pressure causes flame to come closer to the burner resulting in damage to the burner. This will also ensure proper turbulence at low load operation and helps in avoiding the fire ball to become less intense and dilated.

(viii) Ensure Uniform coal flow through all coal pipes with preferably high coal fineness by conducting dirty air pitot test at minimum mill loading.

(ix) Optimize mill PA flow while ensuring no coal settles in coal pipes (Air Fuel velocity in the mill discharge pipe should not be below 20 m/s) and velocity at burner nozzle is more than speed of flame propagation. Modify PA Vs Coal flow curve accordingly (constant PA for 0 to 50% coal flow range).

(x) It is suggested to implement online monitoring of coal discharge pipe temperature to capture coal settling tendency due to low optimised PA flows.

(xi) Ensure no air ingress into furnace and flue gas ducts. Continuous CO monitoring is suggested to validate excess O_2 as CO is unaffected by air-in-leakages. Hence reducing zones in furnace can be eliminated.

(xii) It is suggested to ensure Coal mill steam inerting system charged and in auto with high CO value.

(xiii) In case of TDBFP, steam source from CRH should be available. Steam source changeover from Extraction to CRH and vice versa should be smooth to avoid disturbance in the Feed water flow.

(xiv) Superheater and Reheater metal temperature during load reduction and low load operation should be kept under limit.

(xv) Mill outlet temperature should be maintained minimum 70°C for Indian coals if required, SCAPH to be charged.

(xvi) Ensure Furnace to Wind box delta P are in Auto Mode of operation. For ensuring stability at 55% TMCR load, non-firing coal dampers' opening (coal dampers of mill which are not in service) should be optimized (typically < 30%) to increase Furnace-Wind Box DP and to ensure combustion quality.

(xvii) Unburnt Carbon in Ash is to be analysed frequently to assess combustion quality.

(xviii) To avoid drum level disturbances due to opening of BFP recirculation valves during disturbances at low loads, replacing ON/OFF recirculation valve with Control valve may be considered for better control.

(xix) Sliding pressure curve to be reviewed for lower load operation wherever applicable.

(xx) Developing online PA fan operating point display and installation of reliable stall sensing mechanism for better monitoring and control. It is suggested to install stall Protection Measures in PA Fans and ID/FD fans. In case, no. of Mills is to be reduced to ensure minimum feeder loading, PA header pressure is to be suitably modified to prevent PA Fan stalling.

(xxi) In once through supercritical boiler, Feed Water flow control is of utmost importance. Feed water flow is dependent on function based on boiler load index. The implementation of this function must be ensured with fair amount of accuracy.

(xxii) For once through boiler, steps are to be taken to ensure that water level at Water Separator Storage tank does not increase by ensuring appropriate degree of superheat at water separator inlet.

2.4.2 Turbine

(i) TG governor characteristics to be checked periodically during shutdown.

(ii) Turbine casing top bottom differential temperature during load reduction and low load operation should be kept under limit.

2.4.3 General

(i) Calibration of all the critical parameters measuring instruments is highly essential.

(ii) For 55% minimum load operation the ramp rates (up/down) shall be about 2%. However, in future the proposed new regulation shall have to be followed regarding the ramp rates.

(iii) All steam & water analysis system (SWAS) is charged and available for online monitoring.

(iv) RGMO (Restrictive Governor mode operation) may have to be bypassed.

2.5. Procedure:

2.5.1 Gradually reduce the Unit load by reducing load set point till loading comes to 80%.

2.5.2 To further reduce the Unit load, take out one feeder (either bottom or top) from auto and gradually reduce the coal feeding and stop the Milling system. Mill combination plays an important role in flame stability and to maintain rated main steam and reheat steam temperatures. Select the Milling system to be stopped according to the behaviour of the Boiler.

2.5.3 Mill cut-out procedure:

i. Gradually reduce feeder speed / coal flow through feeder to minimum either manually or by reducing the feeder bias set point

ii. Ensure that the Mill outlet temperature does not increase by modulating the hot air and cold air dampers

iii. Reduce PA flow through the Mill as per the reduced coal flow.

iv. Open mill inerting steam (If available) valve, if the coal fired is having high volatile matter, to avoid mill explosions during lean mixture conditions.

v. Stop the feeder

vi. Close hot air damper and gate

vii. Keep minimum cold PA through the Mill, till the Mill outlet temperature comes down

viii. Close the cold air damper and cold air gate.

ix. Stop the Mill after ensuring no coal is left in the Mill.

2.5.4 Following the above step reduce the coal feeding and stop one more Milling system at about 60% of unit load. Ensure that minimum 3 consecutive Mills are in service or a gap of not more than one elevation. For a safer side ensure each of the running mill is loaded more than 50%.

2.5.5 Running fewer mills at higher loading over running more mills at lower loading increases the combustion stability; hence restrict the number of mills according to individual mill loading >60%. (This may create a situation where in case of one running mill trips Unit tripping on flame failure has a very high probability. Reliability of feeders and Mills to be very high. Mill unloading due to foreign material in Feeder or Mill need to be avoided).

2.5.6 Air Preheater cold end corrosion due to low flue gas temperature at low loads and low average cold end temperatures in winter season. SCAPH to kept in charged condition as per the requirement.

2.5.7 Ensure wind box pressure is maintained around 50 to 60 mmWCL by proper operation of SADC and excess air adjustment during load reduction.

2.5.8 Deviation in Super heater and Reheater temperatures from rated values at low load operation can be reduced by adjusting mill combination, burner tilts or biasing fuel to upper burner levels, increasing O2, and Optimising wall soot blower operation frequency. All these actions result in balancing heat transfer in the first pass and convective pass.

2.5.9 Ensure SH & RH temperature variation is within +/- 15 ^{0}C. Check for any transients in differential expansion of turbine rotor and casing. Ensure HP turbine exhaust temperature is within limit.

2.5.10 Rate of saturation temperature change in boiler drum is to be monitored and limited while reducing the load. Drum top/bottom temperature difference to be maintained within limits during load reduction.

2.5.11 Soot blowing is not possible at low loads as it causes further disturbance in boiler flame. Unit load needs to be increased for carrying out soot blowing as and when required.

2.5.12 To gain confidence, after reducing the load to 60% of rated load, for initial load reducing trials, wait for 1 hr and observe all the parameters like flame intensity, MS/HRH temperatures, SH/RH spray levels, etc. for their stability.

2.5.13 Keep reducing the Unit load further to reduce the Unit load to 55% of rated capacity.

2.5.14 Open on BFP recirculation valve depending upon the requirement based on design flow Vs speed curve at low load.

2.5.15 Operate unit on modified sliding pressure (wherever available) mode to avoid possible steaming in economizer during load reduction.

2.5.16 Diligently monitor system chemistry during load reduction.

2.6. Operational Issues faced in Low load operation in case of Ball and Tube mill:

2.6.1 Difficulty in operating at low load conditions for units using Ball and Tube mills due to inherent limitations.

2.6.2 During single mill operation at 2 elevation may be explored at 55% operation without oil support.

2.6.3 During 1 ½ mill operation (ball tube mill) there may be a chance of explosion of mill when it operates with one side continuously. It is good practice to run the mill with both sides in service to avoid unwanted happenings.

2.6.4 During 2 mills low load operation, the constraint of ignition energy permissive in the adjacent elevation has to take into consideration and forced to run the mills with unequal loadings results in fluctuations of boiler load/stability of unit and which leads to chances of tripping of unit.

Total 18 units of 4310 MW capacity are running on Ball and Tube Mill. After extensive deliberation by the Committee, it has been suggested to Conduct a pilot test in association with OEM for Low Load operation (55%) at a 210 MW size Unit of DVC running on Ball and tube mill so that the operational issues being faced by such units can be studied in detailed and resolved accordingly.

2.7. Long Term Concerns/Measures:

2.7.1 Increased stresses in thick components of boiler and turbine due to cycling and higher equipment life consumption. Life time monitoring systems may be considered for thick wall components for better control and monitoring.

2.7.2 Increased Equipment failures and non-availability. Usage of Predictive Analytics for early detection of equipment anomalies with subsequent actions may be considered. Since all equipment shall have cyclic loading due to ramp up and down, proper Condition Monitoring is to be taken up with a predetermined schedule – in consultation with OEM, for assessment of equipment health. Further Capex allocation is to be ensured for through overhauling of all lead bearing equipment during annual shutdown

2.7.3 Increased O&M cost and decreased reliability. PM schedule to be reviewed for equipment and additional points may be included in checklist in consultation with OEM to minimise equipment failure.

2.7.4 Overall unit efficiency, heat rate and APC deterioration will increase financial burden.

2.7.5 Usage of Performance Optimisation tools for minimising losses due to deteriorated heat rate and APC at low loads.

2.7.6 With lowering load, amount of steam entering the feed water heater decreases, and the amount of drain also decreases, therefore it becomes difficult to control the drain level.

2.7.7 Steam pressure decreases with lowering load. At the economizer, the feed water temperature may approach saturated liquid temperature, and evaporation may occur. If evaporation occurs, the feed water flow may be interrupted, and the metal temperature of the water-cooling wall may rise.

2.7.8 In imported coal-based plant, Fuel flow and air flow decrease, and balance of fuel and air sometimes collapses at some space in furnace of boiler, and combustion becomes unstable.

2.7.9 The methodology of Biomass firing and impact of biomass firing on flame stability at 55% MCR to be explored.

2.7.10 Mill Centre pipe may be cleared periodically as a precaution.

2.7.11 Plant specific practices based on the design and equipment condition to be followed at 55% TML for safe and efficient Unit operation.

2.7.12 Higher ash accumulation is observed in flue gas path due low flue gas velocity endangering structural stability. To be monitored and suitable action to be taken. At any point do not allow water to enter into FG ducts.

2.7.13 Low Primary air flows may lead to Primary Air fans operating in stalling zone, especially in case of a coal mill trip at lower loads.

2.7.14 High Super heater and Reheater sprays at low loads lead to increased tendency of deposits in super heaters, reheaters and turbine blades. Ensure that the Station adheres to Water chemistry guidelines. Consider changing the chemical treatment regime to AVT(O) from AVT(R) to mitigate the adverse effects at low load operations.

2.7.15 Mill Centre pipe may be cleared periodically as a precaution.

2.7.16 Ensuring equalisation in PF flow in coal pipe by periodic mill maintenance and orifice adjustments.

2.7.17 Installation of vibration monitoring instruments in critical rotating equipment, if not available.

2.7.18 Monitoring of emissions parameters like SPM, NOx and SOx, and performance parameters like Boiler efficiency, unit heat rate, APC may be done periodically.

2.7.19 Critical parameters like Unburnt carbon, APH exit temperature, FEGT, coal fineness, APH pressure drop should be monitored closely.

3. TRAINING OF OPERATORS AND TRAINERS

3.1. Objective

The purpose of operator training is to train and assess operators in plant operation such as start-up and shut-down, supervision, monitoring and control during normal, emergency situations and in safety procedures. For safe and efficient plant operation at 55% minimum load, there is a need for developing trained plant personnel.

In a highly automated plant and to suit the changing needs of the thermal power plant training, Simulator is helpful to maintain a high level of proficiency of operators. Simulator is highly flexible, can be used in different ways to run a thermal unit.

3.2. Requirement

55% operation of Thermal plant requires highly efficient and skill manpower to ramp down the load and ramp up the load with desired parametric operation particularly for 210 MW and 500 MW Thermal generating units. Adequate training is required on Simulator for developing the confidence in operators to run the power plant at 55% load without oil support. Many simultaneous parameters monitoring are required for all critical equipments for stable and efficient operation at 55% load without oil support.

3.3. Training Programme

The simulators are capable to train the operators at 55% operation without oil firing.

1. Simulator Calibration: "The simulator training to be imparted shall cover the load cycling from maximum continuous load to 70% minimum load at a ramp rate of about 3% and then from 70% to 55% load at a ramp rate of about 2% without oil firing. It shall also include continuous operation at 55% minimum load". During this operation, all critical parameters are to be monitored and unit operation stability to be checked. Monitoring of Critical Parameters are to be recorded during 55% Operation without oil support. Operators need to record and monitor the parameters and must adopt the process of this operation with more skilled training. With proper training only operator can do successful operation and handle the emergency if any during this operation.
2. The training institutes providing training related to 55% Technical Minimum Load of thermal power plants should be recognised by CEA/MoP or the state governments.
3. Duration & Batch size: The training institute shall impart training as per the modules developed specifically for the above operation regime. The training duration shall be of 2 weeks for Operators, 1 week for trainers and at a time 12-15 operators can be trained. No of trainers per batch should be 2-3. Focus areas

in the Simulator training will be cold and warm start up conditions, 55% Operation (Manual) –Ramp Up with ramp rate, 55% Operation (Manual) -Ramp down with ramp rate, 55% Operation (Auto) –Ramp Up with ramp rate, 55% Operation (Auto) -Ramp down with ramp rate, Emergencies & Malfunctions, Unit Stable Operation, Critical Equipment Changeover etc.

The capability of simulators needs to be assessed and fine-tuned as per the requirement of 55% load operation at Institute of NPTI, Central, State and Private power training centres where Simulators are available. The details of available Simulators for Thermal Power Plants at NPTI and various Utilities is attached as Annexure II.

The 210 MW and 500MW Simulator Training material of NPTI has been attached as Annexure I.

3.4. Recommendation

Plant Operators/Trainers must train on the simulator for 55% Load operation with 3% ramp rate above 70% load and 2% ramp rate below 70% load and without oil support. Simulator Training to the power Plant operators will enhance their skills and make them ready for low load operation without oil support and help in making the plant stable during ramp up and ramp down at lower load.

The operators of Central, state and private utilities can also be trained at the training centres of NPTI or the training centres of major utilities to gain confidence. Further, utilities which have achieved 55% load operation without oil support in their units can extend the support for achieving the 55% operation at other utilities which are facing difficulties. In this regard the list of NTPC's units operating at 55% load along with their location is attached as Annexure III.

As far as possible the simulator training pertaining to the 55% Technical Minimum Load of thermal power plants shall be plant specific.

ANNEXURE I

National Power Training Institute

(Under Ministry of Power, Govt of India)

500 MW SIMULATOR TRAINING MATERIAL

For Lower Load Operation (55% Operation)

NPTI Complex, Sector-33,

Faridabad – 121003 (Haryana)

Introduction

For safe, efficient and economical thermal power plant operation, there are a significant numbers of thermal power plants around the world and new plants based on coal firing are also added into operation regularly. This creates an increasing need for trained thermal power plant personnel.

The thermal power plant simulator model is used for both the training of newly-hired employees and refresher courses of personnel with earlier experience. The main purpose of the Thermal Power Plant simulator is to train and assess operators in the operation of Distributed Control Systems (DCS) and in plant operation, including training in plant start-up and shut-down, emergency situations and safety procedures.

Utilizing thermal power plant operation as the basis for simulation provides our student and employee with a strong foundation, ensuring that their operational procedures and practices will enhance the plant economic efficiency and safety measures.

Objectives/ Purpose

The main purpose of the Thermal Power Plant simulator is to train and assess operators in general plant operation, including training in plant start-up and shut-down, supervision, monitoring and control during normal, emergency situations and in safety procedures. In addition, the simulator can be used as a powerful tool for engineers and plant management to verify process design and control strategies prior to start-up of a plant as well as investigation and testing of operational problems that are normally not allowable under real plant normal operating conditions.

Our simulator is highly fidelity and can be used in a number of different ways to suit the changing needs of the thermal power plant.

Power plant simulator is an effective training tool, with which the actual characteristics of a power plant can be generated through real time execution of mathematical models of various systems on a computer. The trainee operator quickly gains experience in normal, abnormal and emergency operation of power plant through Simulator Training. Operator confidence is increased, resulting in improved efficiency of power plant operating personnel, better equipped to respond to problems and emergencies. The hands-on training in a highly realistic environment provided by the training Simulator cannot be substituted by any other form of training. A well-trained operator runs a plant safely and expensive downtime caused by operator error is significantly reduced. In a highly automated plant, refresher training on Simulator also helps experienced operators to maintain a high level of proficiency.

General

High-Fidelity Simulator for the NPTI 500 MW Unit consist of Functional Design Specification (FDS) is an expansion of the proposal to include information and details not available at the time of proposal. The simulator will realistically represent the systems, processes, and controls, including startups, shutdowns, normal and abnormal operations, and malfunctions, subject to the scope outlined in the signed specification.

The simulator will provide dynamic simulation of a 500MW TPP unit. This 500 MW unit includes, coal Fired, balanced draft and controlled circulation Drum type Boiler.

The simulator will also be a tool for initial training and retraining of control room operators, operation supervisors, and other plant equipment operators in:

- Various plant systems, equipment and their functions
- Following specific plant operating procedures
- Abnormal and emergency events, including malfunctions

The process model consists of the following major systems:

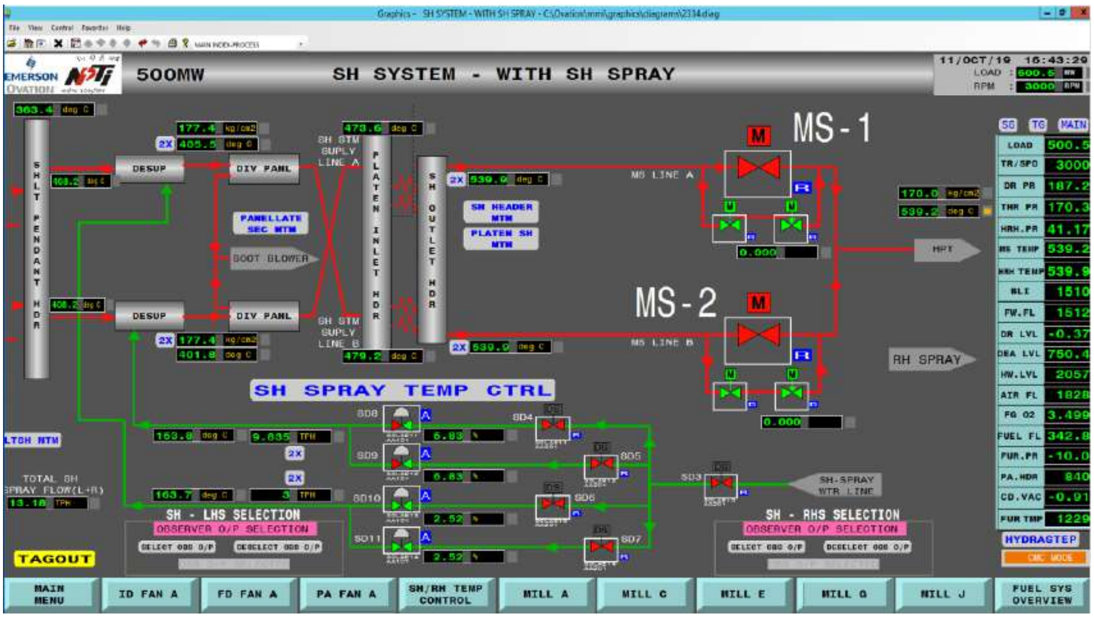
- Turbine
- Boiler
- Balance of Plant
- Electrical
- Miscellaneous Systems

Boiler Model

The boiler section of the process model will be defined in the following sections. The model schematics are based on 500MW design information, system descriptions, P&ID's, verbal and written information from NPTI personnel and will include the following major systems:

Steam from the Drum is directed to the series of Six (6) nodes of Steam cooled walls. It is then passed through the Low Temp SH, SH divisional Panel & Final SH. The superheated steam from the Final SH outlet header node is directed to MS1 network by means of two (2) flow boundaries, feeding inlet steam to the high-pressure section of the turbine.

The Superheaters are Physically Modelled.



Steam at high pressure & temperature from the outlet node of the HP turbine is directed to the RH inlet header node through two (2) cold RH flow paths. Reheater arrangement consist of two (2) headers, one is for inlet & other for outlet and twelve (12) nodes for tube section with six (6) nodes in each parallel flow path. Steam flows through the nodes and gains heat from the heat slabs corresponding to each node.

Turbine Model

The Turbine and its related system of the process model will be represented on the MS1 network (Main Steam & Extraction Steam Network No.1), and will include the following major systems:

- Turbine System
- Boiler Feed Pump Turbine
- Governing Valves System
- Gland Steam Sealing System
- Turbine Drain System

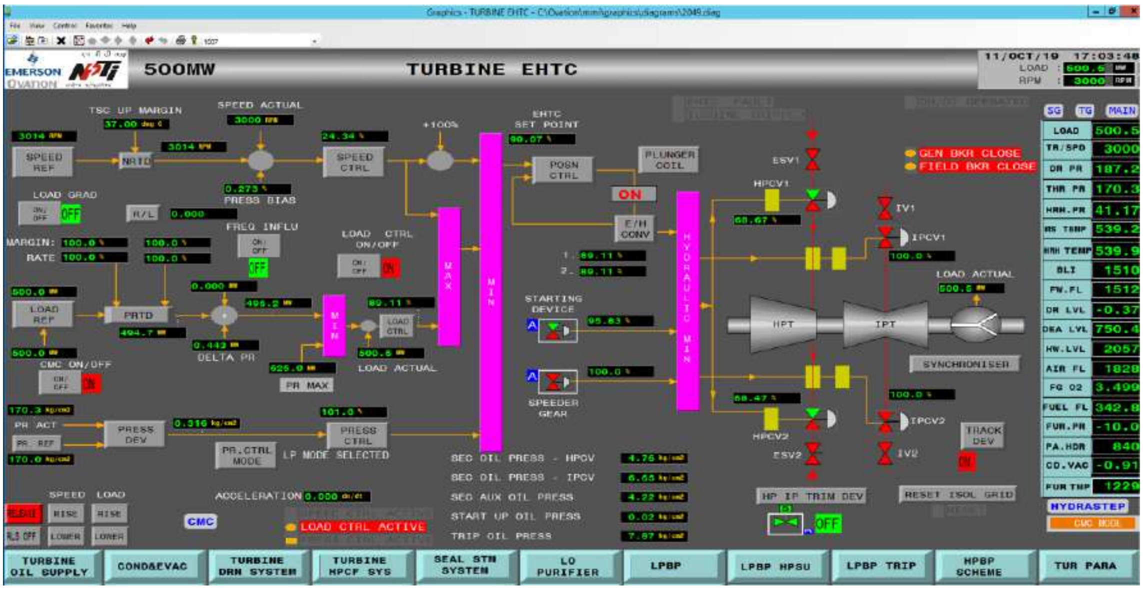
The turbine unit consists of a 500 MW Three Cylinder Single Reheat Condensing Turbine designed for high operating efficiencies and maximum reliability. Turbine icons are used in the model as per the number of extractions. High Pressure (HP) and Intermediate Pressure (IP) and Low Pressure (LP) turbines are taken on a single shaft. High pressure and high temperature steam from the BR1 network is directed through flow & pressure boundaries to the HP turbine inlet node in the MS1 network through two (2) HPT stop valves (ESV) and two (2) HPT control valves.

Steam is directed from the HP turbine exit node to the reheater inlet node, which is then passed through the reheater. The hot reheated steam is then fed to the IP turbine in the MS1 network through two (2) IPT Stop Valves (IVSV) and two (2) IPT Control Valves (IVCV). Steam from the IP turbine exit node is directed to the LP turbine inlet node through a crossover flow path. By opening the HP bypass valve, steam is fed into the cold reheat line.

The de-superheating station is represented as a node in the model to reduce the temperature and pressure. By opening the LP bypass valve, steam is fed into the condenser from the hot reheat.

Steam is extracted from the nodes in the turbine icon and flows through the feed water heaters shells. There are six (3) extractions on the LP Turbine, two (2) on IP Turbine and one (1) on the Cold Reheat (CRH) Line. Extraction #1 is located on the cold reheat line and supplies to HP feed water heater #6A and HP feed water heater #6B. Extraction #2 is from the IP turbine and supplies to HP feed water heater #5A and HP feed water heater #5B. Extraction #3 is from IP turbine to Deaerator and BFPT. Extractions #4, #5, #6 from the LP turbine and supplies steam to LP heaters #3, #2, #1 respectively.

Turbine system section is Physically Modeled. The electro-hydraulic system and governing system are Physically Modeled.



Critical parameters of the 500 MW Thermal Simulator Graphics Representation

NPTI 500 MW Unit Simulator Critical Parameters

Parameter	%Accuracy	Normal	Unit
Main Steam mass flow rate	±2	1498.5	t/h
Main Steam Pressure	±2	176.7	kg/cm2 (g)
Main Steam Temperature	±2	540	°C
Fuel flow	±2	344	t/h
Fuel Heating Value	±2	3300 (HHV)	kcal/kg
Hot Reheat Steam mass flow rate	±2	1335.1	t/h
Hot Reheat Pressure	±2	41	kg/cm2 (g)
Hot Reheat Temperature	±2	540	°C
Combustion Air Flow	±2	1847	t/h
Combustion Air temperature	±2	312	°C
Condensate flow	±2	1177.64	t/h
Feedwater Flow	±2	1481.5	t/h
Feedwater Temperature	±2	253	°C
Economizer Gas Exit Temperature	±2	335	°C
Furnace Pressure	±2	-5	mmwc
Condenser Vacuum	±2	77	mmhg(abs)
Steam Turbine Generator Net Power	±2	500	MW

Coordinated Master Control in Service (CMC)

Coordinated Master Control interfaces the turbine and boiler control together by generating boiler demand with Turbine Target Load point and Coordinated -Master Control point and M.S. pressure set point. Coordinated Master Control can be put in service generally after turbine is loaded to 60% loads.

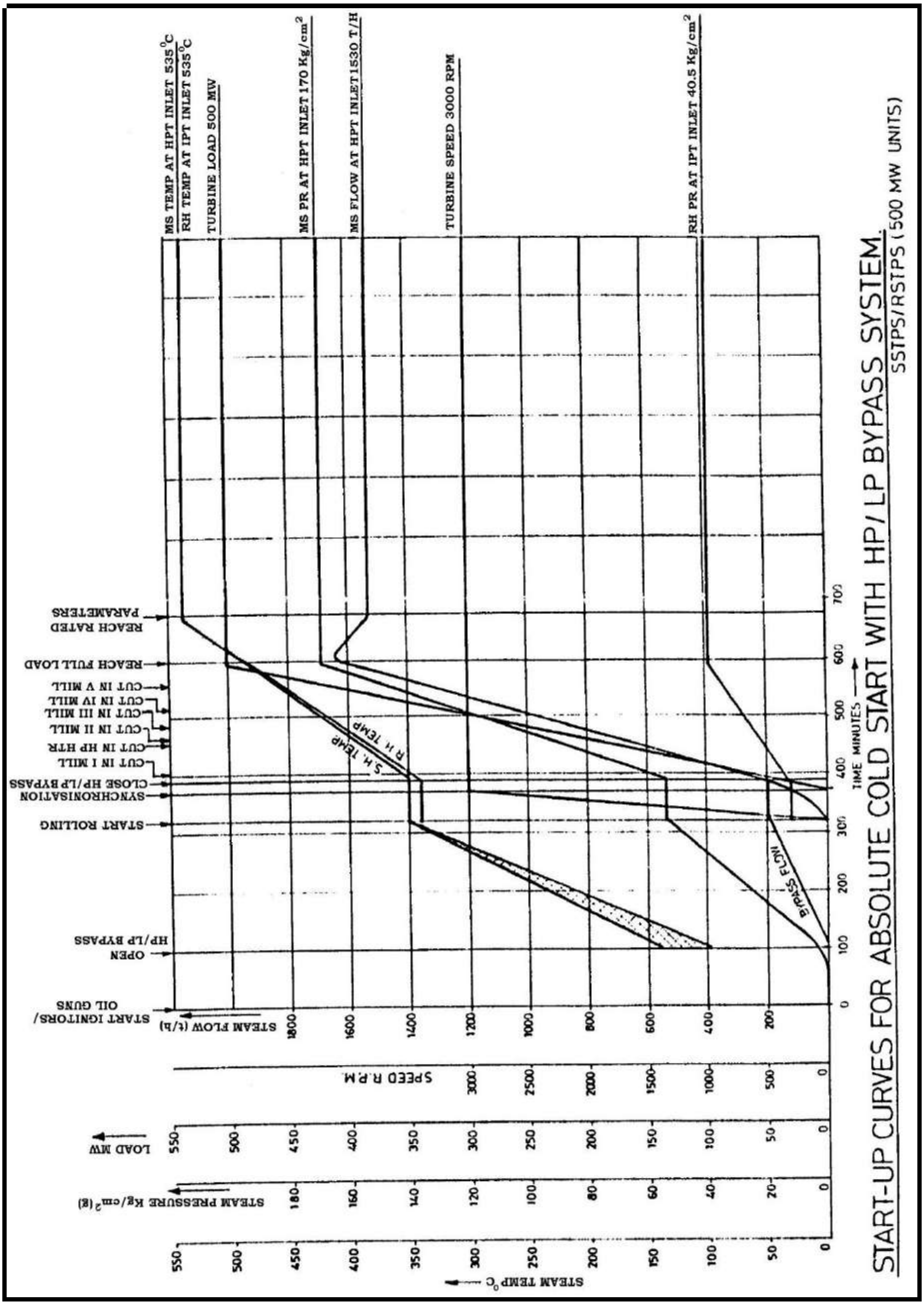
Ensure the following:

1. From the Turbine EHTC Graphic, check the following: -
   a) Load control – ON
   b) Pressure Control Mode – LP Mode Selection
2. Coordinate Master Control- Put the Throttle Pressure Set point same as the running pressure (Ensure Operator mode selection: Constant pressure mode

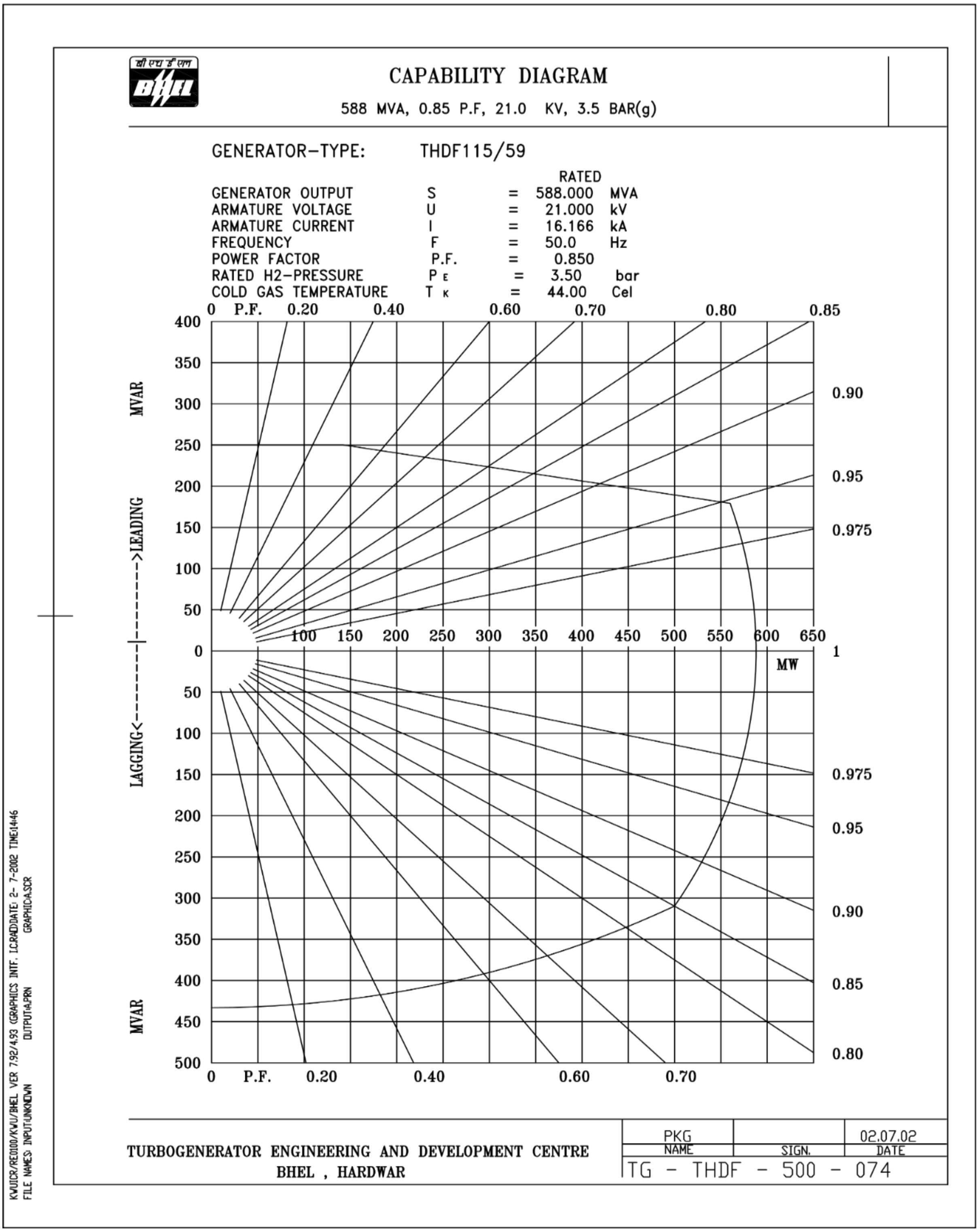
graphics. The pressure set point on EHTC graphic and CMC graphic should be same).

3. Put all the mills in Auto and then put the 'fuel master' in Auto from Graphic of Fuel Flow Control.
4. Put the 'Boiler Master Control' in Auto
5. Put the Turbine in CMC mode from Graphic
6. Click on "CMC" tab in graphic
7. Ensure "Co-ordinated" is flashing in Red colour.
8. Unit Load will be maintained as per operator set point.

Start-up Curve



Generator Capability Curve



Lowering Load –Thermal Backing Operation (55 % Operation Training)

State of Plant - Ensure

- M/C on Load.
- SH/RH spray control on auto.
- Drum level control on auto.
- Furnace pressure control on auto.
- Aux. Steam pressure/temp. Control on auto.
- Ensure igniters and oil guns are in position to be operated in case of requirement
- Mill temp. On auto.
- PA control on auto.
- Burner Tilt system are in alignment with all corners
- SADC on auto.
- HFO temp is adequate.
- Six mills are in service.
- AB, CD, EF elevation oil guns are available.
- Burner Tilt operation OK.
- HP /LP bypass on auto.
- EBD is available for operation.
- FRS high range in service and low range is available.
- Fire fighting equipment's are available.
- WW & APH Soot blowing system is available.
- Feed water flow management in lined condition with TDBFP.
- SH/RH Spray Control in auth with Set points.
- TG Governor & LL setting should be proper.

1. Check HP / LP bypass operation is O.K. and again ensure furnace to wind box dP in Auto Mode. Mills outlet Temperature should be in the range of 65 to 80 Deg C for Indian and Imported Coal.
2. Machine is still in CMC mode; reduce the load gradually from graphics from "OPR LOAD SP" Tab.
3. Steam flow will be reduced, Allow the pressure to drop with the reduction in load.
4. Observe the reduction rate of temperature prescribed by the manufacturer for turbine but never exceeding the forced cooling rate of boiler if required to regulate load to maintain MS and HRH temperature constant.
5. Check Throttle Pressure and Actual Pressure for any wide variation difference.
6. Adjust air flow for required O2 % and Monitor CO.
7. Again reduce the load gradually and check the conditions of Boiler and Turbine, Machine is still in CMC operation.

8. Reduce the up to from 500 MW to 300 MW in the step manner with time stamping of load 5 to 10 MW per minute and observe the Critical parameters. Ramp Down rate up to 55% should be such that it should be in the range of 1.0 to 2.0 % (5 to 10 MW per minute) to make stable parameters. In case of wide variation in parameters, lets parameter to be made stable and observe the position of different parameters and let them to stabilize. Boiler flame stability is very important during ramp down or ramp up process. Every moment of time availability and reliability of mills and feeder needs to be ensured.
9. If Machine is old age More than 12-15 years, please ensure
    - Feed flow
    - Air Flow
    - PA Header Flow
    - Furnace Pressure Control
    - Fuel Flow control
    - Check also bypasses operations.
10. Bring out machine from CMC mode around 270-300 MW and manually reduce the load from the CMC graphics from Tab "LOAD REF/LOAD SP.
11. Close the extraction of HP heaters and bring out HP heaters charging and observe the HP heaters.
12. Further reduce the load and reduce the coal firing and gradually bring out one coal mill from service and if required take two mills but support with oil if unit is old.
13. Reduce Coal demand further and still coal master in auto and check further all critical parameters. Change over from TDBFP to MDBFP, if required.
14. Load Operation need fine control for drum level, drum pressure. If at any moments of time, flame disturbed wide fluctuation may be observed in drum. If required support of oil guns to be taken immediately and ensure pair mode and elevation mode should be available at respective elevation.
15. Density difference at lower load with respect to water and steam is very important for stable operation and balanced load profile.
16. Soot blowing at lower load is to be avoided as it make disturbance in the Flame and Furnace draft.
17. Reduction in Turbine load also reflect disturbance in Condenser vacuum, which need to be monitored perfectly.
18. Metal Temperature and Air Pre-heater, SCAPH Temperature needs to be monitored.
19. In case of Disturbance in Load, Control the MS Pressure and Feed water to avoid tripping & Ensure flame stability.
20. For Older Units, Control System and Control Loops Tuning are required. Some Loops and Sub-loops Control Response are slow, which need to be retuned for ramp up and ramp down as per unit operation and Design Specification, Technical documents.

Critical Set Point Parameters of 500 MW Thermal Power Plant

Sr.No	Equipment	Set Point
1	DMCW(SG)	LONG RECIRCULATION VALVE = 3kg/cm2
2	DMCW(TG)	LONG RECIRCULATION VALVE = 3kg/cm2
3	HOTWELL FILLING	NORMAL VALVE = 1800MMWC EMERGENCY VALVE = 1740MMWC
4	GSC	RECIRCULATION VALVE = 400T/HR
5	DEAERATOR	LEVEL CONTROL VALVE = 750MM
6	HP BYPASS	BP-1 = 35kg/cm2 BPE-1 = 350 DEG C BP-2 = 35kg/cm2 BPE-2 = 350 DEG C
7	LP BYPASS	CV = 5 kg/cm2 CV-1 = 100T/HR CV-2 = 100T/HR
8	FURNACE DRAFT	PRESSURE = - (8 TO 10 MMWC)
9	PA FAN HEADER	PRESSURE = 850 MMWC
10	LFO PUMP DISCHARGE	HEADER PRESSURE = 20 kg/cm2
11	LFO HEADER	PRESSURE = 10 kg/cm2
12	HFO PUMP DISCHARGE	HEADER PRESSURE = 20 kg/cm2
13	HFO HEADER	PRESSURE= 10 kg/cm2
14	HFO HEATER	TEMPERATURE SET POINT = 125 DEG C
15	HFO HEADER	FLOW CONTROL MAIN VALVE = 10 kg/cm2
16	TURBINE DRAIN HPCV	TEMPERATURE SET POINT = 300 DEG C
17	GENERATOR COOLING WATER	TEMPERATURE SET POINT = 45 DEG C

National Power Training Institute

(Under Ministry of Power, Govt.Of.India)

210 MW SIMULATOR TRAINING MATERIAL

For Lower Load Operation (55% Operation)

NPTI Complex, Sector-33,

Faridabad – 121003 (Haryana)

Introduction

For safe, efficient and economical thermal power plant operation, there are a significant numbers of thermal power plants around the world and new plants based on coal firing are also added into operation regularly. This creates an increasing need for trained thermal power plant personnel.

The thermal power plant simulator model is used for both the training of newly-hired employees and refresher courses of personnel with earlier experience. The main purpose of the Thermal Power Plant simulator is to train and assess operators in the operation of Distributed Control Systems (DCS) and in plant operation, including training in plant start-up and shut-down, emergency situations and safety procedures.

Utilizing thermal power plant operation as the basis for simulation provides our student and employee with a strong foundation, ensuring that their operational procedures and practices will enhance the plant economic efficiency and safety measures.

Objectives/ Purpose

The main purpose of the Thermal Power Plant simulator is to train and assess operators in general plant operation, including training in plant start-up and shut-down, supervision, monitoring and control during normal, emergency situations and in safety procedures. In addition, the simulator can be used as a powerful tool for engineers and plant management to verify process design and control strategies prior to start-up of a plant as well as investigation and testing of operational problems that are normally not allowable under real plant normal operating conditions.

Our simulator is highly fidelity and can be used in a number of different ways to suit the changing needs of the thermal power plant.

Power plant simulator is an effective training tool, with which the actual characteristics of a power plant can be generated through real time execution of mathematical models of various systems on a computer. The trainee operator quickly gains experience in normal, abnormal and emergency operation of power plant through Simulator Training. Operator confidence is increased, resulting in improved efficiency of power plant operating personnel, better equipped to respond to problems and emergencies. The hands-on training in a highly realistic environment provided by the training Simulator cannot be substituted by any other form of training. A well-trained operator runs a plant safely and expensive downtime caused by operator error is significantly reduced. In a highly automated plant, refresher training on Simulator also helps experienced operators to maintain a high level of proficiency.

General

High-Fidelity Simulator for the NPTI 500 MW Unit consist of Functional Design Specification (FDS) is an expansion of the proposal to include information and details not available at the time of proposal. The simulator will realistically represent the systems, processes, and controls, including startups, shutdowns, normal and abnormal operations, and malfunctions, subject to the scope outlined in the signed specification.

The simulator will provide dynamic simulation of a 500MW TPP unit. This 500 MW unit includes, coal Fired, balanced draft and controlled circulation Drum type Boiler.

The simulator will also be a tool for initial training and retraining of control room operators, operation supervisors, and other plant equipment operators in:

- Various plant systems, equipment and their functions
- Following specific plant operating procedures
- Abnormal and emergency events, including malfunctions

The process model consists of the following major systems:

- Turbine
- Boiler
- Balance of Plant
- Electrical
- Miscellaneous Systems

Boiler Model

The boiler section of the process model will be defined in the following sections. The model schematics are based on 210 MW design information, system descriptions, P&ID's, verbal and will include the major systems:

- Combustion Air & Gas System
- Fuel Oil & Coal Firing System
- Boiler Water Side System
- Economizer
- Superheater
- Reheater

Turbine Model

The Turbine and its related system of the process model will be represented on the JTOPSOFTWARE MS1 network, and will include the following major systems:

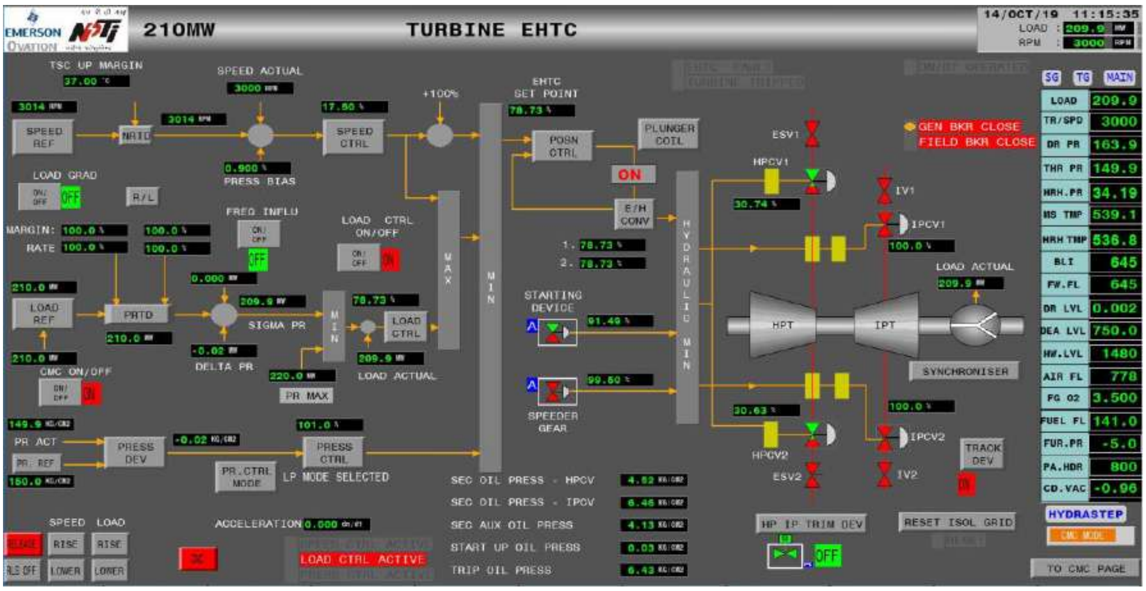
- Turbine System
- Governing Valves System
- Gland Steam Sealing System
- Turbine Drain System

- Turbine lube oil system
- Turbine evacuation system

The turbine unit consists of a 210 MW Three Cylinder Single Reheat Condensing Turbine designed for high operating efficiencies and maximum reliability. Turbine icons are used in the model as per the number of extractions. High Pressure (HP) and intermediate pressure (IP) and Low Pressure (LP) turbines are taken on a single shaft. High pressure and high temperature steam from the BR1 network is directed through flow & pressure boundaries to the HP turbine inlet node in the MS1 network through two (2) HPT Stop Valves (ESV) and two (2) HPT Control Valves. Steam is directed from the HP turbine exit node to the re-heater inlet node, which is then passed through the re-heater. The hot reheated steam is then fed to the IP turbine in the MS1 network through two (2) IPT Stop Valves (IVSV) and two (2) IPT Control Valves (IVCV). Steam from the IP turbine exit node is directed to the LP turbine inlet node through a crossover flow path. By opening the HP bypass valve, steam is fed into the cold reheat line. The de-superheating station is represented as a node in the model to reduce the temperature and pressure. By opening the LP bypass valve, steam is fed into the condenser from the hot reheat.

Steam is extracted from the nodes in the turbine icon and flows through the feed water heaters shells. There are three (3) extractions on the LP Turbine, two (2) on IP Turbine and one (1) on the Cold Reheat (CRH) Line. Extraction #6 is located on the cold reheat line and supplies to HP feed water heater#6. Extraction #5 is from the IP turbine and supplies to HP feed water heater #5. Extraction #4 is from IP turbine to Deaerator. Extractions #3, #2, #1 the LP turbine and supplies steam to LP heaters #3, #2, #1 respectively.

Turbine system section is Physically Modeled.



Critical parameters of the 210 MW Thermal Simulator Graphics Representations

Balance of Plant System Model

The balance of plant (BOP) section of the process model will be represented on the Main Steam (MS1) network, and will include the following major systems:

- Condensate System
- Auxiliary Steam System
- Heater Bypass
- Heater Drain & Vent System
- Condensate Water Makeup System
- Steam Coil Air Pre-Heaters (SCAPH)
- Circulating Water System
- Auxiliaries Cooling Water System
- Equipment Cooling Water System

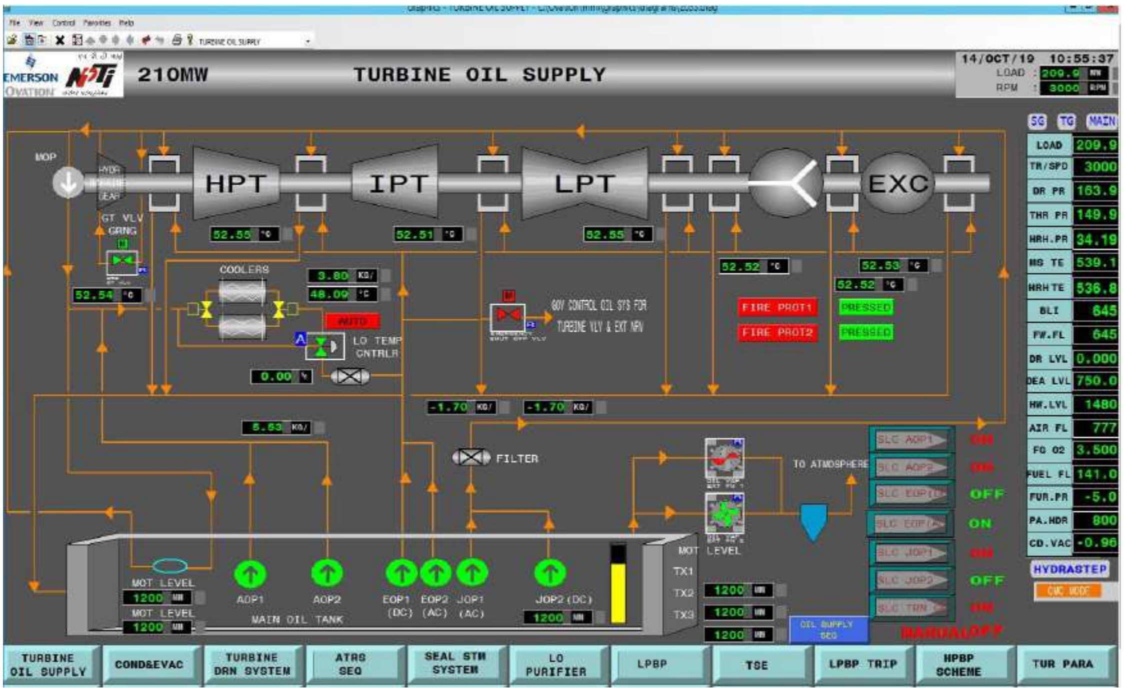
Turbine Lube Oil System

The turbine lube oil system supplies oil to the turbine bearings, generator and exciter bearings. The lube oil system also acts as source of control oil which is being used for operation of Control valves, Stop valves, mechanical protections devices and NRV's etc.

This system consists of several major components listed below:

- Turbine Main Oil Tank
- Main Shaft Oil Pump
- Auxiliary Oil Pump
- Jacking Oil Pump
- Emergency Oil Pump
- Injectors
- Lube Oil Coolers
- Filters/Strainers

Main oil tank is represented by a node which is always assumed to have certain mass of oil available during plant operation. AC auxiliary oil pumps, Emergency oil pump, jacking oil pumps take suction from the main oil tank through respective flow paths.



NPTI 210 MW Unit Simulator Critical Parameters

S. No.	Parameter	Units	Design Value
1	Main Steam Flow	Tons/Hr	700.00
2	Main Steam Pressure L	Bar	155.98
3	Main Steam Pressure R	Bar	155.98
4	Feedwater Flow	Tons/Hr	700.00
5	Feedwater Temperature	DEG C	294.00
6	Feedwater Pressure	Bar	172
7	Furnace Pressure	mmwc	-4.00
8	Generator Gross MW	MW	210.00
9	Turbine Speed	RPM	3000.00
10	Cold Reheat Temperature L	DEG C	352.00

S. No.	Parameter	Units	Design Value
11	Cold Reheat Temperature R	DEG C	352.00
12	Cold Reheat Pressure L	Bar	40.4
13	Cold Reheat Pressure R	Bar	40.4
14	Hot Reheat Temperature	DEG C	540.00
15	Hot Reheat Pressure	Bar	38.8
16	Superheat Outlet Temperature	DEG C	537.00
17	Superheat Outlet Pressure	Bar	156.00
18	Condenser Pressure (Vacuum)	KG/CM2	-0.94
19	ECO out gas Temperature	DEG C	356.00
20	Fuel (Coal) Flow	Tons/Hr	148.00

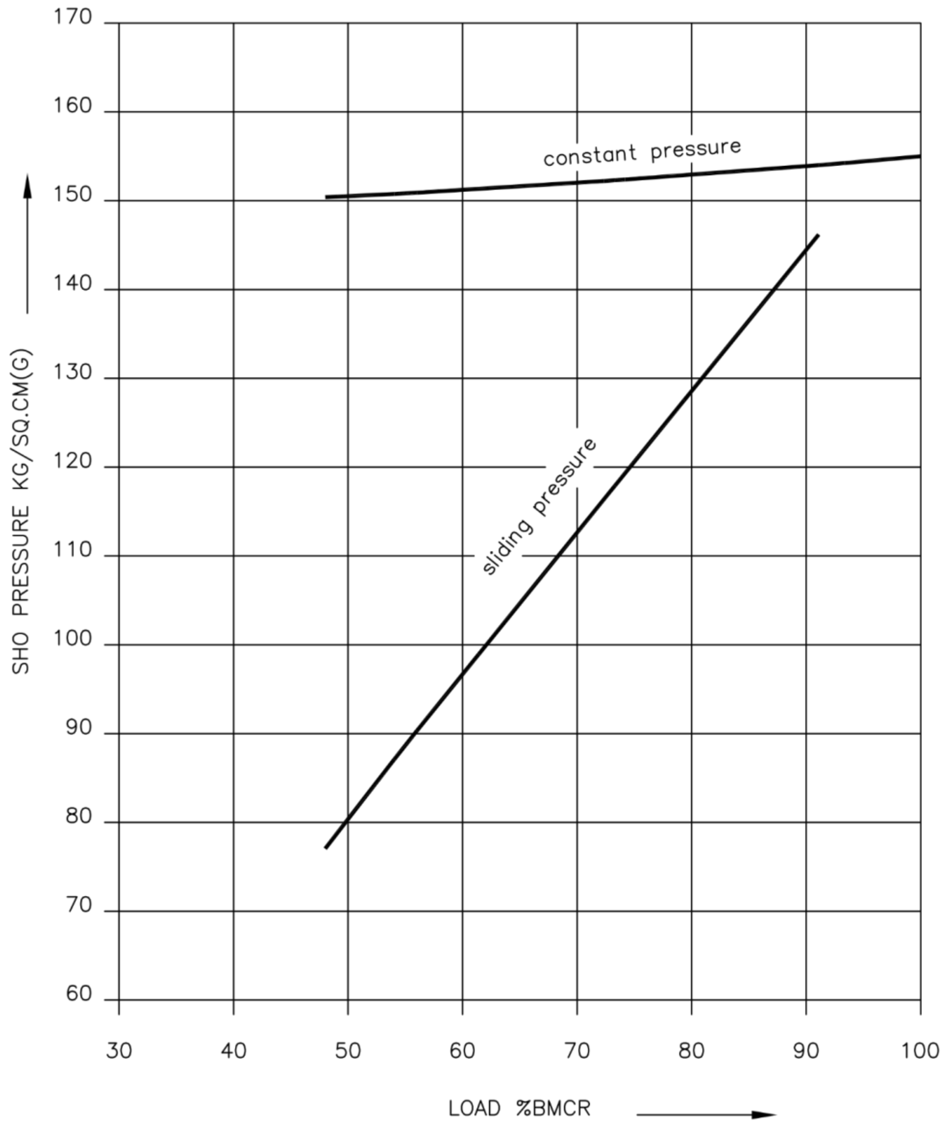
Coordinated Master Control in Service (CMC)

Coordinated Master Control interfaces the turbine and boiler control together by generating boiler demand with Turbine Target Load point and Coordinated -Master Control point and M.S. pressure set point. Coordinated Master Control can be put in service generally after turbine is loaded to 60% loads.

Ensure the following

1. From the Turbine EHTC Graphic, check the following: -
   a) Load control – ON
   b) Pressure Control Mode – LP Mode Selection
2. Coordinate Master Control- Put the Throttle Pressure Set point same as the running pressure (Ensure Operator mode selection: Constant pressure mode graphics. The pressure set point on EHTC graphic and CMC graphic should be same).
3. Put all the mills in Auto and then put the 'fuel master' in Auto from Graphic of Fuel Flow Control.
4. Put the 'Boiler Master Control' in Auto
5. Put the Turbine in CMC mode from Graphic
6. Click on "CMC" tab in graphic
7. Ensure "Co-ordinated" is flashing in Red colour.
8. Unit Load will be maintained as per operator set point.

SHO PRESSURE Vs LOAD



Project :	NTPC/Bongaigaon TPP – 3x250MW							Sheet 3 of 11
Cont No:	0397–0399		Rev.1		Rev.2		Rev.3	
	Sign.	Date	Sign.	Date	Sign.	Date	Sign.	Date
Engineer: JLJ								
Reviewer: MA								
Approver: MA/SCS								

CPT –1801

Lowering Load –Thermal Backing Operation (55 % Operation Training)

State of Plant - Ensure

- M/C on Load.
- SH/RH spray control on auto.
- Drum level control on auto.
- Furnace pressure control on auto.
- Aux. Steam pressure/temp. Control on auto.
- Ensure igniters and oil guns are in position to be operated in case of requirement
- Mill temp. On auto.
- PA control on auto.
- Burner Tilt system are in alignment with all corners
- SADC on auto.
- HFO temp is adequate.
- Six mills are in service.
- AB, CD, EF elevation oil guns are available.
- Burner Tilt operation OK.
- HP /LP bypass on auto.
- EBD is available for operation.
- FRS high range in service and low range is available.
- Fire fighting equipment's are available.
- WW & APH Soot blowing system is available.
- Feed water flow management in lined condition with TDBFP.
- SH/RH Spray Control in auth with Set points.
- TG Governor & LL setting should be proper.

1. Check HP / LP bypass operation is O.K. and again ensure furnace to wind box dP in Auto Mode. Mills outlet Temperature should be in the range of 65 to 80 Deg C for Indian and Imported Coal.
2. Machine is still in CMC mode; reduce the load gradually from graphics from "OPR LOAD SP" Tab.
3. Steam flow will be reduced, Allow the pressure to drop with the reduction in load.
4. Observe the reduction rate of temperature prescribed by the manufacturer for turbine but never exceeding the forced cooling rate of boiler if required to regulate load to maintain MS and HRH temperature constant.
5. Check Throttle Pressure and Actual Pressure for any wide variation difference.
6. Adjust air flow for required O2 % and Monitor CO.
7. Again reduce the load gradually and check the conditions of Boiler and Turbine, Machine is still in CMC operation.

8. Reduce the up to from 210 MW to 125 MW in the step manner with time stamping of load 2 to 5 MW per minute and observe the Critical parameters. Ramp Down rate up to 55% should be such that it should be in the range of 1.0 to 2.0 % (2 to 5 MW per minute) to make stable parameters. In case of wide variation in parameters, lets parameter to be made stable and observe the position of different parameters and let them to stabilize. Boiler flame stability is very important during ramp down or ramp up process. Every moment of time availability and reliability of mills and feeder needs to be ensured.
9. If Machine is old age More than 12-15 years, please ensure
   - Feed flow
   - Air Flow
   - PA Header Flow
   - Furnace Pressure Control
   - Fuel Flow control
   - Check also bypasses operations.
10. Bring out machine from CMC mode around 135-150 MW and manually reduce the load from the CMC graphics from Tab "LOAD REF/LOAD SP.
11. Close the extraction of HP heaters and bring out HP heaters charging and observe the HP heaters.
12. Further reduce the load and reduce the coal firing and gradually bring out one coal mill from service and if required take two mills but support with oil if unit is old.
13. Reduce Coal demand further and still coal master in auto and check further all critical parameters. Change over from TDBFP to MDBFP, if required.
14. Load Operation need fine control for drum level, drum pressure. If at any moments of time, flame disturbed wide fluctuation may be observed in drum. If required support of oil guns to be taken immediately and ensure pair mode and elevation mode should be available at respective elevation.
15. Density difference at lower load with respect to water and steam is very important for stable operation and balanced load profile.
16. Soot blowing at lower load is to be avoided as it make disturbance in the Flame and Furnace draft.
17. Reduction in Turbine load also reflect disturbance in Condenser vacuum, which need to be monitored perfectly.
18. Metal Temperature and Air Pre-heater, SCAPH Temperature needs to be monitored.
19. In case of Disturbance in Load, Control the MS Pressure and Feed water to avoid tripping & Ensure flame stability.
20. For Older Units, Control System and Control Loops Tuning are required. Some Loops and Sub-loops Control Response are slow, which need to be retuned for ramp up and ramp down as per unit operation and Design Specification, Technical documents.

ANNEXURE II

Details of Available Simulators of Thermal Power Plants:

S.No	Name of the Utility	No. of Simulators with Capacity	Location	Supplier
1	NPTI	210/500 MW	Faridabad, Durgapur, Nagpur, Banglore, Shivpuri, Alapuzzha	M/s Emerson
2	KSTPS , KOTA	01 – 195MW	Kota Super Thermal Power Station (KSTPS), Kota	STEAG ENERGY Pvt. Ltd., Noida, New Delhi
3	SSTPS, Suratgarh	01 – 250 MW	Suratgarh Super Thermal Power Station (SSTPS), Suratgarh, Baran	STEAG ENERGY Pvt. Ltd., Noida, New Delhi
4	Jindal Power Limited , Tamnar ,Raigarh	01 – 600 MW	Jindal Institute of Power Technology, Jindal Power Limited , Tamnar, Raigarh,	BHEL Make Plant – Supplier M/S Honeywell
5	Jindal Power Limited , Tamnar ,Raigarh	01 – 250 MW	Jindal Institute of Power Technology, Jindal Power Limited , Tamnar, Raigarh,	BHEL Make Plant – Supplier M/S Honeywell
6	Jindal Power Limited , Tamnar ,Raigarh	01 – 135 MW	Jindal Institute of Power Technology, Jindal Power Limited , Tamnar, Raigarh,	CFBC boiler – Supplier M/S Emerson
7	Guru Gobind Singh Super Thermal Plant Ropar (PSPCL)	06 – 210MW	Guru Gobind Singh Super Thermal Plant Ropar (PSPCL)	Tri-Angle Simulation Pvt. Ltd. Mumbai.
8	WBPDCL	01- 210MW	Bakreshwar Thermal Plant	GSE Solution
9	TANGEDCO	01 – 800 MW (under 37stablishment)	North Chennai Thermal Power project – III	M/s.- BHEL
10	TANGEDCO	Establishment of Simulators at Thermal Training Institute & Research Centre for 210 MW and 600 MW is under process		

11	CESC Limited	01 – 250MW	Budge Budge Generating Station, Pujali	STEAG Energy Services (India) Pvt. Ltd.
12	GSECL	01 – 500 , 660 , 800MW	Wanakbori Thermal Power Station	BHEL
13	MAHAGENCO	02 – 210MW	Nashik Training Centre	M/s Traingle Simulation Pvt. Ltd , Mumbai
14	MAHAGENCO	01 – 500MW	Nashik Training Centre	BHEL Max DNA Based
15	MAHAGENCO	02 – 660MW	Koradi Training Centre , Nagpur	Steag Energy Services (India) Pvt. Ltd.
16	MAHAGENCO	01 – 500MW	Training Sub Centre , CSTPS	M/s Traingle Simulation Pvt. Ltd , Mumbai
17	APGENCO	04 – 210MW	Traning institute, Dr. NTTPS, APGENCO	M/s BHEL, EDN, Banglore
18	APGENCO	01 – 500 MW	Traning institute, Dr. NTTPS, APGENCO	M/s BHEL, EDN, Banglore
19	APGENCO	01 – 600 MW	Traning institute, Dr. NTTPS, APGENCO	M/s BHEL, EDN, Banglore
20	NTPC LTD	01-500MW 01-250MW	Korba	Emerson Process Management
21	NTPC LTD	01-660MW	Sipat	Yokogawa Ltd
22	NTPC LTD	01-660MW 01-800 MW	Solapur	M/s Steag Ltd
23	TSGENCO	01-500 MW 01-800MW (Installation of LVS Pending in 800 MW Simulator)	CETD, Adm. Building, KTPS-VI, Paloncha, Kothagudem	M/s BHEL, EDN, Banglore

ANNEXURE III

NTPC Group Coal Station Details: Operating at 55% MTL

S.No	NTPC Coal Stations	State	Installed Capacity (MW)
1	Singrauli	Uttar Pradesh	2000
2	Rihand	Uttar Pradesh	3000
3	Unchahar	Uttar Pradesh	1550
4	Tanda	Uttar Pradesh	1760
5	Dadri coal	Uttar Pradesh	1820
6	Mouda	Maharashtra	2320
7	Korba	Chhattisgarh	2600
8	Vindhyachal	Madhya Pradesh	4760
9	Sipat	Chhattisgarh	2980
10	Ramagundam	Telangana	2600
11	Simhadri	Andhra Pradesh	2000
12	Farakka	West Bengal	2100
13	Kahalgaon	Bihar	2340
14	Barh	Bihar	1980
15	Talcher kaniha	Odisha	3000
16	Bongaigaon	Assam	750
17	Kudgi	Karnataka	2400
18	Solapur	Maharashtra	1320
19	Gadarwara	Madhya Pradesh	1600
20	Lara	Chhattisgarh	1600
21	Barauni	Bihar	720
22	Darlipalli	Odisha	1600
23	Khargone	Madhya Pradesh	1320
	NTPC COAL		**48120**

JV and Subsidiaries

1	Bhilai PP III	Chhattisgarh	500
2	Kanti	Bihar	390
3	Jhajjar	Haryana	1500
4	Vallur	Tamilnadu	1500
5	BRBCL	Bihar	1000
6	NPGCL	Bihar	1980
7	Meja	Uttar Pradesh	1320
			8190
	TOTAL NTPC GROUP		**56310**

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. No. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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PART III—Section 4
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PUBLISHED BY AUTHORITY

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No. 834]	**NEW DELHI, FRIDAY, DECEMBER 15, 2023/AGRAHAYANA 24, 1945**

केंद्रीय विद्युत प्राधिकरण

अधिसूचना

नई दिल्ली, 15 दिसम्बर , 2023

सं. केविप्रा-टीएच-14-21/5/2023-टीआरएम प्रभाग.—केंद्रीय विद्युत प्राधिकरण (कोयला आधारित तापीय उत्पादन इकाइयों का बहुमुखी संचालन) विनियम, 2023 को सीईए-टीएच-17-13/4/2022-टीईटीडी डिवीजन दिनांक 30 जनवरी, 2023 के तहत केंद्रीय विद्युत प्राधिकरण द्वारा अधिसूचित किया गया था;

और जबकि उक्त विनियमों के विनियम 5 के उप-विनियमन (2) में यह अपेक्षा की गई है कि कोयला आधारित ताप विद्युत उत्पादन इकाइयों के बहुमुखी प्रचालन का कार्यान्वयन प्राधिकरण द्वारा समय-समय पर विनिर्दिष्ट चरणबद्ध योजना के अनुसार होगा;

और जबकि हितधारकों की टिप्पणियों को शामिल करने के बाद चरणबद्ध योजना को अंतिम रूप दिया गया है। प्राधिकरण द्वारा अनुमोदित अंतिम चरण योजना अनुलग्नक में दी गई है।

अनुलग्नक

(चरणबद्ध योजना)

1. उपियोगिताएं नीचे उल्लिखित चरणबद्ध योजना के विभिन्न चरणों के तहत निर्धारित अवधि के भीतर इकाइयों को पूरी तरह से संशोधित करेंगी।

2. उपियोगिताओं को चरणबद्ध योजना में प्रत्येक इकाई के लिए उल्लिखित एक महीने की अधिकतम शटडाउन अवधि का लाभ उठाना होगा।

3. जहां तक संभव हो, उपियोगिताओं को वार्षिक ओवर हॉल (एओएच) अवधि के साथ बहुमुखी प्रचालन के लिए उन्नयन/रेट्रोफिट कार्यों की शटडाउन अवधि से मेल खाना चाहिए।

4. उपियोगिता संबंधित क्षेत्रीय विद्युत समिति (आरपीसी) के समन्वय से बहुमुखी प्रचालन के लिए उन्नयन/रेट्रोफिट कार्यों के लिए इकाइयों की शटडाउन अवधि की योजना बनाएंगी।

5. चरणबद्ध योजना के तहत निम्नलिखित पांच चरणों की पहचान की गई है जिसमें एक प्रारम्भिक चरण भी शामिल है:

I. चरण – प्राम्भिक

अवधि: मार्च, 2024 तक पूरा किया जाना है

इस चरण के तहत, विभिन्न ताप विद्युत संयंत्रों की कुल 5850 मेगावाट (मेगावाट) क्षमता की निम्नलिखित 10 इकाइयों की योजना बनाई गई है और उनकी पहचान की गई है जिसके बहुमुखी प्रचालन के लिए अध्ययन, फील्ड परीक्षण, रेट्रोफिट आदि पहले ही शुरू किए जा चुके हैं। बहुमुखी संचालन के लिए उन्नयन/रेट्रोफिटिंग का कार्य 31 मार्च, 2024 से पहले पूरा किया जाना है।

	प्रारंभिक चरण (मई, 2023 - मार्च, 2024)					
चरण	**सेक्टर**	**संगठन**	**परियोजना का नाम**	**इकाई न.**	**क्षमता (मे.वा.)**	**क्षेत्र**
प्रारम्भिक	केन्द्रीय	एन टी पी सी	मउदा टी पी एस	1	500	प. क्षे.
प्रारम्भिक	केन्द्रीय	एन टी पी सी	सिम्हादरी	3	500	द. क्षे.
प्रारम्भिक	केन्द्रीय	एन टी पी सी	दादरी	6	490	उ. क्षे.
प्रारम्भिक	केन्द्रीय	डी वी सी	मेजिया टी पी एस	8	500	पू. क्षे.
प्रारम्भिक	केन्द्रीय	नेवेली लिग्नाइट	नेवेली न्यू टी पी पी	2	500	द. क्षे.
प्रारम्भिक	राज्य	के पी सी एल	यरमारस टी पी एस	1	800	द. क्षे.
प्रारम्भिक	राज्य	जी एस ई सी एल	वानकबोरी टी पी पी	6	800	प. क्षे.
प्रारम्भिक	राज्य	आर आर वी यू एन एल	सूरतगढ़ एस सी टी पी पी	8	660	उ. क्षे.
प्रारम्भिक	राज्य	डब्ल्यू बी पी डी सी	सागरदिघी टी पी एस	3	500	पू. क्षे.
प्रारम्भिक	निजी	सी ई पी एल	मुथियारा	2	600	द. क्षे.
कुल प्रारम्भिक चरण				**10**	**5850**	

II. चरण -I

अवधि: जुलाई, 2024 से जून, 2026 तक

इस चरण के अंतर्गत, विभिन्न ताप विद्युत संयंत्रों की कुल मिलाकर 51080 मेगावाट क्षमता की निम्नलिखित इकाइयों की योजना बनाई गई है और बहुमुखी प्रचालन के लिए उन्नयन/रेट्रोफिटिंग के लिए उनकी पहचान की गई है जिसमें अध्ययन और क्षेत्र परीक्षण सहित इस चरण को 2 वर्षों के भीतर यानी जुलाई, 2024 से जून, 2026 तक पूरा किया जाना है।

		चरण 1 (जुलाई, 2024 - जून, 2026)								
वर्ष	**माह**	**चरण**	**सेक्टर**	**संगठन**	**परियोजना का नाम**	**इकाई न.**	**क्षमता (मे.वा.)**	**कमिशनिंग की तिथि**	**पिट हेड**	**क्षेत्र**
2024	नवंबर	चरण 1	राज्य	यू पी आर वी यू एन एल	हरदुआगंज टी पी एस	10	660	1/29/2022	नहीं	उ. क्षे.
2024	नवंबर	चरण 1	निजी	जी पी जी एस एल(जीवीके)	गोइंदवाल साहिब	2	270	3/15/2016	नहीं	उ. क्षे.
2024	नवंबर	चरण 1	राज्य	ए पी पी डी सी एल	दामोदरम संजीवैया टी पी एस	3	800	3/9/2023	नहीं	द. क्षे.
2024	नवंबर	चरण 1	राज्य	टी एस जी ई एन सी ओ	भद्राद्री टी पी पी	4	270	1/9/2022	नहीं	द. क्षे.
2024	नवंबर	चरण 1	राज्य	टी ए एन जी ई डी	मेट्टूर टी पी एस-II	1	600	10/11/2012	नहीं	द. क्षे.

				सी ओ						
2024	नवंबर	चरण 1	केन्द्रीय	एन टी पी सी	गदरवारा टी पी पी	2	800	2/16/2021	नहीं	प. क्षे.
2024	नवंबर	चरण 1	निजी	आर के एम पी पी एल	उचपिनदा टी पी पी	3	360	9/12/2017	नहीं	प. क्षे.
2024	नवंबर	चरण 1	केन्द्रीय	एन टी पी सी	मउदा टी पी एस	3	660	3/28/2016	नहीं	प. क्षे.
2024	नवंबर	चरण 1	निजी	ए पी एल	मुन्दरा टी पी एस	8	660	3/3/2012	नहीं	प. क्षे.
2024	नवंबर	चरण 1	केन्द्रीय	डी वी सी	बोकारो टी पी एस `ए ` EXP	1	500	3/22/2016	नहीं	पू. क्षे.
	नवंबर कुल					**10**	**5580**			
2024	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	6	660	3/31/2021	नहीं	उ. क्षे.
2024	दिसम्बर	चरण 1	निजी	जी पी जी एस एल (जीवीके)	गोइंदवाल साहिब	1	270	2/14/2016	नहीं	उ. क्षे.
2024	दिसम्बर	चरण1	निजी	आई टी पी सी एल	आई टी पी सी एल टी पी पी	2	600	4/18/2016	नहीं	द. क्षे.
2024	दिसम्बर	चरण 1	निजी	एच एन पी सी	विजग टी पी पी	2	520	3/30/2016	नहीं	द. क्षे.
2024	दिसम्बर	चरण1	केन्द्रीय	एन टी पी सी	सिम्हादरी	4	500	3/30/2012	नहीं	द. क्षे.
2024	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी सी	लारा टी पी पी	2	800	7/12/2020	नहीं	प. क्षे.
2024	दिसम्बर	चरण1	निजी	रत्न इंडिया	नासिक (पी) टी पी एस	5	270	5/30/2017	नहीं	प. क्षे.
2024	दिसम्बर	चरण 1	निजी	ए पी एल	रायखेड़ा टी पी पी	2	685	3/28/2016	नहीं	प. क्षे.
2024	दिसम्बर	चरण 1	निजी	सी जी पी एल	मुन्दरा यू एम टी पी पी	1	800	2/25/2012	नहीं	प. क्षे.
2024	दिसम्बर	चरण 1	निजी	आई बी पी आई एल	उत्कल टी पी पी (इंड बराठ)	1	350	2/25/2016	नहीं	पू. क्षे.
	दिसम्बर कुल					**10**	**5455**			
2025	जनवरी	चरण 1	केन्द्रीय	एन टी पी सी	मेजा एस टी पी पी	2	660	1/12/2021	नहीं	उ. क्षे.
2025	जनवरी	चरण 1	निजी	एस पी पी एल	थूथुकुडी एस टी IV	1	525	11/30/2021	नहीं	द. क्षे.
2025	जनवरी	चरण 1	राज्य	एस सी सी एल	सिंगरेनी टी पी पी	1	600	3/13/2016	नहीं	द. क्षे.
2025	जनवरी	चरण 1	केन्द्रीय	एन टी ई सी एल	वल्लूर टी पी पी	1	500	3/28/2012	नहीं	द. क्षे.
2025	जनवरी	चरण 1	केन्द्रीय	एन टी पी सी	खरगोन एस टी पी पी	2	660	3/24/2020	नहीं	प. क्षे.
2025	जनवरी	चरण 1	निजी	रत्न इंडिया	नासिक (पी) टी पी एस	4	270	5/19/2017	नहीं	प. क्षे.
2025	जनवरी	चरण 1	निजी	बालको	बालको टी पी एस	2	300	3/24/2016	नहीं	प. क्षे.
2025	जनवरी	चरण 1	केन्द्रीय	डी वी सी	रघुनाथपुर टी पी पी	2	600	1/18/2016	नहीं	पू. क्षे.
	जनवरी कुल					**8**	**4115**			
2025	फ़रवरी	चरण 1	राज्य	आर आर वी यू एन एल	सूरतगढ़ एस टी पी पी	7	660	3/15/2020	नहीं	उ. क्षे.
2025	फ़रवरी	चरण 1	केन्द्रीय	एन टी पी सी	उन्चाहर टी पी एस	5	210	9/28/2006	नहीं	उ. क्षे.
2025	फ़रवरी	चरण 1	राज्य	टी एस जी ई एन सी ओ	भद्राद्री टी पी पी	3	270	3/26/2021	नहीं	द. क्षे.
2025	फ़रवरी	चरण 1	राज्य	के पी सी एल	बेल्लारी टी पी एस	3	700	3/1/2016	नहीं	द. क्षे.
2025	फ़रवरी	चरण 1	केन्द्रीय	एन टी पी सी	खरगोन एस टी पी पी	1	660	9/29/2019	नहीं	प. क्षे.
2025	फ़रवरी	चरण 1	निजी	एस के एस	बिन्जकोते टी पी पी	2	300	4/25/2017	नहीं	प. क्षे.
2025	फ़रवरी	चरण 1	निजी	जे एच ए पी एल	सेइओनि टी पी पी	1	600	3/22/2016	नहीं	प. क्षे.
2025	फ़रवरी	चरण 1	केन्द्रीय	एन टी पी सी	कुदगी एस टी पी पी	1	800	12/25/2016	नहीं	द. क्षे.
	फ़रवरी कुल					**8**	**4200**			
2025	मार्च	चरण 1	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	5	660	9/28/2019	नहीं	उ. क्षे.
2025	मार्च	चरण1	राज्य	टी एस जी ई एन सी ओ	भद्राद्री टी पी पी	2	270	12/7/2020	नहीं	द. क्षे.
2025	मार्च	चरण 1	निजी	एस ई आई एल	पैनामपुरम टी पी पी	2	660	9/3/2015	नहीं	द. क्षे.
2025	मार्च	चरण 1	निजी	टी आर एन ई	नवापारा टी पी पी	2	300	4/18/2017	नहीं	प. क्षे.
2025	मार्च	चरण 1	राज्य	एम ए एच ए जी ई एन सी ओ	चंद्रपुर (महाराष्ट्र) एस टी पी एस	9	500	3/21/2016	नहीं	प. क्षे.
2025	मार्च	चरण 1	निजी	टी एस पी एल	तलवंडी साबो टी पी पी	3	660	3/29/2016	नहीं	उ. क्षे.
2025	मार्च	चरण 1	राज्य	सी एस पी जी सी एल	मारवा टी पी एस	2	500	7/15/2016	नहीं	प. क्षे.
2025	मार्च	चरण 1	निजी	सी जी पी एल	मुन्द्रा यू एम टी पी पी	3	800	10/16/2012	नहीं	प. क्षे.

2025	मार्च	चरण 1	राज्य	एस सी सी एल	सिंगरेनी टी पी पी	2	600	11/25/2016	नहीं	द. क्षे.
	मार्च कुल					**9**	**4950**			
2025	जुलाई	चरण 1	राज्य	आर आर वी यू एन एल	छबडा टी पी पी	6	660	3/29/2019	नहीं	उ. क्षे.
2025	जुलाई	चरण 1	राज्य	टी एस जी ई एन सी ओ	भद्राद्री टी पी पी	1	270	6/5/2020	नहीं	द. क्षे.
2025	जुलाई	चरण 1	केन्द्रीय	एन टी पी एल	थूथूकुडी (जे वी) टी पी पी	2	500	7/9/2015	नहीं	द. क्षे.
2025	जुलाई	चरण 1	केन्द्रीय	एन टी पी सी	गदरवारा टी पी पी	1	800	3/29/2019	नहीं	प. क्षे.
2025	जुलाई	चरण 1	निजी	रतन इंडिया	नासिक (पी) टी पी एस	3	270	4/14/2017	नहीं	प. क्षे.
2025	जुलाई	चरण 1	निजी	एस ई आई एल	एस जी पी एल टी पी पी	1	660	11/12/2016	नहीं	द. क्षे.
2025	जुलाई	चरण 1	राज्य	एम ए एच ए जी ई एन सी ओ	कोराड़ी टी पी एस	9	660	3/15/2016	नहीं	प. क्षे.
	जुलाई कुल					**7**	**3820**			
2025	नवंबर	चरण 1	केन्द्रीय	एन टी पी सी	मेजा एस टी पी पी	1	660	3/31/2018	नहीं	उ. क्षे.
2025	नवंबर	चरण 1	राज्य	टी एस जी ई एन सी ओ	कोथागुडेम टी पी एस (स्तर-7)	12	800	12/26/2018	नहीं	द. क्षे.
2025	नवंबर	चरण 1	राज्य	ए पी पी डी सी एल	दामोदरम संजीवैया टी पी एस	2	800	3/17/2015	नहीं	द. क्षे.
2025	नवंबर	चरण 1	राज्य	एम पी पी जी सी एल	श्री सिंगाजी टी पी पी	4	660	3/27/2019	नहीं	प. क्षे.
2025	नवंबर	चरण 1	केन्द्रीय	एन टी पी सी	सोलापुर एस टी पी एस	1	660	4/7/2017	नहीं	प. क्षे.
2025	नवंबर	चरण 1	निजी	आर के एम पी पी एल	उचपिंदा टी पी पी	2	360	1/28/2016	नहीं	प. क्षे.
2025	नवंबर	चरण 1	केन्द्रीय	एन टी ई सी एल	वल्लूर टी पी पी	2	500	2/28/2013	नहीं	द. क्षे.
2025	नवंबर	चरण 1	निजी	सी जी पी एल	मुन्द्रा यू एम टी पी पी	2	800	7/17/2012	नहीं	प. क्षे.
2025	नवंबर	चरण 1	निजी	एस पी पी एल	शिरपुर टी पी पी	1	150	9/28/2017	नहीं	प. क्षे.
	नवंबर कुल					**9**	**5390**			
2025	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी सी	कुदगी एस टी पी पी	3	800	3/12/2018	नहीं	द. क्षे.
2025	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी एल	थूथूकुडी (जे वी) टी पी पी	1	500	3/10/2015	नहीं	द. क्षे.
2025	दिसम्बर	चरण 1	निजी	आर के एम पी पी एल	उचपिंदा टी पी पी	4	360	3/20/2019	नहीं	प. क्षे.
2025	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी सी	मउदा टी पी एस	4	660	3/18/2017	नहीं	प. क्षे.
2025	दिसम्बर	चरण 1	राज्य	टी ए एन जी ई डी सी ओ	उत्तरी चेन्नई टी पी एस	4	600	9/13/2013	नहीं	द. क्षे.
2025	दिसम्बर	चरण 1	केन्द्रीय	एन टी पी सी	लारा टी पी पी	1	800	3/23/2018	नहीं	प. क्षे.
2025	दिसम्बर	चरण 1	निजी	रतन इंडिया	अमरावती	5	270	3/12/2015	नहीं	प. क्षे.
	दिसम्बर कुल					**7**	**3990**			
2026	जनवरी	चरण 1	राज्य	आर आर वी यू एन एल	छबडा टी पी पी	5	660	4/4/2017	नहीं	उ. क्षे.
2026	जनवरी	चरण 1	राज्य	ए पी जी ई एन सी ओ	रायलसीमा टी पी एस	6	600	3/12/2018	नहीं	द. क्षे.
2026	जनवरी	चरण 1	निजी	एस ई आई एल	पैनामपुरम टी पी पी	1	660	2/7/2015	नहीं	द. क्षे.
2026	जनवरी	चरण 1	राज्य	एम पी पी जी सी एल	श्री सिंगाजी टी पी पी	3	660	11/18/2018	नहीं	प. क्षे.
2026	जनवरी	चरण 1	निजी	रतन इंडिया	नासिक (पी) टी पी एस	2	270	2/15/2017	नहीं	प. क्षे.
2026	जनवरी	चरण 1	राज्य	टी ए एन जी ई डी सी ओ	उत्तरी चेन्नई टी पी एस	5	600	3/9/2013	नहीं	द. क्षे.
2026	जनवरी	चरण 1	निजी	ए पी एल	मुन्द्रा टी पी एस	9	660	3/9/2012	नहीं	प. क्षे.
2026	जनवरी	चरण 1	निजी	डब्ल्यू पी सी एल	अकलतरा टी पी एस	2	600	1/18/2018	नहीं	प. क्षे.
2026	जनवरी	चरण 1	केन्द्रीय	एन टी पी सी	मउदा टी पी एस	2	500	3/29/2013	नहीं	प. क्षे.
	जनवरी कुल					**9**	**5210**			
2026	फ़रवरी	चरण 1	केन्द्रीय	एन टी पी सी	उन्चाहर टी पी एस	6	500	3/31/2017	नहीं	उ. क्षे.
2026	फ़रवरी	चरण 1	राज्य	के पी सी एल	यरमारस टी पी पी	2	800	3/29/2017	नहीं	द. क्षे.
2026	फ़रवरी	चरण 1	राज्य	ए पी पी डी सी एल	दामोदरम संजीवैया टी पी एस	1	800	8/28/2014	नहीं	द. क्षे.
2026	फ़रवरी	चरण 1	निजी	ए पी एल	माहन टी पी पी	2	600	10/7/2018	नहीं	प. क्षे.
2026	फ़रवरी	चरण 1	राज्य	एम ए एच ए जी ई एन सी ओ	कोराड़ी टी पी एस	10	660	12/28/2016	नहीं	प. क्षे.
2026	फ़रवरी	चरण 1	केन्द्रीय	एन टी पी सी	सोलापुर एस टी पी एस	2	660	3/30/2019	नहीं	प. क्षे.
2026	फ़रवरी	चरण 1	निजी	सी जी पी एल	मुन्द्रा यू एम टी पी पी	5	800	3/18/2013	नहीं	प. क्षे.
	फ़रवरी कुल					**7**	**4820**			
2026	मार्च	चरण 1	केन्द्रीय	एन टी पी सी	कुदगी एस टी पी पी	2	800	3/23/2017	नहीं	द. क्षे.
2026	मार्च	चरण 1	केन्द्रीय	एन टी ई सी एल	वल्लूर टी पी पी	3	500	2/28/2014	नहीं	द. क्षे.
2026	मार्च	चरण 1	निजी	एस के एस	बिन्जकोते टी पी पी	1	300	3/28/2018	नहीं	प. क्षे.
2026	मार्च	चरण 1	निजी	टी आर एन ई	नवापारा टी पी पी	1	300	8/14/2016	नहीं	प. क्षे.
2026	मार्च	चरण 1	राज्य	एम ए एच ए जी	पारली टी पी एस	8	250	3/30/2016	नहीं	प. क्षे.

				ई एन सी ओ						
2026	मार्च	चरण I	निजी	एम बी पी एम पी एल	अनुप्पुर टी पी पी	2	600	3/30/2016	नहीं	प. क्षे.
2026	मार्च	चरण I	निजी	सी जी पी एल	मुन्द्रा यू एम टी पी पी	4	800	1/16/2013	नहीं	प. क्षे.
	मार्च कुल					**7**	**3550**			
	कुल इकाईयाँ एवं क्षमता (चरण I)					**91**	**51080**			

III. चरण - II

अवधि: जुलाई, 2026 से जून, 2028

इस चरण के अंतर्गत, विभिन्न ताप विद्युत संयंत्रों की कुल मिलाकर 46825 मेगावाट क्षमता की निम्नलिखित 100 इकाइयों की योजना बनाई गई है और अध्ययन और फील्ड परीक्षणों सहित बहुमुखी प्रचालन वास्ते उन्नयन/रेट्रोफिटिंग के लिए उनकी पहचान की गई है। इस चरण को 2 वर्षों के भीतर यानी जुलाई, 2026 से जून, 2028 तक पूरा किया जाना है।

			चरण II (जुलाई, 2026 –जून, 2028)						
वर्ष	**माह**	**सेक्टर**	**संगठन**	**परियोजना का नाम**	**इकाई न.**	**क्षमता (मे. वा.)**	**कमिशनिंग की तिथि**	**पिट हेड**	**क्षेत्र**
2026	जुलाई	निजी	आर के एम पी पी एल	उच्चपिंडा टी पी पी	1	360	10/28/2015	नहीं	प. क्षे.
2026	जुलाई	निजी	जे पी एल	तमनार टी पी पी	1	600	1/7/2015	नहीं	प. क्षे.
2026	जुलाई	निजी	डी बी पी सी एल	बरदर्हा टी पी एस	1	600	2/23/2014	नहीं	प. क्षे.
2026	जुलाई	निजी	ए पी एल	माहन टी पी पी	1	600	2/24/2013	नहीं	प. क्षे.
2026	जुलाई	निजी	एस ई आई एल	एस जी पी एल टी पी पी	2	660	2/15/2017	नहीं	द. क्षे.
2026	जुलाई	केन्द्रीय	एन टी पी सी	उत्तरी करनपुरा एस टी पी पी	1	660	1/18/2023	नहीं	पू.क्षे.
2026	जुलाई	निजी	ए डी एच यू एन आई के	महादेव प्रसाद एस टी पी पी	2	270	3/29/2013	नहीं	पू.क्षे.
2026	जुलाई	केन्द्रीय	एन टी पी सी	बोंगाईगाँव टी पी पी	3	250	3/23/2019	नहीं	उ.पू.क्षे.
	जुलाई कुल				**8**	**4000**			
2026	अगस्त	राज्य	जी एस ई सी एल	सिक्का REP. टी पी एस	4	250	9/25/2015	नहीं	प. क्षे.
2026	अगस्त	राज्य	एम पी पी जी सी एल	श्री सिंगाजी टी पी पी	2	600	10/15/2014	नहीं	प. क्षे.
2026	अगस्त	निजी	रतन इंडिया	अमरावती टी पी एस	2	270	2/17/2014	नहीं	प. क्षे.
2026	अगस्त	निजी	जी एम आर एनर्जी	जी एम आर वरोरा टी पी एस	1	300	2/7/2013	नहीं	प. क्षे.
2026	अगस्त	राज्य	टी एस जी ई एन सी ओ	काकतीय टी पी एस	2	600	12/31/2015	नहीं	द. क्षे.
2026	अगस्त	केन्द्रीय	एन पी जी सी एल	नबीनगर एस टी पी पी	3	660	3/6/2022	नहीं	पू. क्षे.
2026	अगस्त	केन्द्रीय	एन टी पी सी	मुजफ्फरपुर टी पी एस	4	195	3/24/2016	नहीं	पू. क्षे.
2026	अगस्त	निजी	जी एम आर एनर्जी	कमलंगा टी पी एस	1	350	3/29/2013	नहीं	पू. क्षे.
	अगस्त कुल				**8**	**3225**			
2026	नवंबर	निजी	एम सी सी पी एल	बन्दाखर टी पी पी	1	300	6/19/2015	नहीं	प. क्षे.
2026	नवंबर	निजी	ए पी एल	तिरोरा टी पी एस	5	660	9/25/2014	नहीं	प. क्षे.
2026	नवंबर	राज्य	एम पी पी जी सी एल	सतपुड़ा टी पी एस	11	250	12/25/2013	नहीं	प. क्षे.
2026	नवंबर	निजी	एच एन पी सी	विज़ग टी पी पी	1	520	12/27/2015	नहीं	द. क्षे.
2026	नवंबर	केन्द्रीय	एन टी पी सी	नबीनगर टी पी पी	4	250	11/10/2021	नहीं	पू. क्षे.
2026	नवंबर	केन्द्रीय	डी वी सी	कोडरमा टी पी पी	2	500	2/15/2013	नहीं	पू. क्षे.
2026	नवंबर	केन्द्रीय	एन टी पी सी	बोंगाईगाँव टी पी पी	1	250	6/22/2015	नहीं	उ.पू.क्षे.
2026	नवंबर	राज्य	आर आर वी यू एन एल	कालीसिंध टी पी एस	2	600	6/6/2015	नहीं	उ. क्षे.
	नवंबर कुल				**8**	**3330**			
2026	दिसम्बर	निजी	बालको	बालको टी पी एस	1	300	6/4/2015	नहीं	प. क्षे.
2026	दिसम्बर	निजी	जे पी पी वी एल	निगरी टी पी पी	1	660	8/29/2014	नहीं	प. क्षे.
2026	दिसम्बर	राज्य	एम पी पी जी सी एल	श्री सिंगाजी टी पी पी	1	600	11/18/2013	नहीं	प. क्षे.
2026	दिसम्बर	निजी	आई टी पी सी एल	आई टी पी सी एल टी पी पी	1	600	9/19/2015	नहीं	द. क्षे.
2026	दिसम्बर	केन्द्रीय	एन टी पी सी	बर I	1	660	10/30/2021	नहीं	पू. क्षे.
2026	दिसम्बर	केन्द्रीय	एन टी पी सी	मुजफ्फरपुर टी पी एस	3	195	3/31/2015	नहीं	पू. क्षे.
2026	दिसम्बर	निजी	ए डी एच यू एन आई के	महादेव प्रसाद एस टी पी पी	1	270	11/19/2012	नहीं	पू. क्षे.
2026	दिसम्बर	निजी	एन पी एल	राजपुरा टी पी पी	2	700	7/6/2014	नहीं	उ. क्षे.
	दिसम्बर कुल				**8**	**3985**			
2027	जनवरी	निजी	एम बी पी एम पी एल	अनुप्पुर टी पी पी	1	600	4/20/2015	नहीं	प. क्षे.

2027	जनवरी	निजी	डब्ल्यू पी सी एल	अकलतरा टी पी एस	4	600	8/22/2014	नहीं	प. क्षे.
2027	जनवरी	निजी	डी आई पी एल	धारीवाल टी पी पी	1	300	11/3/2013	नहीं	प. क्षे.
2027	जनवरी	निजी	सी ई पी एल	मुथियारा टी पी पी	1	600	12/2/2014	नहीं	द. क्षे.
2027	जनवरी	केन्द्रीय	एन टी पी सी	न्यू नबीनगर टी पी पी	2	660	3/31/2021	नहीं	पू. क्षे.
2027	जनवरी	केन्द्रीय	एन टी पी सी	बर II	5	660	3/4/2015	नहीं	पू. क्षे.
2027	जनवरी	निजी	एम पी एल	मैथोन आर बी टी पी पी	2	525	3/31/2012	नहीं	पू. क्षे.
2027	जनवरी	निजी	टी एस पी एल	तलवंडी साबो टी पी पी	1	660	6/17/2014	नहीं	उ. क्षे.
	जनवरी कुल				**8**	**4605**			
2027	फ़रवरी	राज्य	महाजेनको	कोराड़ी टी पी एस	8	660	3/30/2015	नहीं	प. क्षे.
2027	फ़रवरी	निजी	डी आई पी एल	धारीवाल टी पी पी	2	300	5/28/2014	नहीं	प. क्षे.
2027	फ़रवरी	निजी	जी एम आर एनर्जी	जी एम आर वरोरा टी पी एस	2	300	8/27/2013	नहीं	प. क्षे.
2027	फ़रवरी	केन्द्रीय	एन टी पी सी	न्यू नबीनगर टी पी पी	1	660	7/12/2019	नहीं	पू. क्षे.
2027	फ़रवरी	निजी	एच ई एल	हल्दिया टी पी पी	2	300	2/16/2015	नहीं	पू. क्षे.
2027	फ़रवरी	केन्द्रीय	डी वी सी	दुर्गापुर स्टील टी पी एस	2	500	3/23/2012	नहीं	पू. क्षे.
2027	फ़रवरी	राज्य	आर आर वी यू एन एल	कालीसिंध टी पी एस	1	600	5/2/2014	नहीं	उ. क्षे.
	फ़रवरी कुल				**7**	**3320**			
2027	मार्च	राज्य	जी एस ई सी एल	सिक्का REP. टी पी एस	3	250	3/29/2015	नहीं	प. क्षे.
2027	मार्च	निजी	वी वी एल	सलोरा टी पी पी	1	135	4/10/2014	नहीं	प. क्षे.
2027	मार्च	निजी	डब्ल्यू पी सी एल	अकलतरा टी पी एस	3	600	8/13/2013	नहीं	प. क्षे.
2027	मार्च	राज्य	महाजेनको	भुसावल टी पी एस	5	500	3/30/2012	नहीं	प. क्षे.
2027	मार्च	निजी	जे आई टी पी एल	देरंग टी पी पी	2	600	1/24/2015	नहीं	पू. क्षे.
2027	मार्च	निजी	एल पी जी सी एल	ललितपुर टी पी एस	1	660	3/26/2016	नहीं	उ. क्षे.
2027	मार्च	निजी	एन पी एल	राजपुरा टी पी पी	1	700	1/24/2014	नहीं	उ. क्षे.
	मार्च कुल				**7**	**3445**			
2027	जुलाई	राज्य	महाजेनको	चंद्रपुर (महाराष्ट्र) एस टी पी एस	8	500	3/29/2015	नहीं	प. क्षे.
2027	जुलाई	निजी	ए पी एल	अवंथा भंडार	1	600	3/31/2014	नहीं	प. क्षे.
2027	जुलाई	निजी	ए पी एल	तिरोरा टी पी एस	3	660	6/10/2013	नहीं	प. क्षे.
2027	जुलाई	निजी	एच ई एल	हल्दिया टी पी पी	1	300	1/14/2015	नहीं	पू. क्षे.
2027	जुलाई	राज्य	डब्ल्यू बी पी डी सी	सागरदिघी टी पी एस	4	500	12/15/2016	नहीं	पू. क्षे.
2027	जुलाई	निजी	टी एस पी एल	तलवंडी साबो टी पी पी	2	660	10/25/2015	नहीं	उ. क्षे.
2027	जुलाई	निजी	ए पी एल	कवाई टी पी एस	2	660	12/24/2013	नहीं	उ. क्षे.
	जुलाई कुल				**7**	**3880**			
2027	अगस्त	निजी	जे पी एल	तमनार टी पी पी	4	600	3/28/2015	नहीं	प. क्षे.
2027	अगस्त	निजी	वी आई पी	बुटीबोरी टी पी पी	1	300	3/31/2014	नहीं	प. क्षे.
2027	अगस्त	निजी	जे पी पी वी एल	बीना टी पी एस	2	250	3/31/2013	नहीं	प. क्षे.
2027	अगस्त	केन्द्रीय	एन टी पी सी	नबीनगर टी पी पी	3	250	2/26/2019	नहीं	पू. क्षे.
2027	अगस्त	केन्द्रीय	डी वी सी	रघुनाथपुर टी पी पी	1	600	8/24/2014	नहीं	पू. क्षे.
2027	अगस्त	निजी	एल पी जी सी एल	ललितपुर टी पी एस	2	660	1/8/2016	नहीं	उ. क्षे.
2027	अगस्त	निजी	ए पी एल	कवाई टी पी एस	1	660	5/28/2013	नहीं	उ. क्षे.
	अगस्त कुल				**7**	**3320**			
2027	नवंबर	निजी	डी बी पी सी एल	बरदर्हा टी पी एस	2	600	3/24/2015	नहीं	प. क्षे.
2027	नवंबर	राज्य	सी एस पी जी सी एल	मारवा टी पी एस	1	500	3/30/2014	नहीं	प. क्षे.
2027	नवंबर	निजी	ए पी एल	तिरोरा टी पी एस	2	660	3/25/2013	नहीं	प. क्षे.
2027	नवंबर	केन्द्रीय	एन टी पी सी	बरौनी टी पी एस	9	250	3/31/2018	नहीं	पू. क्षे.
2027	नवंबर	निजी	जे आई टी पी एल	देरंग टी पी पी	1	600	4/10/2014	नहीं	पू. क्षे.
2027	नवंबर	निजी	पी पी जी सी एल	प्रयागराज टी पी पी	2	660	9/6/2016	नहीं	उ. क्षे.
2027	नवंबर	राज्य	यू पी आर वी यू एन एल	परिच्छा टी पी एस	6	250	3/11/2013	नहीं	उ. क्षे.
	नवंबर कुल				**7**	**3520**			
2027	दिसम्बर	निजी	रतन इंडिया	अमरावती टी पी एस	4	270	3/4/2015	नहीं	प. क्षे.
2027	दिसम्बर	निजी	जे पी एल	तमनार टी पी पी	3	600	3/30/2014	नहीं	प. क्षे.
2027	दिसम्बर	केन्द्रीय	एन टी पी सी	बरौनी टी पी एस	8	250	1/11/2018	नहीं	पू. क्षे.
2027	दिसम्बर	राज्य	डी पी एल	डी. पी. एल. टी पी एस	8	250	3/31/2014	नहीं	पू. क्षे.
2027	दिसम्बर	केन्द्रीय	एन टी पी सी	नबीनगर टी पी पी	1	250	3/20/2016	नहीं	पू. क्षे.
2027	दिसम्बर	निजी	पी पी जी सी एल (टाटा)	प्रयागराज टी पी पी	3	660	5/22/2017	नहीं	उ. क्षे.
	दिसम्बर कुल				6	2280			
2028	जनवरी	निजी	जे पी पी वी एल	निगरी टी पी पी	2	660	2/27/2015	नहीं	प. क्षे.
2028	जनवरी	निजी	ए पी एल	तिरोरा टी पी एस	4	660	3/23/2014	नहीं	प. क्षे.
2028	जनवरी	राज्य	एम पी पी जी सी एल	सतपुड़ा टी पी एस	10	250	3/22/2013	नहीं	प. क्षे.
2028	जनवरी	निजी	एच एम ई एल	हिरंमाये टी पी पी	2	150	12/31/2017	नहीं	पू. क्षे.
2028	जनवरी	निजी	जी एम आर एनर्जी	कमलंगा टी पी एस	3	350	3/21/2014	नहीं	पू. क्षे.
2028	जनवरी	निजी	एल पी जी सी एल	ललितपुर टी पी एस	3	660	4/1/2016	नहीं	उ. क्षे.

	जनवरी कुल				**6**	**2730**			
2028	फ़रवरी	निजी	ए पी एल	रायखेडा टी पी पी	1	685	2/24/2015	नहीं	प. क्षे.
2028	फ़रवरी	निजी	जे पी एल	तमनार टी पी पी	2	600	3/10/2014	नहीं	प. क्षे.
2028	फ़रवरी	निजी	आई ई पी एल	बेला टी पी एस	1	270	3/20/2013	नहीं	प. क्षे.
2028	फ़रवरी	निजी	एच एम ई एल	हिरमाये टी पी पी	1	150	6/7/2017	नहीं	पू. क्षे.
2028	फ़रवरी	केन्द्रीय	एन टी पी सी	बोंगाईगाँव टी पी पी	2	250	3/22/2017	नहीं	उ.पू.क्षे.
2028	फ़रवरी	निजी	रतन इंडिया	अमरावती टी पी एस	1	270	3/25/2013	नहीं	प. क्षे.
2028	फ़रवरी	केन्द्रीय	एन टी पी सी	बर II	4	660	11/20/2013	नहीं	पू. क्षे.
	फ़रवरी कुल				**7**	**2885**			
2028	मार्च	निजी	रतन इंडिया	अमरावती टी पी एस	3	270	1/29/2015	नहीं	प. क्षे.
2028	मार्च	निजी	रतन इंडिया	नासिक (पी) टी पी एस	1	270	2/25/2014	नहीं	प. क्षे.
2028	मार्च	राज्य	जी एस ई सी एल	उकाई टी पी एस	6	500	3/5/2013	नहीं	प. क्षे.
2028	मार्च	केन्द्रीय	एन टी पी सी	नबीनगर टी पी पी	2	250	4/3/2017	नहीं	पू. क्षे.
2028	मार्च	निजी	पी पी जी सी एल (टाटा)	प्रयागराज टी पी पी	1	660	12/25/2015	नहीं	उ. क्षे.
2028	मार्च	निजी	जी एम आर एनर्जी	कमलंगा टी पी एस	2	350	9/28/2013	नहीं	पू. क्षे.
	मार्च कुल				**6**	**2300**			
				कुल इकाईयाँ एवं क्षमता (चरण II)	**100**	**46825**			

IV. चरण - III

इस चरण के अंतर्गत, विभिन्न ताप विद्युत संयंत्रों की कुल मिलाकर 37215 मेगावाट क्षमता की इकाइयों की निम्नलिखित 101 इकाइयों की योजना बनाई गई है और अध्ययन और फील्ड परीक्षणों सहित बहुमुखी प्रचालन वास्ते उन्नयन/ रेट्रोफिटिंग के लिए उनकी पहचान की गई है। इस चरण को 18 महीने की अवधि के भीतर यानी जुलाई, 2028 से दिसंबर, 2029 तक पूरा किया जाना है।

			चरण III (जुलाई , 2028 – दिसम्बर, 2029)						
वर्ष	**माह**	**सेक्टर**	**संगठन**	**परियोजना का नाम**	**इकाई न.**	**क्षमता (मे. वा.)**	**कमिशनिंग की तिथि**	**पिट हेड**	**क्षेत्र**
2028	जुलाई	निजी	आर. पी. एस. सी. एल.	रोज़ा टी पी पी चरण -II	3	300	12/28/2011	नहीं	उ. क्षे.
2028	जुलाई	राज्य	यू पी आर वी यू एन एल	परिच्छा टी पी एस	3	210	3/29/2006	नहीं	उ. क्षे.
2028	जुलाई	केन्द्रीय	नेवेली लिग्नाईट	नेवेली न्यू टी पी पी	1	500	12/20/2019	हाँ	द. क्षे.
2028	जुलाई	राज्य	ऐ पी जी ई एन सी ओ	रायलसीमा टी पी एस	4	210	11/20/2007	नहीं	द. क्षे.
2028	जुलाई	निजी	ऐ पी एल	मुन्द्रा टी पी एस	7	660	11/7/2011	नहीं	प. क्षे.
2028	जुलाई	निजी	जे एस डब्ल्यू ई एल	जे एस डब्ल्यू रत्नागिरी टी पी पी	1	300	8/24/2010	नहीं	प. क्षे.
2028	जुलाई	निजी	जे पी एल	ओ पी जिंदल टी पी एस	4	250	6/17/2008	नहीं	प. क्षे.
2028	जुलाई	केन्द्रीय	एन टी पी सी	दर्लिपाली एस टी पी एस	2	800	7/21/2021	हाँ	पू. क्षे.
2028	जुलाई	राज्य	डब्ल्यू बी पी डी सी	बकरेश्वर टी पी एस	5	210	12/24/2007	नहीं	पू. क्षे.
	जुलाई कुल				**9**	**3440**			
2028	अगस्त	राज्य	यू पी आर वी यू एन एल	हरदुआगंज टी पी एस	8	250	9/27/2011	नहीं	उ. क्षे.
2028	अगस्त	राज्य	टी एस जी ई एन सी ओ	कोथागुदेम टी पी एस (न्यू)	11	500	6/26/2011	नहीं	द. क्षे.
2028	अगस्त	राज्य	ए पी जी ई एन सी ओ	रायलसीमा टी पी एस	3	210	1/25/2007	नहीं	द. क्षे.
2028	अगस्त	निजी	जे एस डब्ल्यू ई एल	जे एस डब्ल्यू रत्नागिरी टी पी पी	4	300	10/8/2011	नहीं	प. क्षे.
2028	अगस्त	निजी	ए पी एल	मुन्द्रा टी पी एस	3	330	8/2/2010	नहीं	प. क्षे.
2028	अगस्त	केन्द्रीय	एन एस पी सी एल	भिलाई टी पी एस	1	250	4/20/2008	नहीं	प. क्षे.
2028	अगस्त	केन्द्रीय	एन टी पी सी	दर्लिपाली एस टी पी एस	1	800	12/30/2019	हाँ	पू. क्षे.
2028	अगस्त	केन्द्रीय	ए पी एल	तिरोरा टी पी एस	1	660	9/11/2012	नहीं	प. क्षे.
2028	अगस्त	केन्द्रीय	एन टी पी सी	इंदिरा गाँधी एस टी पी पी	3	500	11/7/2012	नहीं	उ. क्षे.
2028	अगस्त	राज्य	डब्ल्यू बी पी डी सी	सागरदिघी टी पी एस	2	300	12/21/2007	नहीं	पू. क्षे.
	अगस्त कुल				**10**	**4100**			

2028	नवंबर	राज्य	एच पी जी सी एल	राजीव गाँधी टी पी एस	2	600	10/1/2010	नहीं	उ. क्षे.
2028	नवंबर	निजी	ए पी एल	उडुपी टी पी पी	2	600	4/16/2011	नहीं	द. क्षे.
2028	नवंबर	केन्द्रीय	नेवेली लिग्नाईट	नेवेली (ई एक्स टी) टी पी एस	2	210	7/22/2003	हाँ	द. क्षे.
2028	नवंबर	राज्य	महाजेनको	खापरखेडा टी पी एस	5	500	8/5/2011	नहीं	प. क्षे.
2028	नवंबर	निजी	डब्ल्यू पी सी एल	वर्धा वरोरा टी पी पी	1	135	6/5/2010	नहीं	प. क्षे.
2028	नवंबर	निजी	जे पी एल	ओ पी जिंदल टी पी एस	3	250	3/6/2008	नहीं	प. क्षे.
2028	नवंबर	केन्द्रीय	डी वी सी	दुर्गापुर स्टील टी पी एस	1	500	7/29/2011	नहीं	पू. क्षे.
2028	नवंबर	निजी	जे पी पी वी एल	बीना टी पी एस	1	250	8/12/2012	नहीं	प. क्षे.
2028	नवंबर	राज्य	डी पी एल	डी पी एल टी पी एस	7	300	11/24/2007	नहीं	पू. क्षे.
	नवंबर कुल				**9**	**3345**			
2028	दिसम्बर	निजी	आर पी एस सी एल	रोज़ा टी पी पी चरण -I	2	300	6/26/2010	नहीं	उ. क्षे.
2028	दिसम्बर	राज्य	ए पी जेनको	रायलसीमा टी पी एस	5	210	12/31/2010	नहीं	द. क्षे.
2028	दिसम्बर	राज्य	के पी सी एल	रायचूर टी पी एस	7	210	12/11/2002	नहीं	द. क्षे.
2028	दिसम्बर	निजी	ए पी एल	मुन्द्रा टी पी एस	6	660	7/20/2011	नहीं	प. क्षे.
2028	दिसम्बर	राज्य	महाजेनको	पारस टी पी एस	2	250	3/27/2010	नहीं	प. क्षे.
2028	दिसम्बर	निजी	जे पी एल	ओ पी जिंदल टी पी एस	2	250	2/10/2008	नहीं	प. क्षे.
2028	दिसम्बर	केन्द्रीय	डी वी सी	कोडरमा टी पी पी	1	500	7/20/2011	नहीं	पू. क्षे.
2028	दिसम्बर	निजी	जे एच पी एल (एच आर)	महात्मा गाँधी टी पी एस	1	660	1/12/2012	नहीं	उ. क्षे.
2028	दिसम्बर	राज्य	डब्ल्यू बी पी डी सी	संतल्दी टी पी एस	5	250	11/7/2007	नहीं	पू. क्षे.
	दिसम्बर कुल				**9**	**3290**			
2029	जनवरी	राज्य	एच पी जी सी एल	राजीव गाँधी टी पी एस	1	600	3/31/2010	नहीं	उ. क्षे.
2029	जनवरी	निजी	ए पी एल	उडुपी टी पी पी	1	600	7/23/2010	नहीं	पू. क्षे.
2029	जनवरी	केन्द्रीय	नेवेली लिग्नाईट	नेवेली (ई एक्स टी) टी पी एस	1	210	10/21/2002	हाँ	पू. क्षे.
2029	जनवरी	निजी	जे एस डब्ल्यू ई एल	जे एस डब्ल्यू रत्नागिरी टी पी पी	3	300	5/6/2011	नहीं	प. क्षे.
2029	जनवरी	निजी	लैंको	पथादी टी पी पी	2	300	3/25/2010	नहीं	प. क्षे.
2029	जनवरी	राज्य	सी एस पी जी सी एल	डी एस पी एम टी पी एस	2	250	12/11/2007	नहीं	प. क्षे.
2029	जनवरी	निजी	एम पी एल	मैथोन आर बी टी पी पी	1	525	6/30/2011	नहीं	पू. क्षे.
2029	जनवरी	केन्द्रीय	एन टी पी सी	सिम्हादरी	2	500	8/24/2002	नहीं	द. क्षे.
2029	जनवरी	केन्द्रीय	डी वी सी	मेजिया टी पी एस	4	210	10/12/2004	नहीं	पू. क्षे.
	जनवरी कुल				**9**	**3495**			
2029	फ़रवरी	निजी	आर पी एस सी एल	रोज़ा टी पी पी चरण - I	1	300	2/10/2010	नहीं	उ. क्षे.
2029	फ़रवरी	राज्य	के पी सी एल	रायचूर टी पी एस	8	250	6/26/2010	नहीं	द. क्षे.
2029	फ़रवरी	निजी	टी ए क्यू ए	नेवेली टी पी एस (जेड)	1	250	10/21/2002	नहीं	द. क्षे.
2029	फ़रवरी	निजी	डब्ल्यू पी सी एल	वर्धा वरोरा टी पी पी	4	135	4/30/2011	नहीं	प. क्षे.
2029	फ़रवरी	निजी	ए पी एल	मुन्द्रा टी पी एस	2	330	3/17/2010	नहीं	प. क्षे.
2029	फ़रवरी	निजी	जे पी एल	ओ पी जिंदल टी पी एस	1	250	9/2/2007	नहीं	प. क्षे.
2029	फ़रवरी	राज्य	डब्ल्यू बी पी डी सी	संतल्दी टी पी एस	6	250	6/29/2011	नहीं	पू. क्षे.
2029	फ़रवरी	निजी	आर पी एस सी एल	रोज़ा टी पी पी चरण –II	4	300	3/28/2012	नहीं	उ. क्षे.
2029	फ़रवरी	निजी	टाटा पी सी एल	जोजोबेरा टी पी एस	3	120	2/1/2002	नहीं	पू. क्षे.
	फ़रवरी कुल				**9**	**2185**			
2029	मार्च	राज्य	पी एस पी सी एल	जी एच टी पी एस (लहरा मोहब्बत)	4	250	7/31/2008	नहीं	उ. क्षे.
2029	मार्च	राज्य	टी एस जी ई एन सी ओ	काकतीय टी पी एस	1	500	5/27/2010	नहीं	द. क्षे.
2029	मार्च	निजी	डब्ल्यू पी सी एल	वर्धा वरोरा टी पी पी	3	135	1/21/2011	नहीं	प. क्षे.
2029	मार्च	राज्य	महाजेनको	पारली टी पी एस	7	250	2/10/2010	नहीं	प. क्षे.
2029	मार्च	राज्य	एम पी पी जी सी एल	संजय गाँधी टी पी एस	5	500	6/18/2007	नहीं	प. क्षे.
2029	मार्च	निजी	एस ई एल	स्टरलाइट टी पी पी	2	600	12/29/2010	नहीं	पू. क्षे.
2029	मार्च	निजी	ई पी जी एल	सलाया टी पी पी	2	600	6/13/2012	नहीं	प. क्षे.
2029	मार्च	राज्य	महाजेनको	भुसावल टी पी एस	4	500	3/7/2012	नहीं	प. क्षे.
2029	मार्च	राज्य	डब्ल्यू बी पी डी सी	बकरेश्वर टी पी एस	4	210	3/21/2001	नहीं	पू. क्षे.

	मार्च कुल				9	3545			
2029	जुलाई	राज्य	एच पी जी सी एल	यमुना नगर टी पी एस	2	300	3/29/2008	नहीं	उ. क्षे.
2029	जुलाई	राज्य	ए पी जेनको	डॉ. एन. टाटा राव टी पी एस	7	500	10/8/2009	नहीं	द. क्षे.
2029	जुलाई	निजी	ए पी एल	मुन्द्रा टी पी एस	5	660	12/26/2010	नहीं	प. क्षे.
2029	जुलाई	निजी	ए पी एल	मुन्द्रा टी पी एस	1	330	8/4/2009	नहीं	प. क्षे.
2029	जुलाई	राज्य	महाजेनको	पारस टी पी एस	1	250	5/31/2007	नहीं	प. क्षे.
2029	जुलाई	निजी	एस ई एल	स्टरलाइट टी पी पी	1	600	10/14/2010	नहीं	पू. क्षे.
2029	जुलाई	केन्द्रीय	एन टी पी सी	इंदिरा गाँधी एस टी पी पी	1	500	10/31/2010	नहीं	उ. क्षे.
2029	जुलाई	राज्य	यू पी आर वी यू एन एल	हरदुआगंज टी पी एस	9	250	5/25/2012	नहीं	उ. क्षे.
2029	जुलाई	निजी	टाटा पी सी एल	जोजोबेरा टी पी एस	2	120	2/1/2001	नहीं	पू. क्षे.
	जुलाई कुल				**9**	**3510**			
2029	अगस्त	राज्य	पी एस पी सी एल	जी एच टी पी एस (लहरा मोहब्बत)	3	250	1/3/2008	नहीं	उ. क्षे.
2029	अगस्त	निजी	जे एस डब्ल्यू ई एल	तोरंगल्लू टी पी एस (एस बी यू-II)	2	300	8/24/2009	नहीं	द. क्षे.
2029	अगस्त	निजी	ए पी एल	मुन्द्रा टी पी एस	4	330	12/20/2010	नहीं	प. क्षे.
2029	अगस्त	केन्द्रीय	एन एस पी सी एल	भिलाई टी पी एस	2	250	7/12/2009	नहीं	प. क्षे.
2029	अगस्त	राज्य	सी एस पी जी सी एल	डी एस पी एम टी पी एस	1	250	3/30/2007	नहीं	प. क्षे.
2029	अगस्त	राज्य	के पी सी एल	बेल्लारी टी पी एस	2	500	3/23/2012	नहीं	द. क्षे.
2029	अगस्त	केन्द्रीय	एन टी पी सी	इंदिरा गाँधी एस टी पी पी	2	500	11/5/2011	नहीं	उ. क्षे.
2029	अगस्त	निजी	ई पी जी एल	सलाया टी पी पी	1	600	2/22/2012	नहीं	प. क्षे.
2029	अगस्त	केन्द्रीय	डी वी सी	मेजिया टी पी एस	7	500	9/30/2010	नहीं	पू. क्षे.
	अगस्त कुल				**9**	**3480**			
2029	नवंबर	राज्य	एच पी जी सी एल	यमुना नगर टी पी एस	1	300	11/1/2007	नहीं	उ. क्षे.
2029	नवंबर	निजी	जे एस डब्ल्यू ई एल	तोरंगल्लू टी पी एस(एस बी यू-II)	1	300	4/23/2009	नहीं	द. क्षे.
2029	नवंबरr	निजी	जे एस डब्ल्यू ई एल	जे एस डब्ल्यू रत्नागिरी टी पी पी	2	300	12/9/2010	नहीं	प. क्षे.
2029	नवंबरr	निजी	लैंको	पथादी टी पी पी	1	300	6/4/2009	नहीं	प. क्षे.
2029	नवंबर	राज्य	महाजेनको	पारली टी पी एस	6	250	2/16/2007	नहीं	प. क्षे.
2029	नवंबर	राज्य	ओ पी जी सी	आई बी वैली टी पी एस	4	660	7/2/2019	हाँ	पू. क्षे.
2029	नवंबरr	निजी	जे एच पी एल (एच आर)	महात्मा गाँधी टी पी एस	2	660	4/11/2012	नहीं	उ. क्षे.
2029	नवंबर	केन्द्रीय	एन टी पी सी	दादरी (एन सी टी पी पी)	5	490	1/25/2010	नहीं	उ. क्षे.
2029	नवंबर	राज्य	यू पी आर वी यू एन एल	परिच्छा टी पी एस	5	250	5/24/2012	नहीं	उ. क्षे.
2029	नवंबर	निजी	सी ई एस सी	बज़ बज़ टी पी एस	3	250	9/29/2009	नहीं	पू. क्षे.
	नवंबर कुल				**10**	**3760**			
2029	दिसम्बर	राज्य	यू पी आर वी यू एन एल	परिच्छा टी पी एस	4	210	12/28/2006	नहीं	उ. क्षे.
2029	दिसम्बर	राज्य	केपीसीएल	बेल्लारी टी पी एस	1	500	12/3/2007	नहीं	द. क्षे.
2029	दिसम्बर	निजी	डब्ल्यूपीसीएल	वर्धा वरोरा टी पी पी	2	135	10/10/2010	नहीं	प. क्षे.
2029	दिसम्बर	निजी	टाटा पीसीएल	ट्रोम्बे टी पी एस	8	250	3/26/2009	नहीं	प. क्षे.
2029	दिसम्बर	राज्य	महाजेनको	खापरखेडा टी पी एस	4	210	1/7/2001	नहीं	प. क्षे.
2029	दिसम्बर	राज्य	ओपीजीसी	आई बी वैली टी पी एस	3	660	7/2/2019	हाँ	पू. क्षे.
2029	दिसम्बर	केन्द्रीय	एनटीपीसी	सिम्हाद्री	1	500	2/22/2002	नहीं	द. क्षे.
2029	दिसम्बर	निजी	वीआईपी	बुटीबोरी टी पी पी	2	300	8/17/2012	नहीं	प. क्षे.
2029	दिसम्बर	राज्य	डब्ल्यू बी पी डी सी	सागरदिघी टी पी एस	1	300	7/20/2008	नहीं	पू. क्षे.
	दिसम्बर कुल				**9**	**3065**			
	कुल इकाईयाँ एवं क्षमता (चरण III)				**101**	**37215**			

V. चरण -IV

अवधि: जनवरी, 2030 से दिसंबर, 2030 तक

इस चरण के अंतर्गत, विभिन्न ताप विद्युत संयंत्रों की कुल मिलाकर 55767 मेगावाट क्षमता की इकाइयों की निम्नलिखित 191 इकाइयों की योजना बनाई गई है और अध्ययन और फील्ड परीक्षणों सहित बहुमुखी प्रचालन वास्ते उन्नयन/रेट्रोफिटिंग के लिए उनकी पहचान की गई है। इस चरण को 12 महीने की अवधि के भीतर यानी जनवरी, 2030 से दिसंबर, 2030 तक पूरा किया जाना है।

यदि उपियोगिताओं को यह समझ में आता है कि इस चरण के अंतर्गत 40 वर्ष से अधिक आयु की इकाइयों का 40% प्रचालन व्यवहार्य/संभव नहीं है, तो उपियोगिताएं उपयुक्त रेट्रोफिट/अध्ययन/परीक्षण द्वारा 2-शिफ्ट प्रचालन का विकल्प चुन सकती हैं। हालांकि, इस चरण के अध्ययन/परीक्षण सहित रेट्रोफिट्स की अवधि समान होगी।

		चरण IV (**जनवरी**,2030 - **दिसंबर**,2030)								
वर्ष	माह	सेक्टर	संगठन	**परियोजना का नाम**	इकाई न.	क्षमता (मे. वा.)	कमिशनिंग की तिथि	पिट हेड	**31.12.2029** तक आयु	क्षेत्र
2030	जनवरी	राज्य	यू पी आर वी यू एन एल	अनपारा टी पी एस	7	500	3/6/2016	हाँ	13.8	उ. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	3	500	1/31/2005	हाँ	24.9	उ. क्षे.
2030	जनवरी	राज्य	पी एस पी सी एल	रोपड़ टी पी एस	6	210	3/30/1993	नहीं	36.8	उ. क्षे.
2030	जनवरी	राज्य	आर आर वी यू एन एल	कोटा टी पी एस	4	210	5/1/1989	नहीं	40.7	उ. क्षे.
2030	जनवरी	राज्य	पी एस पी सी एल	रोपड़ टी पी एस	3	210	3/31/1988	नहीं	41.8	उ. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	5	200	2/26/1984	हाँ	45.9	उ. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	1	200	2/14/1982	हाँ	47.9	उ. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	6	500	3/7/2011	हाँ	18.8	पू. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	तालचेर एस टी पी एस	3	500	2/21/2003	हाँ	26.9	पू. क्षे.
2030	जनवरी	राज्य	ओ पी जी सी	आई बी वैली टी पी एस	1	210	6/2/1994	हाँ	35.6	पू. क्षे.
2030	जनवरी	राज्य	डब्ल्यू बी पी डी सी	कोलाघाट टी पी एस	6	210	3/17/1991	नहीं	38.8	पू. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	बरौनी टी पी एस	6	105	5/1/1983	नहीं	46.7	पू. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	7	500	9/26/2004	हाँ	25.3	द. क्षे.
2030	जनवरी	राज्य	टी ए एन जी ई डी सी ओ	उत्तरी चेन्नई टी पी एस	2	210	3/27/1995	नहीं	34.8	द. क्षे.
2030	जनवरी	केन्द्रीय	नेवेली लिग्नाईट	नेवेली टी पी एस-II	7	210	6/19/1993	हाँ	36.6	द. क्षे.
2030	जनवरी	राज्य	ए पी जेनको	डॉ. एन. टाटा राव टी पी एस	4	210	8/23/1990	नहीं	39.4	द. क्षे.
2030	जनवरी	केन्द्रीय	ए पी जेनको	नेवेली टी पी एस-II	1	210	1/17/1988	हाँ	42.0	द. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	3	200	12/13/1984	हाँ	45.1	द. क्षे.
2030	जनवरी	राज्य	टी ए एन जी ई डी सी ओ	थूथुकुडी टी पी एस	1	210	7/9/1979	नहीं	50.5	द. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	13	500	8/6/2015	हाँ	14.4	प. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	12	500	3/22/2013	हाँ	16.8	प. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	सिपत एस टी पी एस	5	500	8/13/2008	हाँ	21.4	प. क्षे.
2030	जनवरी	राज्य	एम पी पी जी सी एल	संजय गांधी टी पी एस	3	210	2/28/1999	नहीं	30.9	प. क्षे.
2030	जनवरी	राज्य	एम पी पी जी सी एल	संजय गांधी टी पी एस	1	210	3/26/1993	नहीं	36.8	प. क्षे.
2030	जनवरी	राज्य	महा जेनको	खापरखेड़ा टी पी एस	2	210	1/8/1990	नहीं	40.0	प. क्षे.
2030	जनवरी	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	5	500	3/25/1988	हाँ	41.8	प. क्षे.
2030	जनवरी	राज्य	महा जेनको	चंद्रपुर(महाराष्ट्र) एस टी पी एस	4	210	3/8/1986	नहीं	43.8	प. क्षे.
2030	जनवरी	राज्य	जी एस ई सी एल	वानाकबोरी टी पी एस	3	210	3/15/1984	नहीं	45.8	प. क्षे.
2030	जनवरी	राज्य	महा जेनको	कोराडी टी पी एस	6	210	3/30/1982	नहीं	47.8	प. क्षे.
2030	जनवरी	निजी	टीओआर. पीओडब्ल्यू. (यू एन ओ एस यू जी ई एन)	साबरमती (डी-एफ स्टेशन)	1	120	10/12/1978	नहीं	51.3	प. क्षे.
	जनवरी कुल				**30**	**8685**				
2030	फ़रवरी	राज्य	यू पी आर वी	अनपरा टी पी एस	6	500	6/8/2015	हाँ	14.6	उ. क्षे.

			यू एन एल							
2030	फ़रवरी	राज्य	पी एस पी सी एल	जीएच टी पी एस (लेह.मोह.)	2	210	10/16/1998	नहीं	31.2	उ. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	दादरी (एन सी टी पी पी)	3	210	3/23/1993	नहीं	36.8	उ. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	ऊंचाहार टी पी एस	2	210	3/22/1989	नहीं	40.8	उ. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	1	110	3/21/1988	नहीं	41.8	उ. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	4	200	11/2/1983	हाँ	46.2	उ. क्षे.
2030	फ़रवरी	राज्य	यू पी आर वी यू एन एल	ओबरा टी पी एस	12	200	3/28/1981	नहीं	48.8	उ. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	7	500	7/31/2009	हाँ	20.4	पू. क्षे.
2030	फ़रवरी	निजी	सी ई एस	बज बज टी पी एस	2	250	3/6/1999	नहीं	30.8	पू. क्षे.
2030	फ़रवरी	राज्य	टी वी एन एल	तेनुघाट टी पी एस	1	210	4/14/1994	नहीं	35.7	पू. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	3	200	8/6/1987	हाँ	42.4	पू. क्षे.
2030	फ़रवरी	राज्य	के पी सी एल	रायचूर टी पी एस	6	210	7/22/1999	नहीं	30.5	द. क्षे.
2030	फ़रवरी	राज्य	ए पी जेनको	रायलसीमा टी पी एस	2	210	2/25/1995	नहीं	34.9	द. क्षे.
2030	फ़रवरी	केन्द्रीय	नेवेली लिग्नाईट	नेवेली टी पी एस-II	6	210	10/30/1992	हाँ	37.2	द. क्षे.
2030	फ़रवरी	राज्य	टी ए एन जी ई डी सी ओ	मेट्टूर टी पी एस	4	210	3/27/1990	नहीं	39.8	द. क्षे.
2030	फ़रवरी	राज्य	टी ए एन जी ई डी सी ओ	मेट्टूर टी पी एस	2	210	12/1/1987	नहीं	42.1	द. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	2	200	5/29/1984	हाँ	45.6	द. क्षे.
2030	फ़रवरी	निजी	एस पी एल	सासन यू एम टी पी पी	6	660	3/19/2015	हाँ	14.8	प. क्षे.
2030	फ़रवरी	राज्य	सी एस पी जी सी एल	कोरबा-वेस्ट टी पी एस	5	500	3/22/2013	हाँ	16.8	प. क्षे.
2030	फ़रवरी	राज्य	एम पी पी जी सी एल	अमरकंटक एक्सटेंशन टी पी एस	3	210	6/15/2008	हाँ	21.6	प. क्षे.
2030	फ़रवरी	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	7	210	12/31/1998	नहीं	31.0	प. क्षे.
2030	फ़रवरी	राज्य	महाजेनको	चंद्रपुर (महाराष्ट्र) एस टी पी एस	6	500	3/11/1992	नहीं	37.8	प. क्षे.
2030	फ़रवरी	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	4	210	12/26/1989	हाँ	40.0	प. क्षे.
2030	फ़रवरी	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	6	210	11/18/1987	नहीं	42.1	प. क्षे.
2030	फ़रवरी	राज्य	महाजेनको	चंद्रपुर (महाराष्ट्र) एस टी पी एस	3	210	5/3/1985	नहीं	44.7	प. क्षे.
2030	फ़रवरी	निजी	टाटा पी सी एल	ट्रॉम्बे टी पी एस	5	500	1/25/1984	नहीं	46.0	प. क्षे.
2030	फ़रवरी	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	1	210	3/23/1982	नहीं	47.8	प. क्षे.
	फ़रवरी कुल				**27**	**7470**				
2030	मार्च	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	6	500	10/17/2013	हाँ	16.2	उ. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	4	110	2/20/1998	नहीं	31.9	उ. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	दादरी (एन सी टी पी पी)	2	210	12/18/1992	नहीं	37.1	उ. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	2	110	3/11/1989	नहीं	40.8	उ. क्षे.
2030	मार्च	राज्य	यू पी आर वी यू एन एल	अनपरा टी पी एस	3	210	3/12/1988	हाँ	41.8	उ. क्षे.
2030	मार्च	राज्य	आर आर वी यू एन एल	कोटा टी पी एस	2	110	7/13/1983	नहीं	46.5	उ. क्षे.
2030	मार्च	राज्य	यू पी आर वी यू एन एल	ओबरा टी पी एस	9	200	1/26/1980	नहीं	50.0	उ. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	6	500	3/16/2008	हाँ	21.8	पू. क्षे.
2030	मार्च	निजी	सी ई एस सी	बज बज टी पी एस	1	250	9/16/1997	नहीं	32.3	पू. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	2	210	3/17/1994	हाँ	35.8	पू. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	2	200	12/24/1986	हाँ	43.0	पू. क्षे.
2030	मार्च	निजी	जे एस डब्ल्यू ई एल	तोरंगल्लू टी पी एस (एस बी यू-I)	2	130	5/16/1999	नहीं	30.6	द. क्षे.
2030	मार्च	राज्य	ए पी जेनको	डॉ. एन. टाटा राव टी पी एस	6	210	2/24/1995	नहीं	34.9	द. क्षे.
2030	मार्च	राज्य	टी ए एन जी ई डी सी ओ	थूथुकुडी टी पी एस	4	210	2/11/1992	नहीं	37.9	द. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	6	500	10/16/1989	हाँ	40.2	द. क्षे.
2030	मार्च	केन्द्रीय	नेवेली लिग्नाइट	नेवेली टी पी एस-II	3	210	3/29/1987	हाँ	42.8	द. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	1	200	10/27/1983	हाँ	46.2	द. क्षे.
2030	मार्च	निजी	एस पी एल	सासन यू एम टी पी पी	5	660	8/24/2014	हाँ	15.4	प. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	11	500	6/14/2012	हाँ	17.6	प. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	सिपत एस टी पी एस	4	500	5/27/2007	हाँ	22.6	प. क्षे.
2030	मार्च	राज्य	जी एस ई सी एल	गांधीनगर टी पी एस	5	210	3/17/1998	नहीं	31.8	प. क्षे.
2030	मार्च	राज्य	जी एस ई सी एल	गांधीनगर टी पी एस	4	210	7/20/1991	नहीं	38.5	प. क्षे.
2030	मार्च	राज्य	महा जेनको	खापरखेड़ा टी पी एस	1	210	3/26/1989	नहीं	40.8	प. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	1	210	10/10/1987	हाँ	42.3	प. क्षे.

2030	मार्च	राज्य	सी एस पी जी सी एल	कोरबा-वेस्ट टी पी एस	3	210	3/26/1985	हाँ	44.8	प. क्षे.
2030	मार्च	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	2	200	10/31/1983	हाँ	46.2	प. क्षे.
2030	मार्च	राज्य	महाजेनको	नासिक टी पी एस	5	210	1/30/1981	नहीं	49.0	प. क्षे.
	मार्च कुल				**27**	**7190**				
2030	जुलाई	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	5	500	5/25/2012	हाँ	17.6	उ. क्षे.
2030	जुलाई	राज्य	पी एस पी सी एल	जी एच टी पी एस (लेह.मोह.)	1	210	12/29/1997	नहीं	32.0	उ. क्षे.
2030	जुलाई	राज्य	पी एस पी सी एल	रोपड़ टी पी एस	5	210	3/29/1992	नहीं	37.8	उ. क्षे.
2030	जुलाई	राज्य	पी एस पी सी एल	रोपड़ टी पी एस	4	210	1/29/1989	नहीं	40.9	उ. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	7	500	11/24/1987	हाँ	42.1	उ. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	3	200	3/28/1983	हाँ	46.8	उ. क्षे.
2030	जुलाई	राज्य	यू पी आर वी यू एन एल	ओबरा टी पी एस	10	200	1/14/1979	नहीं	51.0	उ. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	5	500	3/31/2007	हाँ	22.8	पू. क्षे.
2030	जुलाई	राज्य	टी वी एन एल	तेनुघाट टी पी एस	2	210	10/10/1996	नहीं	33.2	पू. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	5	500	2/16/1994	हाँ	35.9	पू. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	1	200	1/1/1986	हाँ	44.0	पू. क्षे.
2030	जुलाई	राज्य	के पी सी एल	रायचूर टी पी एस	5	210	1/31/1999	नहीं	30.9	द. क्षे.
2030	जुलाई	राज्य	टी ए एन जी ई डी सी ओ	उत्तरी चेन्नई टी पी एस	1	210	10/25/1994	नहीं	35.2	द. क्षे.
2030	जुलाई	केन्द्रीय	नेवेली लिग्नाइट	नेवेली टी पी एस-II	5	210	12/31/1991	हाँ	38.0	द. क्षे.
2030	जुलाई	राज्य	ए पी जेनको	डॉ. एन. टाटा राव टी पी एस	3	210	10/5/1989	नहीं	40.3	द. क्षे.
2030	जुलाई	केन्द्रीय	नेवेली लिग्नाइट	नेवेली टी पी एस-II	2	210	2/6/1987	हाँ	42.9	द. क्षे.
2030	जुलाई	राज्य	टी ए एन जी ई डी सी ओ	थूथुकुडी टी पी एस	3	210	4/16/1982	नहीं	47.7	द. क्षे.
2030	जुलाई	निजी	एस पी एल	सासन यू एम टी पी पी	3	660	5/21/2014	हाँ	15.6	प. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	सिपत एस टी पी एस	3	660	6/2/2012	हाँ	17.6	प. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	10	500	3/8/2007	हाँ	22.8	प. क्षे.
2030	जुलाई	राज्य	महा जेनको	चंद्रपुर (महाराष्ट्र) एस टी पी एस	7	500	10/1/1997	नहीं	32.3	प. क्षे.
2030	जुलाई	राज्य	महा जेनको	चंद्रपुर (महाराष्ट्र) एस टी पी एस	5	500	3/22/1991	नहीं	38.8	प. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	6	500	2/26/1989	हाँ	40.9	प. क्षे.
2030	जुलाई	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	4	500	5/31/1987	हाँ	42.6	प. क्षे.
2030	जुलाई	राज्य	जी एस ई सी एल	उकाई टी पी एस	5	210	1/30/1985	नहीं	44.9	प. क्षे.
2030	जुलाई	राज्य	सी एस पी जी सी एल	कोरबा-वेस्ट टी पी एस	2	210	6/21/1983	हाँ	46.6	प. क्षे.
2030	जुलाई	राज्य	महाजेनको	नासिक टी पी एस	4	210	7/10/1980	नहीं	49.5	प. क्षे.
	जुलाई कुल				**27**	**9150**				
2030	अगस्त	निजी	एल ए पी पी एल	अनपरा सी टी पी एस	2	600	11/15/2011	हाँ	18.1	उ. क्षे.
2030	अगस्त	राज्य	यू पी आर वी यू एन एल	अनपरा टी पी एस	5	500	7/4/1994	हाँ	35.5	उ. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	दादरी (एन सी टी पी पी)	1	210	12/21/1991	नहीं	38.1	उ. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	ऊंचाहार टी पी एस	1	210	11/21/1988	नहीं	41.1	उ. क्षे.
2030	अगस्त	राज्य	यू पी आर वी यू एन एल	अनपरा टी पी एस	2	210	2/28/1987	हाँ	42.9	उ. क्षे.
2030	अगस्त	राज्य	आर आर वी यू एन एल	कोटा टी पी एस	1	110	1/17/1983	नहीं	47.0	उ. क्षे.
2030	अगस्त	राज्य	यू पी आर वी यू एन एल	हरदुआगंज टी पी एस	7	105	3/31/1978	नहीं	51.8	उ. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	तालचेर एस टी पी एस	6	500	2/6/2005	हाँ	24.9	पू. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	4	210	3/18/1996	हाँ	33.8	पू. क्षे.
2030	अगस्त	राज्य	डब्ल्यू बी पी डी सी	कोलाघाट टी पी एस	5	210	12/28/1993	नहीं	36.0	पू. क्षे.
2030	अगस्त	राज्य	डब्ल्यू बी पी डी सी	कोलाघाट टी पी एस	3	210	12/16/1985	नहीं	44.1	पू. क्षे.
2030	अगस्त	निजी	जे एस डब्ल्यू ई एल	तोरंगल्लू टी पी एस (एसबीयू-I)	1	130	1/15/1999	नहीं	31.0	द. क्षे.
2030	अगस्त	राज्य	के पी सी एल	रायचूर टी पी एस	4	210	9/29/1994	नहीं	35.3	द. क्षे.
2030	अगस्त	राज्य	टी ए एन जी ई डी सी ओ	थूथुकुडी टी पी एस	5	210	3/31/1991	नहीं	38.8	द. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	5	500	3/26/1989	हाँ	40.8	द. क्षे.
2030	अगस्त	राज्य	टी ए एन जी ई डी सी ओ	मेट्टूर टी पी एस	1	210	1/4/1987	नहीं	43.0	द. क्षे.
2030	अगस्त	राज्य	टी ए एन जी ई डी सी ओ	थूथुकुडी टी पी एस	2	210	12/17/1980	नहीं	49.1	द. क्षे.

2030	अगस्त	निजी	एस पी एल	सासन यू एम टी पी पी	4	660	3/25/2014	हाँ	15.8	प. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	सिपत एस टी पी एस	2	660	12/24/2011	हाँ	18.0	प. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	9	500	7/27/2006	हाँ	23.4	प. क्षे.
2030	अगस्त	निजी	ए पी एल	दहानू टी पी एस	2	250	3/29/1995	नहीं	34.8	प. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	6	210	2/1/1991	हाँ	38.9	प. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	3	210	2/3/1989	हाँ	40.9	प. क्षे.
2030	अगस्त	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	5	210	9/23/1986	नहीं	43.3	प. क्षे.
2030	अगस्त	निजी	टीओआर. पीओडब्ल्यू. (यू एन ओ एस यू जी ई एन)	साबरमती (डी-एफ स्टेशन)	2	121	12/31/1984	नहीं	45.0	प. क्षे.
2030	अगस्त	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	1	200	2/28/1983	हाँ	46.9	प. क्षे.
2030	अगस्त	राज्य	महाजेनको	नासिक टी पी एस	3	210	4/26/1979	नहीं	50.7	प. क्षे.
	अगस्त कुल				**27**	**7776**				
2030	नवंबर	निजी	एल ए पी पी एल	अनपरा सी टी पी एस	1	600	11/12/2011	हाँ	18.1	उ. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	दादरी (एन सी टी पी पी)	4	210	3/24/1994	नहीं	35.8	उ. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	टांडा टी पी एस	3	110	3/28/1990	नहीं	39.8	उ. क्षे.
2030	नवंबर	राज्य	आर आर वी यू एन एल	कोटा टी पी एस	3	210	9/25/1988	नहीं	41.3	उ. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	6	500	12/23/1986	हाँ	43.1	उ. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	सिंगरौली एस टी पी एस	2	200	11/25/1982	हाँ	47.1	उ. क्षे.
2030	नवंबर	राज्य	यू पी आर वी यू एन एल	ओबरा टी पी एस	11	200	12/31/1977	नहीं	52.0	उ. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	तालचेर एस टी पी एस	5	500	5/13/2004	हाँ	25.7	पू. क्षे.
2030	नवंबर	राज्य	ओ पी जी सी	आई बी वैली टी पी एस	2	210	10/22/1995	हाँ	34.2	पू. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	फरक्का एस टी पी एस	4	500	9/25/1992	हाँ	37.3	पू. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	बरौनी टी पी एस	7	105	3/31/1985	नहीं	44.8	पू. क्षे.
2030	नवंबर	राज्य	टी एस जी ई एन सी ओ	कोठागुडेम टी पी एस (नया)	10	250	2/28/1998	नहीं	31.9	द. क्षे.
2030	नवंबर	राज्य	ए पी जी ई एन सी ओ	डॉ. एन. टाटा राव टी पी एस	5	210	3/31/1994	नहीं	35.8	द. क्षे.
2030	नवंबर	केन्द्रीय	नेवेली लिग्नाइट	नेवेली टी पी एस-II	4	210	3/30/1991	हाँ	38.8	द. क्षे.
2030	नवंबर	राज्य	टी ए एन जी ई डी सी ओ	मेट्टूर टी पी एस	3	210	3/22/1989	नहीं	40.8	द. क्षे.
2030	नवंबर	राज्य	के पी सी एल	रायचूर टी पी एस	2	210	3/2/1986	नहीं	43.9	द. क्षे.
2030	नवंबर	राज्य	ए पी जी ई एन सी ओ	डॉ. एन. टाटा राव टी पी एस	2	210	10/10/1980	नहीं	49.3	द. क्षे.
2030	नवंबर	निजी	एस पी एल	सासन यू एम टी पी पी	2	660	12/18/2013	हाँ	16.0	प. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	सिपत एस टी पी एस	1	660	6/27/2011	हाँ	18.5	प. क्षे.
2030	नवंबर	राज्य	महाजेनको	खापरखेड़ा टी पी एस	3	210	5/31/2000	नहीं	29.6	प. क्षे.
2030	नवंबर	निजी	ए पी एल	दहानू टी पी एस	1	250	1/6/1995	नहीं	35.0	प. क्षे.
2030	नवंबर	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	5	210	3/31/1990	हाँ	39.8	प. क्षे.
2030	नवंबर	निजी	टीओआर. पीओडब्ल्यू. (यू एन ओ एस यू जी ई एन)	साबरमती (डी-एफ स्टेशन)	3	121	9/28/1988	नहीं	41.3	प. क्षे.
2030	नवंबर	राज्य	सी एस पी जी सी एल	कोरबा-वेस्ट टी पी एस	4	210	3/13/1986	हाँ	43.8	प. क्षे.
2030	नवंबर	राज्य	सी एस पी जी सी एल	कोरबा-वेस्ट टी पी एस	1	210	3/30/1984	हाँ	45.8	प. क्षे.
2030	नवंबर	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	2	210	1/15/1983	नहीं	47.0	प. क्षे.
2030	नवंबर	राज्य	जी एस ई सी एल	उकाई टी पी एस	4	200	3/28/1979	नहीं	50.8	प. क्षे.
	नवंबर कुल				**27**	**7586**				
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	4	500	9/24/2005	हाँ	24.3	उ. क्षे.
2030	दिसम्बर	राज्य	यू पी आर वी यू एन एल	अनपरा टी पी एस	4	500	7/19/1993	हाँ	36.5	उ. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	2	500	7/5/1989	हाँ	40.5	उ. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	रिहंद एस टी पी एस	1	500	3/31/1988	हाँ	41.8	उ. क्षे.
2030	दिसम्बर	राज्य	यू पी आर वी यू एन एल	अनपरा टी पी एस	1	210	3/24/1986	हाँ	43.8	उ. क्षे.
2030	दिसम्बर	राज्य	यू पी आर वी यू एन एल	ओबरा टी पी एस	13	200	7/21/1982	नहीं	47.5	उ. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	तालचेर एस टी पी एस	4	500	10/25/2003	हाँ	26.2	पू. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	3	210	3/24/1995	हाँ	34.8	पू. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	कहलगांव टी पी एस	1	210	3/31/1992	हाँ	37.8	पू. क्षे.
2030	दिसम्बर	राज्य	डब्ल्यू बी पी	कोलाघाट टी पी एस	4	210	1/24/1984	नहीं	46.0	पू. क्षे.

			डी सी							
2030	दिसम्बर	राज्य	टी ए एन जी ई डी सी ओ	उत्तरी चेन्नई टी पी एस	3	210	2/24/1996	नहीं	33.9	द. क्षे.
2030	दिसम्बर	राज्य	ए पी जी ई एन सी ओ	रायलसीमा टी पी एस	1	210	3/31/1994	नहीं	35.8	द. क्षे.
2030	दिसम्बर	राज्य	के पी सी एल	रायचूर टी पी एस	3	210	3/30/1991	नहीं	38.8	द. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	रामागुंडेम एस टी पी एस	4	500	6/26/1988	हाँ	41.5	द. क्षे.
2030	दिसम्बर	राज्य	के पी सी एल	रायचूर टी पी एस	1	210	3/29/1985	नहीं	44.8	द. क्षे.
2030	दिसम्बर	राज्य	ए पी जी ई एन सी ओ	डॉ. एन. टाटा राव टी पी एस	1	210	11/1/1979	नहीं	50.2	द. क्षे.
2030	दिसम्बर	निजी	एस पी एल	सासन यू एम टी पी पी	1	660	5/30/2013	हाँ	16.6	प. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	7	500	11/25/2010	हाँ	19.1	प. क्षे.
2030	दिसम्बर	राज्य	एम पी पी जी सी एल	संजय प्रौद्योगिकी टी पी एस	4	210	11/23/1999	नहीं	30.1	प. क्षे.
2030	दिसम्बर	राज्य	एम पी पी जी सी एल	संजय प्रौद्योगिकी टी पी एस	2	210	3/27/1994	नहीं	35.8	प. क्षे.
2030	दिसम्बर	राज्य	जी एस ई सी एल	गांधी नगर टी पी एस	3	210	3/20/1990	नहीं	39.8	प. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	विंध्याचल एस टी पी एस	2	210	7/23/1988	हाँ	41.5	प. क्षे.
2030	दिसम्बर	राज्य	जी एस ई सी एल	वानकबोरी टी पी एस	4	210	3/9/1986	नहीं	43.8	प. क्षे.
2030	दिसम्बर	केन्द्रीय	एन टी पी सी	कोरबा एस टी पी एस	3	200	3/17/1984	हाँ	45.8	प. क्षे.
2030	दिसम्बर	राज्य	महा जेनको	भुसावल टी पी एस	3	210	9/18/1982	नहीं	47.3	प. क्षे.
2030	दिसम्बर	राज्य	जी एस ई सी एल	उकाई टी पी एस	3	200	1/21/1979	नहीं	51.0	प. क्षे.
	दिसम्बर कुल				**26**	**7910**				
	कुल इकाईयाँ एवं क्षमता (चरण IV)				**191**	**55767**				

राकेश कुमार, सचिव

[विज्ञापन-III/4/असा./617/2023-24]

CENTRAL ELECTRICITY AUTHORITY

NOTIFICATION

New Delhi, the 15th December, 2023

CEA-TH-14-21/5/2023-TRM Division.—Whereas the Central Electricity Authority (Flexible Operation of Coal based Thermal Generating Units) Regulations, 2023 was notified by the Central Electricity Authority vide notification no. CEA-TH-17-13/4/2022-TETD Division dated 30th January, 2023;

And whereas the sub-regulation (2) of regulation 5 of the said regulations requires that the implementation of the flexible operation of the Coal based thermal generating Units shall be as per the Phasing Plan specified by the Authority from time to time;

And whereas the phasing plan has been finalized after incorporating the comments from the stakeholders. The final phasing plan approved by the Authority is attached herein under at **Annexure.**

Annexure

(PHASING PLAN)

1. The utilities shall modify the units strictly within the duration stipulated under various phases in the Phasing Plan mentioned herein under.
2. The utilities shall avail the maximum shutdown period of one month as mentioned against each unit in the Phasing Plan.
3. As far as possible, the utilities shall match the shutdown period of upgradation/retrofits works for flexible operation with Annual Over Haul (AOH) period.
4. The utilities shall plan shutdown period of the units for upgradation/retrofits works for flexible operation in coordination with the respective Regional Power Committee (RPC).
5. The following five phases have been identified under the Phasing Plan including a Pilot Phase:

I. PHASE- PILOT

Duration: To be completed by March, 2024

Under this phase, the following 10 nos. of units of capacity 5850 MegaWatt (MW) in aggregate of various thermal power plants have been planned and identified for which the study, field tests, retrofits etc. have already been initiated for flexible operation. The upgradation/retrofitting for flexible operation to be completed before 31st March, 2024.

PILOT PHASE (May, 2023 - March, 2024)

Phase	Sector	Organisation	Name of Project	Unit No.	Capacity (MW)	Region
Pilot	Central	NTPC	MAUDA TPS	1	500	WR
Pilot	Central	NTPC	SIMHADRI	3	500	SR
Pilot	Central	NTPC	DADRI	6	490	NR
Pilot	Central	DVC	MEJIA TPS	8	500	ER
Pilot	Central	NEYVELI LIGNITE	NEYVELI NEW TPP	2	500	SR
Pilot	State	KPCL	YERMARUS TPS	1	800	SR
Pilot	State	GSECL	WANAKBORI TPP	6	800	WR
Pilot	State	RRVUNL	SURATGARH SCTPP	8	660	NR
Pilot	State	WBPDC	SAGARDIGHI TPS	3	500	ER
Pilot	Private	CEPL	MUTHIARA	2	600	SR
Pilot Phase Total				**10**	**5850**	

II. PHASE-I

Duration: July, 2024 to June, 2026

Under this phase, the following 91 Nos. of units of capacity 51080 MW in aggregate of various thermal power plants have been planned and identified for the upgradation/retrofitting for flexible operation including the study and field tests. This phase to be completed within 2 years i.e. from July, 2024 to June, 2026.

PHASE 1 (JULY , 2024 - JUNE , 2026)

Year	Month	Phase	Sector	Organisation	Name of Project	Unit No.	Capacity (MW)	Date of Commissioning	Pit head	Region
2024	November	Phase 1	State	UPRVUNL	HARDUAGANJ TPS	10	660	1/29/2022	N	NR
2024	November	Phase 1	Private	GPGSL (GVK)	GOINDWAL SAHIB	2	270	3/15/2016	N	NR
2024	November	Phase 1	State	APPDCL	DAMODARAM SANJEEVAIAH TPS	3	800	3/9/2023	N	SR
2024	November	Phase 1	State	TSGENCO	BHADRADRI TPP	4	270	1/9/2022	N	SR
2024	November	Phase 1	State	TANGEDCO	METTUR TPS-II	1	600	10/11/2012	N	SR
2024	November	Phase 1	Central	NTPC	GADARWARA TPP	2	800	2/16/2021	N	WR
2024	November	Phase 1	Private	RKMPPL	UCHPINDA TPP	3	360	9/12/2017	N	WR
2024	November	Phase 1	Central	NTPC	MAUDA TPS	3	660	3/28/2016	N	WR
2024	November	Phase 1	Private	APL	MUNDRA TPS	8	660	3/3/2012	N	WR
2024	November	Phase 1	Central	DVC	BOKARO TPS `A` EXP	1	500	3/22/2016	N	ER
	November Total					**10**	**5580**			
2024	December	Phase 1	Central	NTPC	TANDA TPS	6	660	3/31/2021	N	NR
2024	December	Phase 1	Private	GPGSL (GVK)	GOINDWAL SAHIB	1	270	2/14/2016	N	NR
2024	December	Phase 1	Private	ITPCL	ITPCL TPP	2	600	4/18/2016	N	SR
2024	December	Phase 1	Private	HNPC	VIZAG TPP	2	520	3/30/2016	N	SR
2024	December	Phase 1	Central	NTPC	SIMHADRI	4	500	3/30/2012	N	SR
2024	December	Phase 1	Central	NTPC	LARA TPP	2	800	7/12/2020	N	WR
2024	December	Phase 1	Private	RATTANINDIA	NASIK (P) TPS	5	270	5/30/2017	N	WR
2024	December	Phase 1	Private	APL	RAIKHEDA TPP	2	685	3/28/2016	N	WR
2024	December	Phase 1	Private	CGPL	MUNDRA UMTPP	1	800	2/25/2012	N	WR
2024	December	Phase 1	Private	IBPIL	UTKAL TPP (IND BARATH)	1	350	2/25/2016	N	ER
	December Total					**10**	**5455**			
2025	January	Phase 1	Central	NTPC	MEJA STPP	2	660	1/12/2021	N	NR
2025	January	Phase 1	Private	SPPL	Thoothukudi St IV	1	525	11/30/2021	N	SR
2025	January	Phase 1	State	SCCL	SINGARENI TPP	1	600	3/13/2016	N	SR
2025	January	Phase 1	Central	NTECL	VALLUR TPP	1	500	3/28/2012	N	SR
2025	January	Phase 1	Central	NTPC	KHARGONE STPP	2	660	3/24/2020	N	WR
2025	January	Phase 1	Private	RATTANINDIA	NASIK (P) TPS	4	270	5/19/2017	N	WR
2025	January	Phase 1	Private	BALCO	BALCO TPS	2	300	3/24/2016	N	WR
2025	January	Phase 1	Central	DVC	RAGHUNATHPUR TPP	2	600	1/18/2016	N	ER
	January Total					**8**	**4115**			

2025	Februrary	Phase 1	State	RRVUNL	Suratgarh SCTPP	7	660	3/15/2020	N	NR
2025	Februrary	Phase 1	Central	NTPC	UNCHAHAR TPS	5	210	9/28/2006	N	NR
2025	Februrary	Phase 1	State	TSGENCO	BHADRADRI TPP	3	270	3/26/2021	N	SR
2025	Februrary	Phase 1	State	KPCL	BELLARY TPS	3	700	3/1/2016	N	SR
2025	Februrary	Phase 1	Central	NTPC	KHARGONE STPP	1	660	9/29/2019	N	WR
2025	Februrary	Phase 1	Private	SKS	BINJKOTE TPP	2	300	4/25/2017	N	WR
2025	Februrary	Phase 1	Private	JHAPL	SEIONI TPP	1	600	3/22/2016	N	WR
2025	Februrary	Phase 1	Central	NTPC	KUDGI STPP	1	800	12/25/2016	N	SR
	February Total					**8**	**4200**			
2025	March	Phase 1	Central	NTPC	TANDA TPS	5	660	9/28/2019	N	NR
2025	March	Phase 1	State	TSGENCO	BHADRADRI TPP	2	270	12/7/2020	N	SR
2025	March	Phase 1	Private	SEIL	PAINAMPURAM TPP	2	660	9/3/2015	N	SR
2025	March	Phase 1	Private	TRNE	NAWAPARA TPP	2	300	4/18/2017	N	WR
2025	March	Phase 1	State	MAHAGENCO	CHANDRAPUR(MAHARASHTRA) STPS	9	500	3/21/2016	N	WR
2025	March	Phase 1	Private	TSPL	TALWANDI SABO TPP	3	660	3/29/2016	N	NR
2025	March	Phase 1	State	CSPGCL	MARWA TPS	2	500	7/15/2016	N	WR
2025	March	Phase 1	Private	CGPL	MUNDRA UMTPP	3	800	10/16/2012	N	WR
2025	March	Phase 1	State	SCCL	SINGARENI TPP	2	600	11/25/2016	N	SR
	March Total					**9**	**4950**			
2025	July	Phase 1	State	RRVUNL	CHHABRA TPP	6	660	3/29/2019	N	NR
2025	July	Phase 1	State	TSGENCO	BHADRADRI TPP	1	270	6/5/2020	N	SR
2025	July	Phase 1	Central	NTPL	Thoothukudi (JV) TPP	2	500	7/9/2015	N	SR
2025	July	Phase 1	Central	NTPC	GADARWARA TPP	1	800	3/29/2019	N	WR
2025	July	Phase 1	Private	RATTANINDIA	NASIK (P) TPS	3	270	4/14/2017	N	WR
2025	July	Phase 1	Private	SEIL	SGPL TPP	1	660	11/12/2016	N	SR
2025	July	Phase 1	State	MAHAGENCO	KORADI TPS	9	660	3/15/2016	N	WR
	July Total					**7**	**3820**			
2025	November	Phase 1	Central	NTPC	MEJA STPP	1	660	3/31/2018	N	NR
2025	November	Phase 1	State	TSGENCO	KOTHAGUDEM TPS (STAGE-7)	12	800	12/26/2018	N	SR
2025	November	Phase 1	State	APPDCL	DAMODARAM SANJEEVAIAH TPS	2	800	3/17/2015	N	SR
2025	November	Phase 1	State	MPPGCL	SHREE SINGAJI TPP	4	660	3/27/2019	N	WR
2025	November	Phase 1	Central	NTPC	SOLAPUR STPS	1	660	4/7/2017	N	WR
2025	November	Phase 1	Private	RKMPPL	UCHPINDA TPP	2	360	1/28/2016	N	WR
2025	November	Phase 1	Central	NTECL	VALLUR TPP	2	500	2/28/2013	N	SR
2025	November	Phase 1	Private	CGPL	MUNDRA UMTPP	2	800	7/17/2012	N	WR
2025	November	Phase 1	Private	SPPL	SHIRPUR TPP	1	150	9/28/2017	N	WR
	November Total					**9**	**5390**			
2025	December	Phase 1	Central	NTPC	KUDGI STPP	3	800	3/12/2018	N	SR
2025	December	Phase 1	Central	NTPL	Thoothukudi (JV) TPP	1	500	3/10/2015	N	SR
2025	December	Phase 1	Private	RKMPPL	UCHPINDA TPP	4	360	3/20/2019	N	WR
2025	December	Phase 1	Central	NTPC	MAUDA TPS	4	660	3/18/2017	N	WR
2025	December	Phase 1	State	TANGEDCO	NORTH CHENNAI TPS	4	600	9/13/2013	N	SR
2025	December	Phase 1	Central	NTPC	LARA TPP	1	800	3/23/2018	N	WR
2025	December	Phase 1	Private	RATTANINDIA	AMARAVATI	5	270	3/12/2015	N	WR
	December Total					**7**	**3990**			
2026	January	Phase 1	State	RRVUNL	CHHABRA TPP	5	660	4/4/2017	N	NR
2026	January	Phase 1	State	APGENCO	RAYALASEEMA TPS	6	600	3/12/2018	N	SR
2026	January	Phase 1	Private	SEIL	PAINAMPURAM TPP	1	660	2/7/2015	N	SR
2026	January	Phase 1	State	MPPGCL	SHREE SINGAJI TPP	3	660	11/18/2018	N	WR
2026	January	Phase 1	Private	RATTANINDIA	NASIK (P) TPS	2	270	2/15/2017	N	WR
2026	January	Phase 1	State	TANGEDCO	NORTH CHENNAI TPS	5	600	3/9/2013	N	SR
2026	January	Phase 1	Private	APL	MUNDRA TPS	9	660	3/9/2012	N	WR
2026	January	Phase 1	Private	WPCL	AKALTARA TPS	2	600	1/18/2018	N	WR
2026	January	Phase 1	Central	NTPC	MAUDA TPS	2	500	3/29/2013	N	WR
	January Total					**9**	**5210**			
2026	Februrary	Phase 1	Central	NTPC	UNCHAHAR TPS	6	500	3/31/2017	N	NR
2026	Februrary	Phase 1	State	KPCL	YERMARUS TPP	2	800	3/29/2017	N	SR
2026	Februrary	Phase 1	State	APPDCL	DAMODARAM SANJEEVAIAH TPS	1	800	8/28/2014	N	SR
2026	Februrary	Phase 1	Private	APL	MAHAN TPP	2	600	10/7/2018	N	WR
2026	Februrary	Phase 1	State	MAHAGENCO	KORADI TPS	10	660	12/28/2016	N	WR
2026	Februrary	Phase 1	Central	NTPC	SOLAPUR STPS	2	660	3/30/2019	N	WR
2026	Februrary	Phase 1	Private	CGPL	MUNDRA UMTPP	5	800	3/18/2013	N	WR
	February Total					**7**	**4820**			
2026	March	Phase 1	Central	NTPC	KUDGI STPP	2	800	3/23/2017	N	SR
2026	March	Phase 1	Central	NTECL	VALLUR TPP	3	500	2/28/2014	N	SR
2026	March	Phase 1	Private	SKS	BINJKOTE TPP	1	300	3/28/2018	N	WR
2026	March	Phase 1	Private	TRNE	NAWAPARA TPP	1	300	8/14/2016	N	WR
2026	March	Phase 1	State	MAHAGENCO	PARLI TPS	8	250	3/30/2016	N	WR
2026	March	Phase 1	Private	MBPMPL	ANUPPUR TPP	2	600	3/30/2016	N	WR
2026	March	Phase 1	Private	CGPL	MUNDRA UMTPP	4	800	1/16/2013	N	WR
	March Total					**7**	**3550**			
	TOTAL UNITS AND CAPACITY (Phase I)					**91**	**51080**			

III. PHASE-II

Duration: July, 2026 to June, 2028

Under this phase, the following 100 Nos. of units of capacity 46825 MW in aggregate of various thermal power plants have been planned and identified for the upgradation/retrofitting for flexible operation including the study and field tests. This phase to be completed within 2 years i.e. from July, 2026 to June, 2028.

			PHASE II (JULY,2026 - JUNE ,2028)						
Year	**Month**	**Sector**	**Organisation**	**Name of Project**	**Unit No.**	**Capacity (MW)**	**Date of Commissioning**	**Pit head**	**Region**
2026	July	Private	RKMPPL	UCHPINDA TPP	1	360	10/28/2015	N	WR
2026	July	Private	JPL	TAMNAR TPP	1	600	1/7/2015	N	WR
2026	July	Private	DBPCL	BARADARHA TPS	1	600	2/23/2014	N	WR
2026	July	Private	APL	MAHAN TPP	1	600	2/24/2013	N	WR
2026	July	Private	SEIL	SGPL TPP	2	660	2/15/2017	N	SR
2026	July	Central	NTPC	NORTH KARANPURA STPP	1	660	1/18/2023	N	ER
2026	July	Private	ADHUNIK	MAHADEV PRASAD STPP	2	270	3/29/2013	N	ER
2026	July	Central	NTPC	BONGAIGAON TPP	3	250	3/23/2019	N	NER
	July Total				**8**	**4000**			
2026	August	State	GSECL	SIKKA REP. TPS	4	250	9/25/2015	N	WR
2026	August	State	MPPGCL	SHREE SINGAJI TPP	2	600	10/15/2014	N	WR
2026	August	Private	RATTANINDIA	AMARAVATI TPS	2	270	2/17/2014	N	WR
2026	August	Private	GMR ENERG	GMR WARORA TPS	1	300	2/7/2013	N	WR
2026	August	State	TSGENCO	KAKATIYA TPS	2	600	12/31/2015	N	SR
2026	August	Central	NPGCL	NABINAGAR STPP	3	660	3/6/2022	N	ER
2026	August	Central	NTPC	MUZAFFARPUR TPS	4	195	3/24/2016	N	ER
2026	August	Private	GMR ENERG	KAMALANGA TPS	1	350	3/29/2013	N	ER
	August Total				**8**	**3225**			
2026	November	Private	MCCPL	BANDAKHAR TPP	1	300	6/19/2015	N	WR
2026	November	Private	APL	TIRORA TPS	5	660	9/25/2014	N	WR
2026	November	State	MPPGCL	SATPURA TPS	11	250	12/25/2013	N	WR
2026	November	Private	HNPC	VIZAG TPP	1	520	12/27/2015	N	SR
2026	November	Central	NTPC	NABI NAGAR TPP	4	250	11/10/2021	N	ER
2026	November	Central	DVC	KODARMA TPP	2	500	2/15/2013	N	ER
2026	November	Central	NTPC	BONGAIGAON TPP	1	250	6/22/2015	N	NER
2026	November	State	RRVUNL	KALISINDH TPS	2	600	6/6/2015	N	NR
	November Total				**8**	**3330**			
2026	December	Private	BALCO	BALCO TPS	1	300	6/4/2015	N	WR
2026	December	Private	JPPVL	NIGRI TPP	1	660	8/29/2014	N	WR
2026	December	State	MPPGCL	SHREE SINGAJI TPP	1	600	11/18/2013	N	WR
2026	December	Private	ITPCL	ITPCL TPP	1	600	9/19/2015	N	SR
2026	December	Central	NTPC	BARH I	1	660	10/30/2021	N	ER
2026	December	Central	NTPC	MUZAFFARPUR TPS	3	195	3/31/2015	N	ER
2026	December	Private	ADHUNIK	MAHADEV PRASAD STPP	1	270	11/19/2012	N	ER
2026	December	Private	NPL	RAJPURA TPP	2	700	7/6/2014	N	NR
	December Total				**8**	**3985**			
2027	January	Private	MBPMPL	ANUPPUR TPP	1	600	4/20/2015	N	WR
2027	January	Private	WPCL	AKALTARA TPS	4	600	8/22/2014	N	WR
2027	January	Private	DIPL	DHARIWAL TPP	1	300	11/3/2013	N	WR
2027	January	Private	CEPL	MUTHIARA TPP	1	600	12/2/2014	N	SR
2027	January	Central	NTPC	NEW NABI NAGAR TPP	2	660	3/31/2021	N	ER
2027	January	Central	NTPC	BARH II	5	660	3/4/2015	N	ER
2027	January	Private	MPL	MAITHON RB TPP	2	525	3/31/2012	N	ER
2027	January	Private	TSPL	TALWANDI SABO TPP	1	660	6/17/2014	N	NR
	January Total				**8**	**4605**			
2027	February	State	MAHAGENCO	KORADI TPS	8	660	3/30/2015	N	WR
2027	February	Private	DIPL	DHARIWAL TPP	2	300	5/28/2014	N	WR
2027	February	Private	GMR ENERG	GMR WARORA TPS	2	300	8/27/2013	N	WR

2027	February	Central	NTPC	NEW NABI NAGAR TPP	1	660	7/12/2019	N	ER
2027	February	Private	HEL	HALDIA TPP	2	300	2/16/2015	N	ER
2027	February	Central	DVC	DURGAPUR STEEL TPS	2	500	3/23/2012	N	ER
2027	February	State	RRVUNL	KALISINDH TPS	1	600	5/2/2014	N	NR
	February Total				**7**	**3320**			
2027	March	State	GSECL	SIKKA REP. TPS	3	250	3/29/2015	N	WR
2027	March	Private	VVL	SALORA TPP	1	135	4/10/2014	N	WR
2027	March	Private	WPCL	AKALTARA TPS	3	600	8/13/2013	N	WR
2027	March	State	MAHAGENCO	BHUSAWAL TPS	5	500	3/30/2012	N	WR
2027	March	Private	JITPL	DERANG TPP	2	600	1/24/2015	N	ER
2027	March	Private	LPGCL	LALITPUR TPS	1	660	3/26/2016	N	NR
2027	March	Private	NPL	RAJPURA TPP	1	700	1/24/2014	N	NR
	March Total				**7**	**3445**			
2027	July	State	MAHAGENCO	CHANDRAPUR(MAHA RASHTRA) STPS	8	500	3/29/2015	N	WR
2027	July	Private	APL	AVANTHA BHANDAR	1	600	3/31/2014	N	WR
2027	July	Private	APL	TIRORA TPS	3	660	6/10/2013	N	WR
2027	July	Private	HEL	HALDIA TPP	1	300	1/14/2015	N	ER
2027	July	State	WBPDC	SAGARDIGHI TPS	4	500	12/15/2016	N	ER
2027	July	Private	TSPL	TALWANDI SABO TPP	2	660	10/25/2015	N	NR
2027	July	Private	APL	KAWAI TPS	2	660	12/24/2013	N	NR
	July Total				**7**	**3880**			
2027	August	Private	JPL	TAMNAR TPP	4	600	3/28/2015	N	WR
2027	August	Private	VIP	BUTIBORI TPP	1	300	3/31/2014	N	WR
2027	August	Private	JPPVL	BINA TPS	2	250	3/31/2013	N	WR
2027	August	Central	NTPC	NABI NAGAR TPP	3	250	2/26/2019	N	ER
2027	August	Central	DVC	RAGHUNATHPUR TPP	1	600	8/24/2014	N	ER
2027	August	Private	LPGCL	LALITPUR TPS	2	660	1/8/2016	N	NR
2027	August	Private	APL	KAWAI TPS	1	660	5/28/2013	N	NR
	August Total				**7**	**3320**			
2027	November	Private	DBPCL	BARADARHA TPS	2	600	3/24/2015	N	WR
2027	November	State	CSPGCL	MARWA TPS	1	500	3/30/2014	N	WR
2027	November	Private	APL	TIRORA TPS	2	660	3/25/2013	N	WR
2027	November	Central	NTPC	BARAUNI TPS	9	250	3/31/2018	N	ER
2027	November	Private	JITPL	DERANG TPP	1	600	4/10/2014	N	ER
2027	November	Private	PPGCL	PRAYAGRAJ TPP	2	660	9/6/2016	N	NR
2027	November	State	UPRVUNL	PARICHHA TPS	6	250	3/11/2013	N	NR
	November Total				**7**	**3520**			
2027	December	Private	RATTANINDIA	AMARAVATI TPS	4	270	3/4/2015	N	WR
2027	December	Private	JPL	TAMNAR TPP	3	600	3/30/2014	N	WR
2027	December	Central	NTPC	BARAUNI TPS	8	250	1/11/2018	N	ER
2027	December	State	DPL	D.P.L. TPS	8	250	3/31/2014	N	ER
2027	December	Central	NTPC	NABI NAGAR TPP	1	250	3/20/2016	N	ER
2027	December	Private	PPGCL (Tata)	PRAYAGRAJ TPP	3	660	5/22/2017	N	NR
	December total				**6**	**2280**			
2028	January	Private	JPPVL	NIGRI TPP	2	660	2/27/2015	N	WR
2028	January	Private	APL	TIRORA TPS	4	660	3/23/2014	N	WR
2028	January	State	MPPGCL	SATPURA TPS	10	250	3/22/2013	N	WR
2028	January	Private	HMEL	Hiranmaye TPP	2	150	12/31/2017	N	ER
2028	January	Private	GMR ENERG	KAMALANGA TPS	3	350	3/21/2014	N	ER
2028	January	Private	LPGCL	LALITPUR TPS	3	660	4/1/2016	N	NR
	January Total				**6**	**2730**			
2028	February	Private	APL	RAIKHEDA TPP	1	685	2/24/2015	N	WR
2028	February	Private	JPL	TAMNAR TPP	2	600	3/10/2014	N	WR
2028	February	Private	IEPL	BELA TPS	1	270	3/20/2013	N	WR
2028	February	Private	HMEL	Hiranmaye TPP	1	150	6/7/2017	N	ER
2028	February	Central	NTPC	BONGAIGAON TPP	2	250	3/22/2017	N	NER
2028	February	Private	RATTANINDIA	AMARAVATI TPS	1	270	3/25/2013	N	WR

2028	February	Central	NTPC	BARH II	4	660	11/20/2013	N	ER
	February Total				**7**	**2885**			
2028	March	Private	RATTANINDIA	AMARAVATI TPS	3	270	1/29/2015	N	WR
2028	March	Private	RATTANINDIA	NASIK (P) TPS	1	270	2/25/2014	N	WR
2028	March	State	GSECL	UKAI TPS	6	500	3/5/2013	N	WR
2028	March	Central	NTPC	NABI NAGAR TPP	2	250	4/3/2017	N	ER
2028	March	Private	PPGCL (Tata)	PRAYAGRAJ TPP	1	660	12/25/2015	N	NR
2028	March	Private	GMR ENERG	KAMALANGA TPS	2	350	9/28/2013	N	ER
	March Total				**6**	**2300**			
				TOTAL UNITS AND CAPACITY (Phase II)	**100**	**46825**			

IV. PHASE-III

Duration: July, 2028 to December, 2029

Under this phase, the following 101 Nos. of units of capacity 37215 MW in aggregate of various thermal power plants have been planned and identified for the upgradation/retrofitting for flexible operation including the study and field tests. This phase to be completed within a period of 18 months i.e. from July, 2028 to December, 2029.

			PHASE III (JULY , 2028 - DEC, 2029)						
Year	**Month**	**Sector**	**Organisation**	**Name of Project**	**Unit No.**	**Capacity (MW)**	**Date of Commissioning**	**Pithead**	**Region**
2028	July	Private	RPSCL	ROSA TPP Ph-II	3	300	12/28/2011	N	NR
2028	July	State	UPRVUNL	PARICHHA TPS	3	210	3/29/2006	N	NR
2028	July	Central	NEYVELI LIGNITE	NEYVELI NEW TPP	1	500	12/20/2019	Y	SR
2028	July	State	APGENCO	RAYALASEEMA TPS	4	210	11/20/2007	N	SR
2028	July	Private	APL	MUNDRA TPS	7	660	11/7/2011	N	WR
2028	July	Private	JSWEL	JSW RATNAGIRI TPP	1	300	8/24/2010	N	WR
2028	July	Private	JPL	OP JINDAL TPS	4	250	6/17/2008	N	WR
2028	July	Central	NTPC	DARLIPALI STPS	2	800	7/21/2021	Y	ER
2028	July	State	WBPDC	BAKRESWAR TPS	5	210	12/24/2007	N	ER
	July Total				**9**	**3440**			
2028	August	State	UPRVUNL	HARDUAGANJ TPS	8	250	9/27/2011	N	NR
2028	August	State	TSGENCO	KOTHAGUDEM TPS (NEW)	11	500	6/26/2011	N	SR
2028	August	State	APGENCO	RAYALASEEMA TPS	3	210	1/25/2007	N	SR
2028	August	Private	JSWEL	JSW RATNAGIRI TPP	4	300	10/8/2011	N	WR
2028	August	Private	APL	MUNDRA TPS	3	330	8/2/2010	N	WR
2028	August	Central	NSPCL	BHILAI TPS	1	250	4/20/2008	N	WR
2028	August	Central	NTPC	DARLIPALI STPS	1	800	12/30/2019	Y	ER
2028	August	Private	APL	TIRORA TPS	1	660	9/11/2012	N	WR
2028	August	Central	NTPC	INDIRA GANDHI STPP	3	500	11/7/2012	N	NR
2028	August	State	WBPDC	SAGARDIGHI TPS	2	300	12/21/2007	N	ER
	August Total				**10**	**4100**			
2028	November	State	HPGCL	RAJIV GANDHI TPS	2	600	10/1/2010	N	NR
2028	November	Private	APL	UDUPI TPP	2	600	4/16/2011	N	SR
2028	November	Central	NEYVELI LIGNITE	NEYVELI (EXT) TPS	2	210	7/22/2003	Y	SR
2028	November	State	MAHAGENCO	KHAPARKHEDA TPS	5	500	8/5/2011	N	WR
2028	November	Private	WPCL	WARDHA WARORA TPP	1	135	6/5/2010	N	WR
2028	November	Private	JPL	OP JINDAL TPS	3	250	3/6/2008	N	WR
2028	November	Central	DVC	DURGAPUR STEEL TPS	1	500	7/29/2011	N	ER
2028	November	Private	JPPVL	BINA TPS	1	250	8/12/2012	N	WR
2028	November	State	DPL	D.P.L. TPS	7	300	11/24/2007	N	ER
	November Total				**9**	**3345**			
2028	December	Private	RPSCL	ROSA TPP Ph-I	2	300	6/26/2010	N	NR
2028	December	State	APGENCO	RAYALASEEMA TPS	5	210	12/31/2010	N	SR
2028	December	State	KPCL	RAICHUR TPS	7	210	12/11/2002	N	SR
2028	December	Private	APL	MUNDRA TPS	6	660	7/20/2011	N	WR

2028	December	State	MAHAGENCO	PARAS TPS	2	250	3/27/2010	N	WR
2028	December	Private	JPL	OP JINDAL TPS	2	250	2/10/2008	N	WR
2028	December	Central	DVC	KODARMA TPP	1	500	7/20/2011	N	ER
2028	December	Private	JhPL(HR)	MAHATMA GANDHI TPS	1	660	1/12/2012	N	NR
2028	December	State	WBPDC	SANTALDIH TPS	5	250	11/7/2007	N	ER
	December Total				**9**	**3290**			
2029	January	State	HPGCL	RAJIV GANDHI TPS	1	600	3/31/2010	N	NR
2029	January	Private	APL	UDUPI TPP	1	600	7/23/2010	N	SR
2029	January	Central	NEYVELI LIGNITE	NEYVELI (EXT) TPS	1	210	10/21/2002	Y	SR
2029	January	Private	JSWEL	JSW RATNAGIRI TPP	3	300	5/6/2011	N	WR
2029	January	Private	LANCO	PATHADI TPP	2	300	3/25/2010	N	WR
2029	January	State	CSPGCL	DSPM TPS	2	250	12/11/2007	N	WR
2029	January	Private	MPL	MAITHON RB TPP	1	525	6/30/2011	N	ER
2029	January	Central	NTPC	SIMHADRI	2	500	8/24/2002	N	SR
2029	January	Central	DVC	MEJIA TPS	4	210	10/12/2004	N	ER
	January Total				**9**	**3495**			
2029	February	Private	RPSCL	ROSA TPP Ph-I	1	300	2/10/2010	N	NR
2029	February	State	KPCL	RAICHUR TPS	8	250	6/26/2010	N	SR
2029	February	Private	TAQA	NEYVELI TPS(Z)	1	250	10/21/2002	N	SR
2029	February	Private	WPCL	WARDHA WARORA TPP	4	135	4/30/2011	N	WR
2029	February	Private	APL	MUNDRA TPS	2	330	3/17/2010	N	WR
2029	February	Private	JPL	OP JINDAL TPS	1	250	9/2/2007	N	WR
2029	February	State	WBPDC	SANTALDIH TPS	6	250	6/29/2011	N	ER
2029	February	Private	RPSCL	ROSA TPP Ph-II	4	300	3/28/2012	N	NR
2029	February	Private	TATA PCL	JOJOBERA TPS	3	120	2/1/2002	N	ER
	February Total				**9**	**2185**			
2029	March	State	PSPCL	GH TPS (LEH.MOH.)	4	250	7/31/2008	N	NR
2029	March	State	TSGENCO	KAKATIYA TPS	1	500	5/27/2010	N	SR
2029	March	Private	WPCL	WARDHA WARORA TPP	3	135	1/21/2011	N	WR
2029	March	State	MAHAGENCO	PARLI TPS	7	250	2/10/2010	N	WR
2029	March	State	MPPGCL	SANJAY GANDHI TPS	5	500	6/18/2007	N	WR
2029	March	Private	SEL	STERLITE TPP	2	600	12/29/2010	N	ER
2029	March	Private	EPGL	SALAYA TPP	2	600	6/13/2012	N	WR
2029	March	State	MAHAGENCO	BHUSAWAL TPS	4	500	3/7/2012	N	WR
2029	March	State	WBPDC	BAKRESWAR TPS	4	210	3/21/2001	N	ER
	March Total				**9**	**3545**			
2029	July	State	HPGCL	YAMUNA NAGAR TPS	2	300	3/29/2008	N	NR
2029	July	State	APGENCO	Dr. N.TATA RAO TPS	7	500	10/8/2009	N	SR
2029	July	Private	APL	MUNDRA TPS	5	660	12/26/2010	N	WR
2029	July	Private	APL	MUNDRA TPS	1	330	8/4/2009	N	WR
2029	July	State	MAHAGENCO	PARAS TPS	1	250	5/31/2007	N	WR
2029	July	Private	SEL	STERLITE TPP	1	600	10/14/2010	N	ER
2029	July	Central	NTPC	INDIRA GANDHI STPP	1	500	10/31/2010	N	NR
2029	July	State	UPRVUNL	HARDUAGANJ TPS	9	250	5/25/2012	N	NR
2029	July	Private	TATA PCL	JOJOBERA TPS	2	120	2/1/2001	N	ER
	July Total				**9**	**3510**			
2029	August	State	PSPCL	GH TPS (LEH.MOH.)	3	250	1/3/2008	N	NR
2029	August	Private	JSWEL	TORANGALLU TPS(SBU-II)	2	300	8/24/2009	N	SR
2029	August	Private	APL	MUNDRA TPS	4	330	12/20/2010	N	WR
2029	August	Central	NSPCL	BHILAI TPS	2	250	7/12/2009	N	WR
2029	August	State	CSPGCL	DSPM TPS	1	250	3/30/2007	N	WR
2029	August	State	KPCL	BELLARY TPS	2	500	3/23/2012	N	SR
2029	August	Central	NTPC	INDIRA GANDHI STPP	2	500	11/5/2011	N	NR
2029	August	Private	EPGL	SALAYA TPP	1	600	2/22/2012	N	WR
2029	August	Central	DVC	MEJIA TPS	7	500	9/30/2010	N	ER
	August Total				**9**	**3480**			

2029	November	State	HPGCL	YAMUNA NAGAR TPS	1	300	11/1/2007	N	NR
2029	November	Private	JSWEL	TORANGALLU TPS(SBU-II)	1	300	4/23/2009	N	SR
2029	November	Private	JSWEL	JSW RATNAGIRI TPP	2	300	12/9/2010	N	WR
2029	November	Private	LANCO	PATHADI TPP	1	300	6/4/2009	N	WR
2029	November	State	MAHAGENCO	PARLI TPS	6	250	2/16/2007	N	WR
2029	November	State	OPGC	IB VALLEY TPS	4	660	7/2/2019	Y	ER
2029	November	Private	JhPL(HR)	MAHATMA GANDHI TPS	2	660	4/11/2012	N	NR
2029	November	Central	NTPC	DADRI (NCTPP)	5	490	1/25/2010	N	NR
2029	November	State	UPRVUNL	PARICHHA TPS	5	250	5/24/2012	N	NR
2029	November	Private	CESC	BUDGE BUDGE TPS	3	250	9/29/2009	N	ER
	November Total				**10**	**3760**			
2029	December	State	UPRVUNL	PARICHHA TPS	4	210	12/28/2006	N	NR
2029	December	State	KPCL	BELLARY TPS	1	500	12/3/2007	N	SR
2029	December	Private	WPCL	WARDHA WARORA TPP	2	135	10/10/2010	N	WR
2029	December	Private	TATA PCL	TROMBAY TPS	8	250	3/26/2009	N	WR
2029	December	State	MAHAGENCO	KHAPARKHEDA TPS	4	210	1/7/2001	N	WR
2029	December	State	OPGC	IB VALLEY TPS	3	660	7/2/2019	Y	ER
2029	December	Central	NTPC	SIMHADRI	1	500	2/22/2002	N	SR
2029	December	Private	VIP	BUTIBORI TPP	2	300	8/17/2012	N	WR
2029	December	State	WBPDC	SAGARDIGHI TPS	1	300	7/20/2008	N	ER
	December Total				**9**	**3065**			
	TOTAL UNITS AND CAPACITY (Phase III)				**101**	**37215**			

V. PHASE-IV

Duration: January, 2030 to December, 2030

Under this phase, the following 191 Nos. of units of capacity 55767 MW in aggregate of various thermal power plants have been planned and identified for the upgradation/retrofitting for flexible operation including the study and field tests. This phase to be completed within a period of 12 months i.e. from January, 2030 to December, 2030.

In case the utilities comprehend that 40% operation of units having age more than 40 years under this phase is not viable/possible, the utilities may opt for 2-shift operation by suitable retrofits/study/tests. However the duration for the retrofits including the study/test of this phase shall be the same.

		PHASE IV (JAN,2030 - DEC,2030)								
Year	**Month**	**Sector**	**Organisation**	**Name of Project**	**Unit No.**	**Capacity (MW)**	**Date of Commissioning**	**Pit head**	**Age as on 31.12.2029**	**Region**
2030	January	State	UPRVUNL	ANPARA TPS	7	500	3/6/2016	Y	13.8	NR
2030	January	Central	NTPC	RIHAND STPS	3	500	1/31/2005	Y	24.9	NR
2030	January	State	PSPCL	ROPAR TPS	6	210	3/30/1993	N	36.8	NR
2030	January	State	RRVUNL	KOTA TPS	4	210	5/1/1989	N	40.7	NR
2030	January	State	PSPCL	ROPAR TPS	3	210	3/31/1988	N	41.8	NR
2030	January	Central	NTPC	SINGRAULI STPS	5	200	2/26/1984	Y	45.9	NR
2030	January	Central	NTPC	SINGRAULI STPS	1	200	2/14/1982	Y	47.9	NR
2030	January	Central	NTPC	FARAKKA STPS	6	500	3/7/2011	Y	18.8	ER
2030	January	Central	NTPC	TALCHER STPS	3	500	2/21/2003	Y	26.9	ER
2030	January	State	OPGC	IB VALLEY TPS	1	210	6/2/1994	Y	35.6	ER
2030	January	State	WBPDC	KOLAGHAT TPS	6	210	3/17/1991	N	38.8	ER
2030	January	Central	NTPC	BARAUNI TPS	6	105	5/1/1983	N	46.7	ER

2030	January	Central	NTPC	RAMAGUNDEM STPS	7	500	9/26/2004	Y	25.3	SR
2030	January	State	TANGEDCO	NORTH CHENNAI TPS	2	210	3/27/1995	N	34.8	SR
2030	January	Central	NEYVELI LIGNITE	NEYVELI TPS-II	7	210	6/19/1993	Y	36.6	SR
2030	January	State	APGENCO	Dr. N.TATA RAO TPS	4	210	8/23/1990	N	39.4	SR
2030	January	Central	NEYVELI LIGNITE	NEYVELI TPS-II	1	210	1/17/1988	Y	42.0	SR
2030	January	Central	NTPC	RAMAGUNDEM STPS	3	200	12/13/1984	Y	45.1	SR
2030	January	State	TANGEDCO	Thoothukudi TPS	1	210	7/9/1979	N	50.5	SR
2030	January	Central	NTPC	VINDHYACHAL STPS	13	500	8/6/2015	Y	14.4	WR
2030	January	Central	NTPC	VINDHYACHAL STPS	12	500	3/22/2013	Y	16.8	WR
2030	January	Central	NTPC	SIPAT STPS	5	500	8/13/2008	Y	21.4	WR
2030	January	State	MPPGCL	SANJAY GANDHI TPS	3	210	2/28/1999	N	30.9	WR
2030	January	State	MPPGCL	SANJAY GANDHI TPS	1	210	3/26/1993	N	36.8	WR
2030	January	State	MAHAGENCO	KHAPARKHEDA TPS	2	210	1/8/1990	N	40.0	WR
2030	January	Central	NTPC	KORBA STPS	5	500	3/25/1988	Y	41.8	WR
2030	January	State	MAHAGENCO	CHANDRAPUR (MAHARASHTRA) STPS	4	210	3/8/1986	N	43.8	WR
2030	January	State	GSECL	WANAKBORI TPS	3	210	3/15/1984	N	45.8	WR
2030	January	State	MAHAGENCO	KORADI TPS	6	210	3/30/1982	N	47.8	WR
2030	January	Private	TOR. POW. (UNOSUGEN)	SABARMATI (D-F STATIONS)	1	120	10/12/1978	N	51.3	WR
	January Total				**30**	**8685**				
2030	February	State	UPRVUNL	ANPARA TPS	6	500	6/8/2015	Y	14.6	NR
2030	February	State	PSPCL	GH TPS (LEH.MOH.)	2	210	10/16/1998	N	31.2	NR
2030	February	Central	NTPC	DADRI (NCTPP)	3	210	3/23/1993	N	36.8	NR
2030	February	Central	NTPC	UNCHAHAR TPS	2	210	3/22/1989	N	40.8	NR
2030	February	Central	NTPC	TANDA TPS	1	110	3/21/1988	N	41.8	NR
2030	February	Central	NTPC	SINGRAULI STPS	4	200	11/2/1983	Y	46.2	NR
2030	February	State	UPRVUNL	OBRA TPS	12	200	3/28/1981	N	48.8	NR
2030	February	Central	NTPC	KAHALGAON TPS	7	500	7/31/2009	Y	20.4	ER
2030	February	Private	CESC	BUDGE BUDGE TPS	2	250	3/6/1999	N	30.8	ER
2030	February	State	TVNL	TENUGHAT TPS	1	210	4/14/1994	N	35.7	ER
2030	February	Central	NTPC	FARAKKA STPS	3	200	8/6/1987	Y	42.4	ER
2030	February	State	KPCL	RAICHUR TPS	6	210	7/22/1999	N	30.5	SR
2030	February	State	APGENCO	RAYALASEEMA TPS	2	210	2/25/1995	N	34.9	SR
2030	February	Central	NEYVELI LIGNITE	NEYVELI TPS-II	6	210	10/30/1992	Y	37.2	SR

2030	February	State	TANGEDCO	METTUR TPS	4	210	3/27/1990	N	39.8	SR
2030	February	State	TANGEDCO	METTUR TPS	2	210	12/1/1987	N	42.1	SR
2030	February	Central	NTPC	RAMAGUNDE M STPS	2	200	5/29/1984	Y	45.6	SR
2030	February	Private	SPL	SASAN UMTPP	6	660	3/19/2015	Y	14.8	WR
2030	February	State	CSPGCL	KORBA-WEST TPS	5	500	3/22/2013	Y	16.8	WR
2030	February	State	MPPGCL	AMARKANTA K EXT TPS	3	210	6/15/2008	Y	21.6	WR
2030	February	State	GSECL	WANAKBORI TPS	7	210	12/31/1998	N	31.0	WR
2030	February	State	MAHAGENCO	CHANDRAPUR (MAHARASHT RA) STPS	6	500	3/11/1992	N	37.8	WR
2030	February	Central	NTPC	VINDHYACHA L STPS	4	210	12/26/1989	Y	40.0	WR
2030	February	State	GSECL	WANAKBORI TPS	6	210	11/18/1987	N	42.1	WR
2030	February	State	MAHAGENCO	CHANDRAPUR (MAHARASHT RA) STPS	3	210	5/3/1985	N	44.7	WR
2030	February	Private	TATA PCL	TROMBAY TPS	5	500	1/25/1984	N	46.0	WR
2030	February	State	GSECL	WANAKBORI TPS	1	210	3/23/1982	N	47.8	WR
	February Total				**27**	**7470**				
2030	March	Central	NTPC	RIHAND STPS	6	500	10/17/2013	Y	16.2	NR
2030	March	Central	NTPC	TANDA TPS	4	110	2/20/1998	N	31.9	NR
2030	March	Central	NTPC	DADRI (NCTPP)	2	210	12/18/1992	N	37.1	NR
2030	March	Central	NTPC	TANDA TPS	2	110	3/11/1989	N	40.8	NR
2030	March	State	UPRVUNL	ANPARA TPS	3	210	3/12/1988	Y	41.8	NR
2030	March	State	RRVUNL	KOTA TPS	2	110	7/13/1983	N	46.5	NR
2030	March	State	UPRVUNL	OBRA TPS	9	200	1/26/1980	N	50.0	NR
2030	March	Central	NTPC	KAHALGAON TPS	6	500	3/16/2008	Y	21.8	ER
2030	March	Private	CESC	BUDGE BUDGE TPS	1	250	9/16/1997	N	32.3	ER
2030	March	Central	NTPC	KAHALGAON TPS	2	210	3/17/1994	Y	35.8	ER
2030	March	Central	NTPC	FARAKKA STPS	2	200	12/24/1986	Y	43.0	ER
2030	March	Private	JSWEL	TORANGALLU TPS(SBU-I)	2	130	5/16/1999	N	30.6	SR
2030	March	State	APGENCO	Dr. N.TATA RAO TPS	6	210	2/24/1995	N	34.9	SR
2030	March	State	TANGEDCO	Thoothukudi TPS	4	210	2/11/1992	N	37.9	SR
2030	March	Central	NTPC	RAMAGUNDE M STPS	6	500	10/16/1989	Y	40.2	SR
2030	March	Central	NEYVELI LIGNITE	NEYVELI TPS-II	3	210	3/29/1987	Y	42.8	SR
2030	March	Central	NTPC	RAMAGUNDE M STPS	1	200	10/27/1983	Y	46.2	SR
2030	March	Private	SPL	SASAN UMTPP	5	660	8/24/2014	Y	15.4	WR
2030	March	Central	NTPC	VINDHYACHA L STPS	11	500	6/14/2012	Y	17.6	WR
2030	March	Central	NTPC	SIPAT STPS	4	500	5/27/2007	Y	22.6	WR

2030	March	State	GSECL	GANDHI NAGAR TPS	5	210	3/17/1998	N	31.8	WR
2030	March	State	GSECL	GANDHI NAGAR TPS	4	210	7/20/1991	N	38.5	WR
2030	March	State	MAHAGENCO	KHAPARKHED A TPS	1	210	3/26/1989	N	40.8	WR
2030	March	Central	NTPC	VINDHYACHA L STPS	1	210	10/10/1987	Y	42.3	WR
2030	March	State	CSPGCL	KORBA-WEST TPS	3	210	3/26/1985	Y	44.8	WR
2030	March	Central	NTPC	KORBA STPS	2	200	10/31/1983	Y	46.2	WR
2030	March	State	MAHAGENCO	NASIK TPS	5	210	1/30/1981	N	49.0	WR
	March Total				**27**	**7190**				
2030	July	Central	NTPC	RIHAND STPS	5	500	5/25/2012	Y	17.6	NR
2030	July	State	PSPCL	GH TPS (LEH.MOH.)	1	210	12/29/1997	N	32.0	NR
2030	July	State	PSPCL	ROPAR TPS	5	210	3/29/1992	N	37.8	NR
2030	July	State	PSPCL	ROPAR TPS	4	210	1/29/1989	N	40.9	NR
2030	July	Central	NTPC	SINGRAULI STPS	7	500	11/24/1987	Y	42.1	NR
2030	July	Central	NTPC	SINGRAULI STPS	3	200	3/28/1983	Y	46.8	NR
2030	July	State	UPRVUNL	OBRA TPS	10	200	1/14/1979	N	51.0	NR
2030	July	Central	NTPC	KAHALGAON TPS	5	500	3/31/2007	Y	22.8	ER
2030	July	State	TVNL	TENUGHAT TPS	2	210	10/10/1996	N	33.2	ER
2030	July	Central	NTPC	FARAKKA STPS	5	500	2/16/1994	Y	35.9	ER
2030	July	Central	NTPC	FARAKKA STPS	1	200	1/1/1986	Y	44.0	ER
2030	July	State	KPCL	RAICHUR TPS	5	210	1/31/1999	N	30.9	SR
2030	July	State	TANGEDCO	NORTH CHENNAI TPS	1	210	10/25/1994	N	35.2	SR
2030	July	Central	NEYVELI LIGNITE	NEYVELI TPS-II	5	210	12/31/1991	Y	38.0	SR
2030	July	State	APGENCO	Dr. N.TATA RAO TPS	3	210	10/5/1989	N	40.3	SR
2030	July	Central	NEYVELI LIGNITE	NEYVELI TPS-II	2	210	2/6/1987	Y	42.9	SR
2030	July	State	TANGEDCO	Thoothukudi TPS	3	210	4/16/1982	N	47.7	SR
2030	July	Private	SPL	SASAN UMTPP	3	660	5/21/2014	Y	15.6	WR
2030	July	Central	NTPC	SIPAT STPS	3	660	6/2/2012	Y	17.6	WR
2030	July	Central	NTPC	VINDHYACHA L STPS	10	500	3/8/2007	Y	22.8	WR
2030	July	State	MAHAGENCO	CHANDRAPUR (MAHARASHT RA) STPS	7	500	10/1/1997	N	32.3	WR
2030	July	State	MAHAGENCO	CHANDRAPUR (MAHARASHT RA) STPS	5	500	3/22/1991	N	38.8	WR
2030	July	Central	NTPC	KORBA STPS	6	500	2/26/1989	Y	40.9	WR
2030	July	Central	NTPC	KORBA STPS	4	500	5/31/1987	Y	42.6	WR
2030	July	State	GSECL	UKAI TPS	5	210	1/30/1985	N	44.9	WR
2030	July	State	CSPGCL	KORBA-WEST TPS	2	210	6/21/1983	Y	46.6	WR

2030	July	State	MAHAGENCO	NASIK TPS	4	210	7/10/1980	N	49.5	WR
	July Total				27	9150				
2030	August	Private	LAPPL	ANPARA C TPS	2	600	11/15/2011	Y	18.1	NR
2030	August	State	UPRVUNL	ANPARA TPS	5	500	7/4/1994	Y	35.5	NR
2030	August	Central	NTPC	DADRI (NCTPP)	1	210	12/21/1991	N	38.1	NR
2030	August	Central	NTPC	UNCHAHAR TPS	1	210	11/21/1988	N	41.1	NR
2030	August	State	UPRVUNL	ANPARA TPS	2	210	2/28/1987	Y	42.9	NR
2030	August	State	RRVUNL	KOTA TPS	1	110	1/17/1983	N	47.0	NR
2030	August	State	UPRVUNL	HARDUAGANJ TPS	7	105	3/31/1978	N	51.8	NR
2030	August	Central	NTPC	TALCHER STPS	6	500	2/6/2005	Y	24.9	ER
2030	August	Central	NTPC	KAHALGAON TPS	4	210	3/18/1996	Y	33.8	ER
2030	August	State	WBPDC	KOLAGHAT TPS	5	210	12/28/1993	N	36.0	ER
2030	August	State	WBPDC	KOLAGHAT TPS	3	210	12/16/1985	N	44.1	ER
2030	August	Private	JSWEL	TORANGALLU TPS(SBU-I)	1	130	1/15/1999	N	31.0	SR
2030	August	State	KPCL	RAICHUR TPS	4	210	9/29/1994	N	35.3	SR
2030	August	State	TANGEDCO	Thoothukudi TPS	5	210	3/31/1991	N	38.8	SR
2030	August	Central	NTPC	RAMAGUNDE M STPS	5	500	3/26/1989	Y	40.8	SR
2030	August	State	TANGEDCO	METTUR TPS	1	210	1/4/1987	N	43.0	SR
2030	August	State	TANGEDCO	Thoothukudi TPS	2	210	12/17/1980	N	49.1	SR
2030	August	Private	SPL	SASAN UMTPP	4	660	3/25/2014	Y	15.8	WR
2030	August	Central	NTPC	SIPAT STPS	2	660	12/24/2011	Y	18.0	WR
2030	August	Central	NTPC	VINDHYACHA L STPS	9	500	7/27/2006	Y	23.4	WR
2030	August	Private	APL	DAHANU TPS	2	250	3/29/1995	N	34.8	WR
2030	August	Central	NTPC	VINDHYACHA L STPS	6	210	2/1/1991	Y	38.9	WR
2030	August	Central	NTPC	VINDHYACHA L STPS	3	210	2/3/1989	Y	40.9	WR
2030	August	State	GSECL	WANAKBORI TPS	5	210	9/23/1986	N	43.3	WR
2030	August	Private	TOR. POW. (UNOSUGEN)	SABARMATI (D-F STATIONS)	2	121	12/31/1984	N	45.0	WR
2030	August	Central	NTPC	KORBA STPS	1	200	2/28/1983	Y	46.9	WR
2030	August	State	MAHAGENCO	NASIK TPS	3	210	4/26/1979	N	50.7	WR
	August Total				27	7776				
2030	Novembe r	Private	LAPPL	ANPARA C TPS	1	600	11/12/2011	Y	18.1	NR
2030	Novembe r	Central	NTPC	DADRI (NCTPP)	4	210	3/24/1994	N	35.8	NR
2030	Novembe r	Central	NTPC	TANDA TPS	3	110	3/28/1990	N	39.8	NR
2030	Novembe r	State	RRVUNL	KOTA TPS	3	210	9/25/1988	N	41.3	NR
2030	Novembe r	Central	NTPC	SINGRAULI STPS	6	500	12/23/1986	Y	43.1	NR

2030	November	Central	NTPC	SINGRAULI STPS	2	200	11/25/1982	Y	47.1	NR
2030	November	State	UPRVUNL	OBRA TPS	11	200	12/31/1977	N	52.0	NR
2030	November	Central	NTPC	TALCHER STPS	5	500	5/13/2004	Y	25.7	ER
2030	November	State	OPGC	IB VALLEY TPS	2	210	10/22/1995	Y	34.2	ER
2030	November	Central	NTPC	FARAKKA STPS	4	500	9/25/1992	Y	37.3	ER
2030	November	Central	NTPC	BARAUNI TPS	7	105	3/31/1985	N	44.8	ER
2030	November	State	TSGENCO	KOTHAGUDEM TPS (NEW)	10	250	2/28/1998	N	31.9	SR
2030	November	State	APGENCO	Dr. N.TATA RAO TPS	5	210	3/31/1994	N	35.8	SR
2030	November	Central	NEYVELI LIGNITE	NEYVELI TPS-II	4	210	3/30/1991	Y	38.8	SR
2030	November	State	TANGEDCO	METTUR TPS	3	210	3/22/1989	N	40.8	SR
2030	November	State	KPCL	RAICHUR TPS	2	210	3/2/1986	N	43.9	SR
2030	November	State	APGENCO	Dr. N.TATA RAO TPS	2	210	10/10/1980	N	49.3	SR
2030	November	Private	SPL	SASAN UMTPP	2	660	12/18/2013	Y	16.0	WR
2030	November	Central	NTPC	SIPAT STPS	1	660	6/27/2011	Y	18.5	WR
2030	November	State	MAHAGENCO	KHAPARKHEDA TPS	3	210	5/31/2000	N	29.6	WR
2030	November	Private	APL	DAHANU TPS	1	250	1/6/1995	N	35.0	WR
2030	November	Central	NTPC	VINDHYACHAL STPS	5	210	3/31/1990	Y	39.8	WR
2030	November	Private	TOR. POW. (UNOSUGEN)	SABARMATI (D-F STATIONS)	3	121	9/28/1988	N	41.3	WR
2030	November	State	CSPGCL	KORBA-WEST TPS	4	210	3/13/1986	Y	43.8	WR
2030	November	State	CSPGCL	KORBA-WEST TPS	1	210	3/30/1984	Y	45.8	WR
2030	November	State	GSECL	WANAKBORI TPS	2	210	1/15/1983	N	47.0	WR
2030	November	State	GSECL	UKAI TPS	4	200	3/28/1979	N	50.8	WR
	November Total				**27**	**7586**				
2030	December	Central	NTPC	RIHAND STPS	4	500	9/24/2005	Y	24.3	NR
2030	December	State	UPRVUNL	ANPARA TPS	4	500	7/19/1993	Y	36.5	NR
2030	December	Central	NTPC	RIHAND STPS	2	500	7/5/1989	Y	40.5	NR
2030	December	Central	NTPC	RIHAND STPS	1	500	3/31/1988	Y	41.8	NR
2030	December	State	UPRVUNL	ANPARA TPS	1	210	3/24/1986	Y	43.8	NR
2030	December	State	UPRVUNL	OBRA TPS	13	200	7/21/1982	N	47.5	NR
2030	December	Central	NTPC	TALCHER STPS	4	500	10/25/2003	Y	26.2	ER
2030	December	Central	NTPC	KAHALGAON TPS	3	210	3/24/1995	Y	34.8	ER
2030	December	Central	NTPC	KAHALGAON TPS	1	210	3/31/1992	Y	37.8	ER
2030	December	State	WBPDC	KOLAGHAT	4	210	1/24/1984	N	46.0	ER

				TPS						
2030	December	State	TANGEDCO	NORTH CHENNAI TPS	3	210	2/24/1996	N	33.9	SR
2030	December	State	APGENCO	RAYALASEEM A TPS	1	210	3/31/1994	N	35.8	SR
2030	December	State	KPCL	RAICHUR TPS	3	210	3/30/1991	N	38.8	SR
2030	December	Central	NTPC	RAMAGUNDE M STPS	4	500	6/26/1988	Y	41.5	SR
2030	December	State	KPCL	RAICHUR TPS	1	210	3/29/1985	N	44.8	SR
2030	December	State	APGENCO	Dr. N.TATA RAO TPS	1	210	11/1/1979	N	50.2	SR
2030	December	Private	SPL	SASAN UMTPP	1	660	5/30/2013	Y	16.6	WR
2030	December	Central	NTPC	KORBA STPS	7	500	11/25/2010	Y	19.1	WR
2030	December	State	MPPGCL	SANJAY GANDHI TPS	4	210	11/23/1999	N	30.1	WR
2030	December	State	MPPGCL	SANJAY GANDHI TPS	2	210	3/27/1994	N	35.8	WR
2030	December	State	GSECL	GANDHI NAGAR TPS	3	210	3/20/1990	N	39.8	WR
2030	December	Central	NTPC	VINDHYACHA L STPS	2	210	7/23/1988	Y	41.5	WR
2030	December	State	GSECL	WANAKBORI TPS	4	210	3/9/1986	N	43.8	WR
2030	December	Central	NTPC	KORBA STPS	3	200	3/17/1984	Y	45.8	WR
2030	December	State	MAHAGENCO	BHUSAWAL TPS	3	210	9/18/1982	N	47.3	WR
2030	December	State	GSECL	UKAI TPS	3	200	1/21/1979	N	51.0	WR
	December Total				**26**	**7910**				
	TOTAL UNITS AND CAPACITY (Phase IV)				**191**	**55767**				

RAKESH KUMAR, Secy.

[ADVT.-III/4/Exty./617/2023-24]

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Annexure-A.VI

सत्यमेव जयते

Government of India
Ministry of Power
Central Electricity Authority

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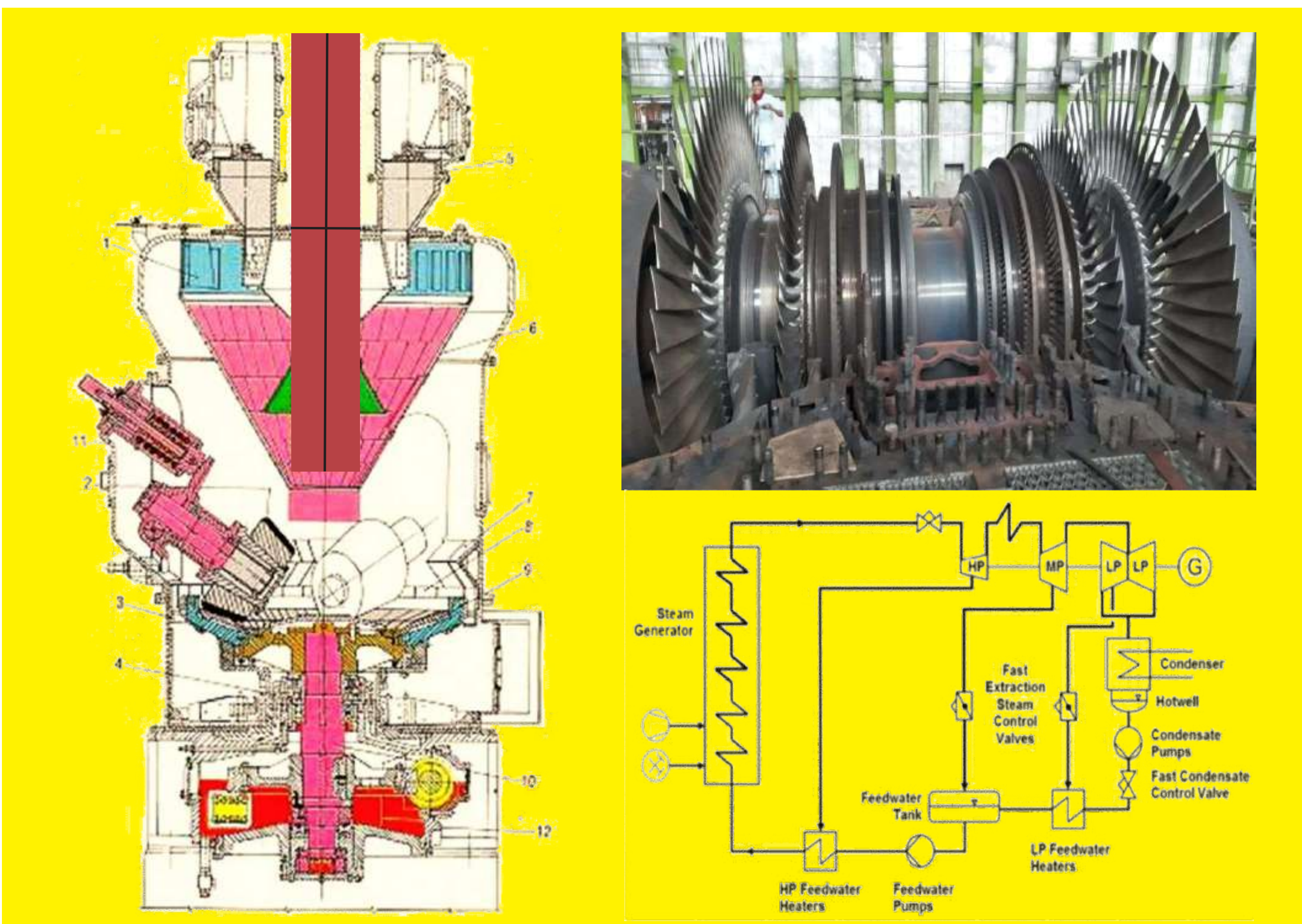
आज़ादी का अमृत महोत्सव

केविप्रा cea

FLEXIBILISATION OF COAL FIRED POWER PLANT



A Roadmap for Achieving 40% Technical Minimum Load

February, 2023

Sewa Bhawan, Sector 1, R K Puram, New Delhi – 110066

घनश्याम प्रसाद
अध्यक्ष तथा पदेन सचिव भारत सरकार
GHANSHYAM PRASAD
Chairperson & Ex-officio Secretary
To the Government Of India

सत्यमेव जयते

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नई दिल्ली–110066
Central Electricity Authority
Ministry of Power
Sewa Bhawan, R. K. Puram
New Delhi-110066

आज़ादी का अमृत महोत्सव

FOREWORD

India has great potential for renewables which has been recognized and a goal for attaining 500GW has been set by year 2030. To achieve the goal of integration of such high level of renewables there are both technical and financial challenges. The thermal units so far has been operated as base load plants which require overhauling. I am happy that TPRM Division, CEA has brought out a comprehensive report on flexible operation of base load thermal plants including operating procedure, challenges, retrofit and roadmap for achieving 40% load operation. The committee which was headed by B.C. Mallick, Chief Engineer, TPRM Division with members from various organizations have put in their valuable efforts and time to bring out an comprehensive reports covering important topics which shall be useful for the thermal utilities. It has also touched the cost aspects for achieving the flexibility of thermal units considering the requirement of retrofits and heat rate deterioration, etc. The pilot tests conducted under the support of CEA at various thermal units have added to the knowledge base of utilities/OEMs and highlighted the issues involved in our thermal units. The guideline has also deliberated on the issues as how these need to be tackled in effective manner.

It needs to be highlighted that flexible thermal units are one of the cheapest source of flexible power presently in the country. Hence, it will be crucial to ready the existing thermal units for the new operating regime enforced by the renewables. It shall help to optimize the operation of thermal units and reduce the emission burden of power generation.

I commend the efforts of Shri B. C. Mallick, Chief Engineer TPRM and Chairman of the committee for formulation of the entire report which shall lay the foundation of the flexibilisation of thermal power in the country.

(Ghanshyam Prasad)

दूरभाष (का०)
TELEPHONE (O)
TELEFAX (O)

सदस्य
तथा पदेन अपर सचिव भारत सरकार
केन्द्रीय विद्युत प्राधिकरण
सेवा भवन, रामाकृष्णा पुरम्

MEMBER
& EX-OFFICIO ADDL. SECRETARY TO THE GOVERNMENT OF INDIA
CENTRAL ELECTRICITY AUTHORITY
SEWA BHAWAN, R. K. PURAM

नई दिल्ली - 110066

NEW DELHI-110066

सत्यमेव जयते

Preface

Flexibilisation of coal fired plants has become inevitable for integration of power generated from renewable energy sources into the grid. The report "Flexibilisation of Coal-fired Power plants - A Roadmap for Achieving 40% Technical Minimum Load" prepared under the Chairmanship of Shri B. C. Mallick, Chief Engineer (TPRM), CEA shall guide the thermal power utilities, regulators and professionals for better understanding of the issues linked to flexibilisation and help them in formulating their future course of action.

I have gone through the report and found it to be very useful. The report is very exhaustive covering important topics like details of the various pilot tests conducted under the direction of CEA, procedure for flexible tests, the control modifications required, impact on the tariff and the future roadmap. In addition report is suggesting to explore the future possibility of two shift operation of thermal units based on the grid requirement.

I congratulate Shri B. C. Mallick, Chief Engineer & Chairman of the committee and other committee members for their valuable efforts in preparing the report.

(A. Balan)
Member (Thermal)

Bikash Chandra Mallick
Chief Engineer

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MINISTRY OF POWER
सेवा भवन, रामाकृष्ण पुरम्
SEWA BHAWAN, RAMAKRISHNA PURAM

नई दिल्ली–110066, दिनांक :
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ACKNOWLEDGEMENT

The power sector is going through transformational changes due to the environmental concerns. There shall be increased share of renewables in the grid in future which shall impose new operational requirement on the large existing thermal fleet. Thermal power utilities are going to find themselves at the receiving end in future, hence thermal units would have to modernize to remain in the business of power generation. The present report shall help thermal utilities in understanding the issues/ up gradations required in the plants and in the skills of the operators. The contents of the report are very comprehensive, incorporates the learnings from the low load tests conducted at various thermal units.

The flexible power is available from Hydro Power Plants, Pump Storage System, Thermal Power Plant and Battery Storage System. The cheapest flexible power may be available from hydro plants/ pump storage system, costlier from thermal power plants and costliest power from Battery storage system. Therefore our first preference to utilize or develop flexible power shall be from hydro/pump storage, second from thermal power plants and lastly from battery storage system.

The committee has considered heat balance study report of BHEL, SIEMENS, GE and actual test report of Dadri TPS, Maithon RBTPS, DSTPS, Sagardighi TPS, WBPDL, Ukai TPS, GESCL, Mouda TPS of NTPC. Accordingly suggested a Road Map for preparing thermal power plants flexible including operating procedure, identification of measure and cost of flexible power.

I would like to thank all the committee members from NTPC, BHEL, POSOCO, Tata Power, Siemens, GE, GESCL, independent consultants, and divisions of thermal wing who have contributed in preparing the report. I am thankful to Chairperson, CEA, Member (Thermal), CEA for their valuable guidance. Finally, I appreciate the efforts of TPRM Div. for their support.

(B.C. Mallick)
Chief Engineer (TPRM) &
Chairman of the Committee

CONTENTS

EXECUTIVE SUMMARY

GOI has set an ambitious target of 500 GW renewable generation by 2029-30 and 175GW by end 2022. There is a delay in capacity addition of 175GW RES due to covid-19 pandemic and the same may be achieved by end 2023. In near future thermal power plants fleet is expected to operate at an average minimum load of 40%. It shall drastically impact the schedule of most of the conventional generating plants and shall lead to operating thermal power plants at part load. Hence, thermal generating units shall haveto be tuned such that they can meet the new load demands in a very effective and efficient manner. And if any gaps are found, the same needs to be fixed.

A committee was constituted under the chairmanship of Sh. B. C. Mallick, Chief Engineer, TPRM Division, CEA with the members from various organizations. The committee would guide the central, state & private utilities in selecting thermal generating units and conducting low load test. The committee would also prepare a guideline for low load operation of TTPs, on the basis of experience gained from the pilot test, to help generating utilities in achieving flexibility in their units.

A comprehensive report has been prepared with the contribution of committee members from various organizations, consultants which are at the forefront for steering this new demand. The report comprises of eleven chapters which tries to covers the various important issues in details. The chapter-1 **"Need for Flexibilisation",** which gives the back ground for the new requirement which has arisen and the challenge faced by the thermal power sector. Chapert-2 "**Key Requirement of Flexibilisation"** elaborates the new regime of operation of power plants, i.e. minimum load, ramp rates requirement. For implementation of flexibilisation, the tests/studies are required to be conducted, the chapter-3, "**Studies Conducted"** describes the tests conducted so far and their major findings**.** The operation of thermal power plant in flexibilisation mode has lot of impact on the plant life, operation and maintenance, efficiency which has been briefly discussed in the chapter-4 "**Challenges of Flexibilisation".** The paradigm of operation of the plant changes due to the flexibilisation, hence new operating procedure which require changes and training of personnel is required to be upgraded (operating procedures). Based on the tests/ studies, there will be a clear picture obtained of the existing capabilities of the plant which shall require to be upgraded. The chapter-5 "**Procedures for low load tests"** describes the procedures in details for attaining the 40% low load operation without oil support and various parameters to be observed carefully during the test tofind the measures to be implemented in the generating unit. The chapter-6 "**Modification Required"** discusses in details the various options available for modification for the performance improvement. The flexibilisation has impact on the fixed and operating cost of the thermal power plant. The committee members have compiled costs for adopting measures for the improvement of flexible performance of thermal power plant as discussed in the chapter-7 "**Cost of Flexible power".** However, the capital costs for retrofit, given in the report, are only indicative in nature actual costs need to be ascertained by conducting a detailed feasibility study as the modifications are plant specific. Further, increased O&M cost form part of fixed tariff and efficiency degradation & increased oil consumption due to EFOR forms part of variable tariff. It has been found that impact of 40% low load operation on tariff (fixed + variable) is maximum about 7 to 8% which may increaseto some extent for old units. "**Two-shift operation"** of thermal power plants has been discussed in the chapter-8. The comparison of flexible power from the various sources is elaborated in the chapter -9 "**Flexible Power from Different Sources".** To refurbish the fleet of thermal units for flexibilisation, the time required for making them equipped forcycling has been presented in the chapter-10 "**Roadmap"**. Finally, in the last chapter-11 "**Conclusion and Way Forward"** the findings of the report have been summarized andsteps for implementation have been recommended.

Looking at the addition of renewables in future, the thermal power utilities will be required to play a very important role. The report prepared by thecommittee shall be beneficial for the utilities for understanding the need and implication of flexible operation of coal fired units.

BACKGROUND

India is moving ahead to achieve nationally determined contribution (NDC) of 40% of installed renewable capacity by 2030. The introduction of large scale renewable generation in the grid is bringing a new set of challenges in the power sector.

The inconsistency and intermittency of solar & wind power has to be managed by other sources of generation in order to ensure the grid stability. Flexible operation of existing coal-fired power plants is very much required to ensure security, reliability of power supply and stability of electricity grids while maximizing generation from renewable energies sources (RES) & integration of the same into grid. Because thermal generation capacity of 209 MW constituting 54% of total installed capacity is the dominant part of power generation in the country and more than 70% of country's energy demand is being met from thermal generation. Thus, flexible operation of thermal power plant is essential for handling the instability & intermittency of renewable generation.

The CEA report "Flexible operation of thermal power plants for integration of renewable generation" was finalized considering 175 GW RES by the committee constituted under chairmanship of Sh. B. C. Mallick, Chief Engineer (TPRM), CEA in January 2019. On the basis of net heat rate increase due to minimum thermal load (MTL) operation,thermal generating units are categorized under very flexible (40% MTL), flexible (45%MTL) and low flexible (50% MTL) group. In a particular day (with 175 GW RES) about 90 very flexible units (24 GW), 78 flexible units (42 GW) & 75 low flexible units (52 GW)from 243 grid synchronized thermal generating units (118 GW) are required for safe &secured grid operation.

In this regard, a committee was constituted under the aegis of CEA for implementation of findings of the above CEA's report and guide utilities for assessing their capabilities & identification of measures to be implemented to enhance flexibility with the following members.

1. Sh. B. C. Mallick, Chief Engineer, TPRM, CEA - Chairman
2. Sh. Rajeev Kumar, Dir./Sh. Pravir Kumar, Dir., TPRM, CEA - Convener
3. Sh. C.P. Jain, Director, TETD, CEA - Member
4. Sh. Y. M. Babu, GM /Sh P Mukherjee, GM /Sh. BVN Kishore, AGM BHEL - Member
5. Sh. N. Nallarasan, ED /Sh. Surajit Banerjee, GM POSOCO - Member
6. Sh. Snehesh Banerjee, AGM, NTPC - Member
7. Sh. A. K. Sinha, Technical Director , Intertek - Member
8. Sh. B.A. Gandhi, Executive Engineer, GSECL - Member
9. Sh. C.P. Tiwari, Head of technology & Process /Sh. Ashok Panda, Chief O&M, Tata Power - Member
10. Sh. Mahesh Kendhe, Head of Product Management, GE – Member

The Chairman of the committee coopted the following members:
1. Sh. Sandeep Chittora, Chief Manager, Siemens
2. Sh. Deepak Tiku, AGM, TPRM, CEA
3. Sh. Rohit Yadav, Dy. Director, TPRM, CEA

The committee shall guide the central, state & private utilities to conduct pilot test for flexible operation and prepare a report as per the following terms of reference -

i. Identify thermal units for pilot test and guide state/central private utilities to conduct pilot test of flexible operation.
ii. Prepare a guideline for pilot test of flexible operation of thermal unit.
iii. Identify measure for flexible operation and monitor implementation of measures at plant level.

OBJECTIVE

The majority of the power generation in the country is thermal, it has to be made flexible in its output for supporting the greening of grid. It would require identifying the thermal units which are technically and economical feasible for flexibilisation. The technical feasibility shall be decided by detailed studies/tests. The studies shall also explore the possibility of carrying out the required retrofits. The flexibilisation of thermal units involve capital expenditure depending upon the modifications required and the operating costs in terms of deteriorating performance, higher maintenance costs and loss of life. The main objectives of the committee are as follows-

- Explore the new technical minimum load of thermal generating units without oil support
- Assessment of thermal flexible power and ramp rate available for integration of renewable generation.
- Identify measures to be implemented thus Capex.
- Identify increase of net heat rate, O&M cost and consumption of life thus Opex.
- Targeting grid security and stability, less impact on tariff.
- Explore cost implication of flexible operation of thermal unit.
- Preparation of Roadmap for achieving new technical minimum load

ABBREVIATIONS

APH	Air Pre Heater
APRDS	Auxiliary steam Pressure Reducing and Desuperheating Station
AVT	All Volatile Treatment
BFP	Boiler Feed Pump
BMCR	Boiler Maximum Continuous Rating
C&I	Control & Instrumentation
CEP	Condensate Extraction Pump
CMC	Coordinated Master Control
CPU	Condensate Polishing Unit
CRH	Cold Reheat
DC	Declared Capacity
DCS	Distributed Control System
DM	De Mineralized
DNB	Departure from Nucleate Boiling
DO	Dissolved Oxygen
EFOR	Equivalent Forced Outage Rate
EHS	Equivalent Hot Start
EOH	Equivalent Operating Hours
ESP	Electro Static Precipitators
FAC	Flow Accelerated Corrosion
FD	Forced Draught
FEGT	Flue Exit Gas Temperature
FGD	Flue Gas Desulphurization
FRS	Feed Regulating Station
GCV	Gross Calorific Value
GW	Giga Watt
HBD	Heat Balance Diagram
HRH	Hot ReHeat
ID	Induced Draft
LRSB	Long Retractable Soot Blower
LTSH	Low Temperature Super Heater
MDBFP	Motor Driven Boiler Feed Pump
MS	Main Steam
MTL	Minimum Technical Load
PA	Primary Air
PC	Pulverised Coal
RAPH	Regenerative Air Preheater
RH	Re Heater
SCAPH	Steam Coil Air Pre Heater
SECD	Security Constrained Economic Dispatch
SH	Super Heater
TDBFP	Turbine Driven Boiler Feed Pump
TMCR	Turbine Maximum Continuous Rating
VM	Volatile matter
WWSB	Water Wall Soot Blower

1. NEED FOR FLEXIBILISATION

1.1 Global Commitments

The focus of power generation in the country had been on thermal power generation in the past as it was cheaper, having lower gestation time compared to hydro power and there are plenty of coal reserves for its sustenance. In recent times, there has been global environmental concerns regarding power generation from fossil fuel and steps are being taken in the country to make the power generation less carbon dependent. In October 2015, India submitted its Intended Nationally Determined Contribution (INDC) to UNFCCC. It aims is to achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance. It also aims to reduce the emission intensity of its GDP by 33% to 35% by 2030 from the 2005 level. Further, to create an additional carbon sink of 2.5 to 3 billion tons of CO_2 equivalent by resorting to additional forest and tree cover by 2030. The above national commitments have made it obligatory for the government to put greater emphasis on the renewables energy resources.

1.2 Thrust on Renewables

Renewable energy sources have the environmental advantages over fossil fuel fired plants, they are emission free, and however, the renewable alternative for bulk power generation was very costly earlier. The reduction in cost of renewable energy sources has given a push to the solar and wind based power generation. In fact, as per the recent cost trends, RE generation sources have become competitive with the conventional electricity generation. One of the major advantages is that India has vast renewable energy potential of around 1050GW which is largely untapped. It is estimated that the solar potential is around 748GWp and the wind potential is greater than 302GW* (MNRE Report 2019-20).

1.2.1 Target 2022

Considering the vast renewable potential, GOI has set an ambitious target of setting up of 175GW installed capacity from renewables (RE) by December 2022. Out of which, 100GW is planned through solar energy, 60GW through wind energy, 10GW through small hydro power, and balance 5GW through biomass-based power projects. The target for solar capacity is to be achieved through 40GW rooftop projects and balance through utility-scale solar plants and ultra-mega solar parks. The Covid-19 pandemic has slowed down the progress of Solar and Wind capacity addition in last 2 years.

1.2.2 Target 2030

To meet the INDC target by 2030, the installed capacity of renewables shall have to be increased. The recent CEA study indicates that the likely total installed capacity by the end of 2029-30 shall be 838.8GW which would include 454.4GW of renewables. With this renewable proposed capacity, the INDC target set for the country shall be easily met.

*at 100m agl.

1.2.3 Present Status

There is already a significant wind power capacity in operation and various initiatives have made solar PV more widespread. A significant growth has been experienced in past few years. The installed capacity of solar and wind is 94 GW as on 31st March, 2022 and total generation is 142 billion units for the period April to March, 2022 which is almost 9.5% of the total energy generation in the country.

1.3 Why stress on thermal generating unit?

Renewable power output has three major key limitations: *variability* varies from moment to moment, *uncertainty* cannot be predicted with any certainty in advance and *concentration*, is concentrated during a limited number of hours of the year. Thus creatinga need for the balancing the demand on various time scales for proper functioning, stability and security of the grid. The inconsistency and intermittency of solar & wind power has to be managed by other sources of generation in order to ensure the gridstability. Flexible operation of existing coal-fired power plants is very much required to ensure security, reliability of power supply and stability of electricity grids while maximizing generation from renewable energies sources (RES) & integration of the same
into grid, because thermal generation capacity of 209 MW constituting 54% of total installed capacity is the dominant part of power generation in the country and more than 70% of country's energy demand is being met from thermal generation. Thus, Flexible operation of thermal power plant is essential for handling the instability of renewable generation.

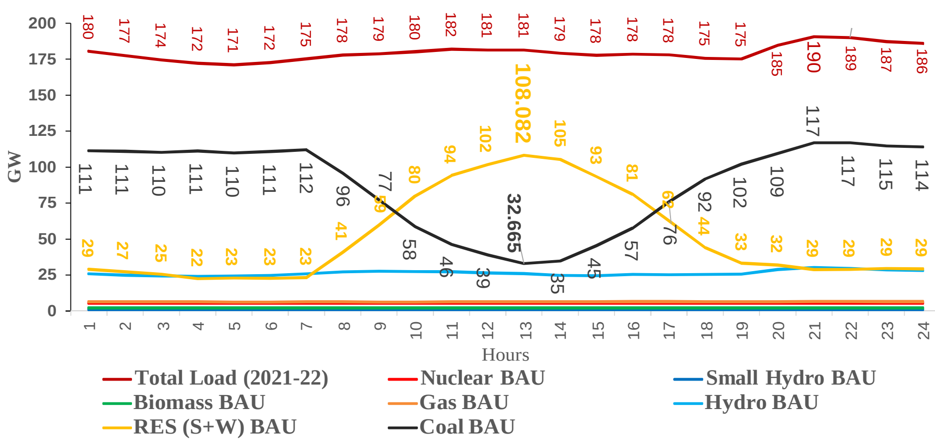


Figure 1.1 Demand & Generation on a critical day
(Source: CEA's report "flexible operation of thermal power plants for integration of renewable generation")

1.4 Load and Generation as predicted in CEA's Report (Jan 2019)

The above figure-1 shows the impact of the renewable generation on the daily net load demand of the grid. The top red curve is the forecasted load demand. The yellow curve is the power output considering the proposed installed capacity of solar and wind. The net load demand (black) is to be met by the fleet of thermal power units in the grid which is very steep. It creates demand of large flexible power from the base load thermal plants, reducing their minimum operating load and requiring steep ramp rates.

A significant proportion of the older coal-fired plants, are based on conventional sub-critical technology which were originally designed and built with steady base load operation. The major change like operating cyclically daily has major impact on coal-fired plant in several areas: operation and maintenance, plant life and economics. Hence, in a scenario of high penetration of renewables (175 GW) by 2023 (expected) there is an urgent requirement of developing the flexible capability of existing thermal power plants.

Further due to part load operation, the utilities will be forced to operate units at lower efficiency. It may therefore be required to undergo modernization of these plants with target of improving heat rate at lower minimum loads. The report presents various solutions that are available to be implemented in thermal power plants to have better operation and maintenance under flexible operation. These related issues are examinedin the following chapters.

2. KEY REQUIREMENT OF FLEXIBILISATION

2.1 Management of grid

The coal-based thermal generation is responsible for meeting more than 74% of India's electricity energy demand and this share is expected to stay near 50% by 2030. Thermal units would experience lower minimum loads and higher ramp rates as the share of variable renewable resources in the energy mix increases. Many studies performed toassess the impact of large scale renewable integration into the Indian power system have captured the aspect of increased flexibility demands on thermal power plants. As per CEA's report "*Flexible operation of thermal power plants for integration of renewable generation*", peak thermal flexible capacity (gross) required on the most critical day in year 2022 was found to be 140 GW considering 175 GW renewable installed capacity and the coordinated efforts from hydro, gas capacity and pumped storage system (PSS), the requirement of thermal capacity could be reduced to 117 GW. Further, the requirement of thermal flexible power is also reduced from 84 GW to 64 GW. Thus, coordinated efforts of hydro, PSS, gas is important for reduction of stress on thermal units and followings have been recommended for balancing the grid:

I. Final Balancing shall be done at national level which will minimize the requirement of balancing power.

II. Hydro power plants are especially suitable for quick supply of flexible power. Coordination with state hydro power plant for reallocation of generation and provision of separate (higher) tariff for flexible hydro power are suggested. If the tariff is increased, hydro rich states (those are continuously operating due to very low cost) will draw power from grid during day time and operate during peaking hours. Tariff (minimum) of flexible hydro power should be higher than the off-peak grid power.

III. Flexible operation of coal-fired plant (up to 40% minimum load).

IV. Study on demand side management (implement TOD metering) including measure targeted at domestic, industrial and e-mobility sector would enable more rationalconsumption pattern of electricity which will improve the off-peak to peak generation ratio of thermal power plants. Thus reduction of regional as well as national peak demand.

V. Study or land survey to avail the geographically advantage for establishment of pump storage.

VI. Two shift operation of smaller size thermal units.

VII. Shifting of Agricultural load from night hours to day during solar peak generation period

VIII. Battery Storage: One of the important source of flexible power is battery storage. This capacity should be as low as possible for the following reason:

   a) Lithium reserves are not available in India.

   b) High cost

c) Service life is about 10 years
d) Disposal issue

In the Indian power system, role of thermal generation has evolved from being operated as base load till recently to be used as the major source of flexible power. With increase in all-India ramping requirements over the years, most of the additional ramping is being met by thermal generation, with maximum thermal ramp touching 250 MW/ minute in 2018-22, as seen in figure 1. The maximum ramp up and ramp down rate as projected in CEA's "*Flexible operation of thermal power plants for integration of renewable generation*" report were 379 MW/min and 422 MW/min. considering 175 GW RES. The increasing need for flexibility is driven by change in demand pattern with round-the-clock power supply, and increasing penetration of RE resources.

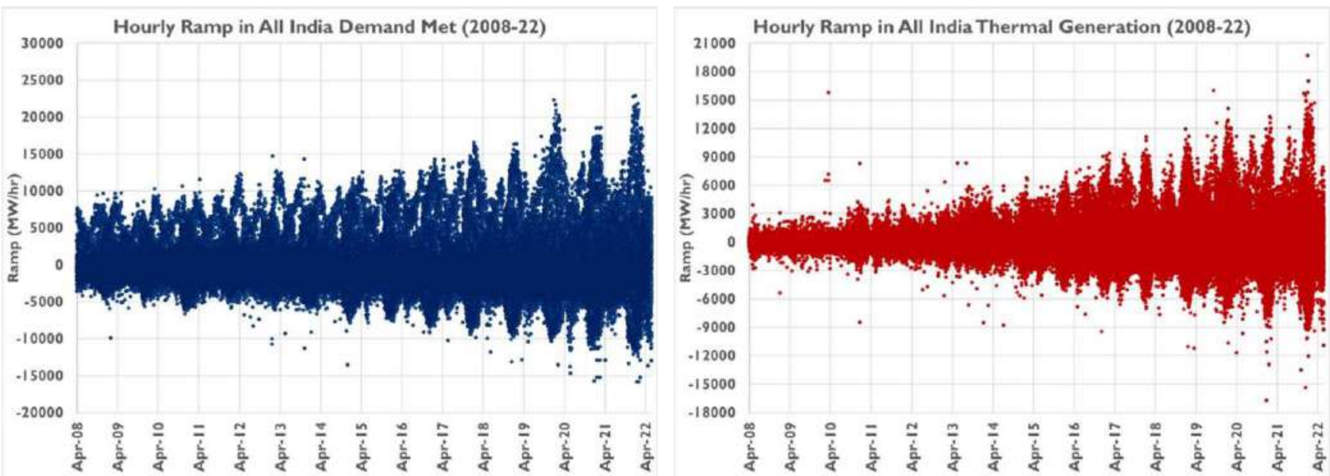


Figure 2.1 Hourly Ramp Rates of Demand and Thermal Generation in India - 2008 to 2022 (Source: POSOCO)

POSOCO report on Flexibility Analysis of Thermal Generation for RE integration utilized time series data of 438 thermal units to quantify flexibility across different units. Here flexibility is expressed as percentage of *(Daily Maximum Generation – Daily Minimum Generation)/Installed Capacity*. The day-wise flexibility requirement of the Indian power system demand is increasing at 8-9 GW/annum, and it reached a maximum of 72GW during winter of 2021-22 (Figure 2.2). On all India basis, thermal flexibility is on increasing trend, approaching 30-35% during 2021-22 (Figure 2.3). About 40% of India's thermal units are reaching minimum generation levels in the range of 60-70% of installed capacity (Figure 2.4).

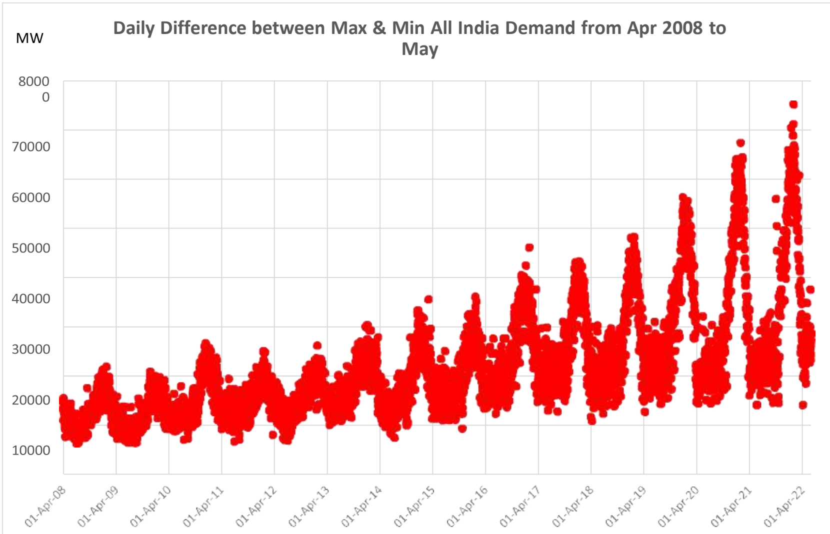


Figure 2.2 Difference between Max. and Min. All India Demand

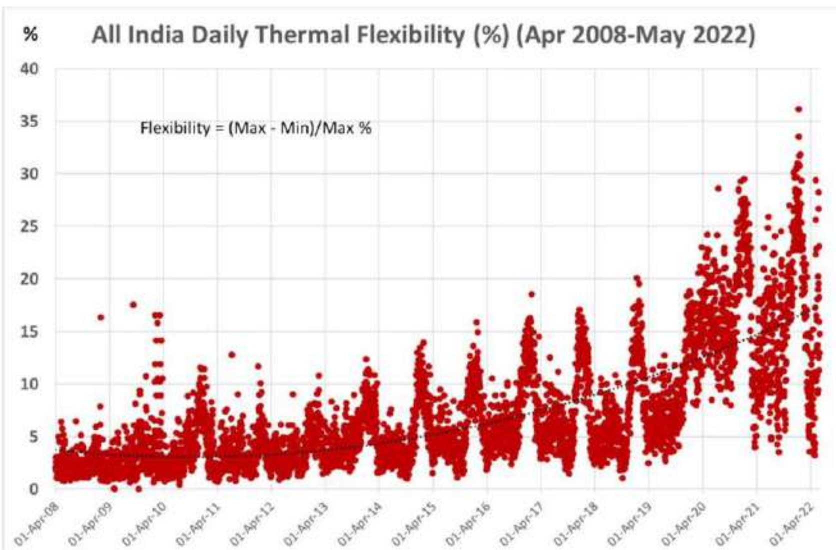


Figure 2.3 Trend of DailyThermal Flexibility

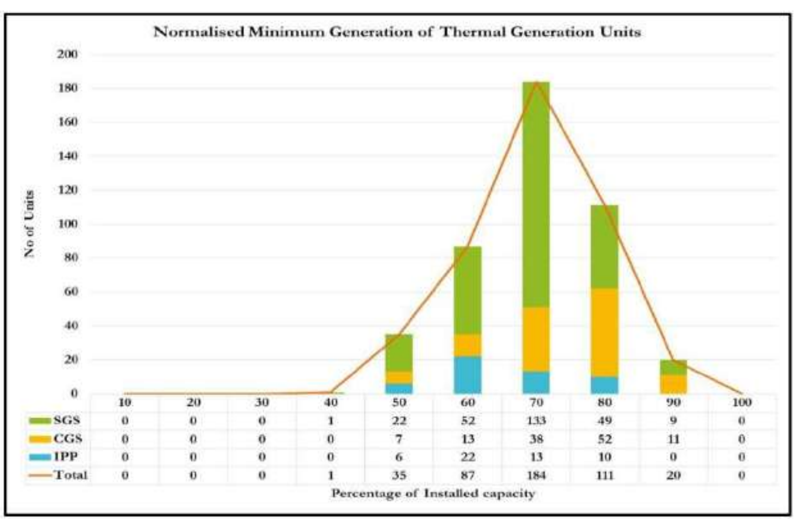


Figure 2.4: Distribution of average minimum generation of thermal units

A pilot study on *Security Constrained Economic Dispatch* (SCED) is operational in national grid since 1st April 2019. It aims at optimizing the production cost of generation at national level while satisfying all plant and system security constraints at all times. 52 thermal inter-state generating stations with 58GW capacity are part of the study. Technical minimum (55% at present) and ramp up/ramp down rates are part of the constraints honoured by SCED. The duals of the binding constraints in SCED have been extracted for the entire period and analyzed in the report on SCED pilot. As expected, the more expensive stations are constrained by technical minimum for most of the time (Figure 2.5).

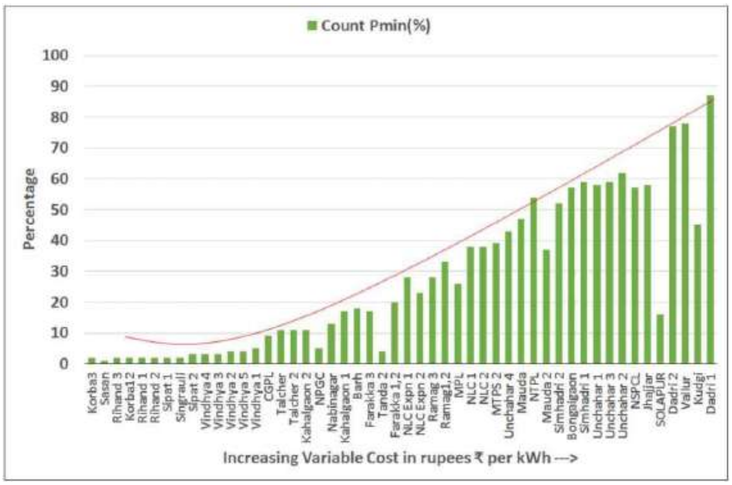


Figure 2.5 Percentage of time technical minimum constraints in SCED (Apr-Dec 2019)

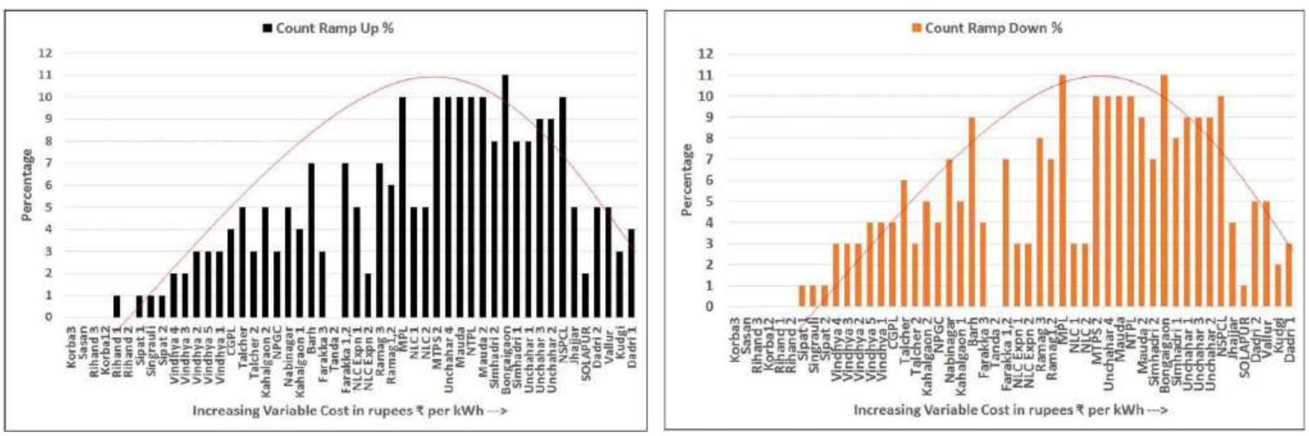


Figure 2.6 Percentage of time ramp up and ramp down constraints in SCED (Apr-Dec 2019)

In the present scenario, with maximum renewable penetration around 18-20% (in energy terms), there are some instances where thermal flexibility is exhausted. Figure 2.7 shows an example from 27th January 2019, showing the trend of total schedule for the thermal ISGS. It can be seen that the total ISGS generation moves from nearly technical minimum (during morning off-peak), to nearly DC (during morning peak), in a matter of a few hours due under drawl by states. Such need for flexibility would get exacerbated with increasing RE.

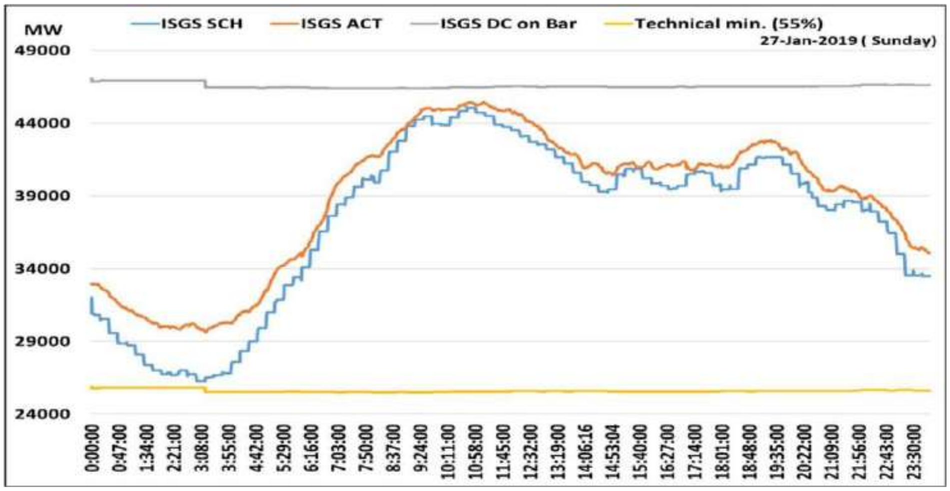


Figure 2.7 Trend of thermal ISGS schedule on 27th January 2019

There are major solar power parks in operation across several locations in the grid. A cloud cover over large solar parks has the potential to create large changes in solar output. These large changes in the generation may disrupt load-generation balance and pose as a potential threat to system operation. In order to manage these unexpected events, it is required that generation fleet has enough flexibility available with them.

2.2 Flexibility for Grid Support Services

The need for flexibility is also manifested in the primary and secondary frequency response provided by thermal units. Experiences from testing of primary frequency response and operation of Automatic Generation Control are summarized below:

2.2.1 Primary Response: Primary response is an important aspect for ensuring frequency control in the interconnected power system. IEGC 2010 mandates Free/RestrictedGovernor mode of operation in coal based units above 200MW. Onsite testing exercise is being carried out in compliance to IEGC, as per requirements it is desired that coal based unit displays sustained stable response corresponding to change in frequency. It is desired that primary response is sustained and stable at all load levels and there is minimum interaction with other control loops in the plants

Secondary Response: Continuous operation of Automatic Generation Control (AGC) has commenced from 20th July 2021. While doing so, all unit level constraints suchas P_{max}, P_{min} and ramp rates furnished by the stations are being honoured. Despite a significant capacity of 62GW included under AGC, the aggregate response obtained fromthe power plants for frequency control is often inadequate. A maximum of around +/- 1500 MW only is being obtained from all the power plants put together. A key reason forthis inadequate response from the power plants is attributed to a limit amounting to 5% of the unit capacity on the AGC, ΔP sent from NLDC imposed on the request of power plants. On account of the above, despite reserves being available in several plants, the same remains unutilized in secondary control.

2.3 Flexible Capacity Required/Available

As per CEA's report on optimal capacity mix for 2029-30 the likely total installed capacity by the end of 2029-30 projected is 8,38,783MW comprising of Hydro 61,657MW (including Hydro Imports 5,856MW), PSP 10,151MW, Small Hydro 5,000 MW, Coal 2,68,511MW, Gas 25,080MW, Nuclear 18,980MW, Solar 299,404MW, Wind 140,000MW and Biomass 10,000MW. With this installed capacity, the INDC target set for India i.e. the percentage of non- fossil fuel capacity in the total installed capacity is to be 40% by 2030 which is likely to be met. The likely renewable installed capacity shall be 450,000MW by March 2030. Recently, GOI has revised the commitment of renewables to 500GW. Hence with higher penetration of renewables (2030) and so as to avoid RE curtailment, the thermal units may have to operate below 40% minimum technical load.

As per the CEA report "*Flexible operation of thermal power plants for integration of renewable generation*" there will be maximum requirement of around 84GW flexible power (for integration of 175 GW RES capacity) from the grid connected thermal capacity of 140GW in year 2021-22. Study on maximum RES generation day in a month, 12 maximum RES generation days corresponding to 12 months of the year, 2021-22 have been calculated after prediction of hourly Generation for year, 2021-22 from Solar, Wind, Nuclear, Gas, small hydro, biomass and then coal. Actually coal generation is calculated figure and it is achieved by subtracting hourly generation of all sources except coal from hourly demand as predicted in EPS and the balanced generation to be met from thermal power plant.

The study highlighted that power generation BAU will lead to operation of the thermal plants at 26% capacity on the most critical day. However, considering flexing of the hydro power, gas based stations, pump storage station the minimum technical load could be improved to 46% from 26%. It is also found from the report that maximum RES generation of 107,798MW, 107,413MW will be available in the month of June, July respectively and ramp down & ramp up rate as calculated will be 380MW/min. & 375MW/min. respectively. As Indian high ash contained coal is not suitable for 26% minimum load operation, various steps have been proposed to improve the average minimum load operation of coal-fired power plant to 45%. However, this figure may be decreased further below 40% considering the 500 GW renewable integration by 2030. Detail study is proposed to ascertain the figure.

2.4 Ramp Rate Required/Available

The detailed analysis on average ramp rate required considering 175GW Renewable installed capacity has been done in CEA's report "Flexible Operation of Thermal Power Plant for integration of renewable Generation" which is reproduced below:

2.4.1 Maximum Ramp Up Rate

(379 MW/min when total demand is 200 GW)

Let us consider the day of highest ramp up rate, when maximum ex-bus generation from thermal plant is 154GW. After considering 10% reserve capacity and 7% APC, about 184GW thermal capacity would be synchronized on that day. Considering 1%/min ramping by the scheduled units, the system capability comes out to be 1840 MW/min. This is substantially higher than the ramp up rate required (379 MW/min.).

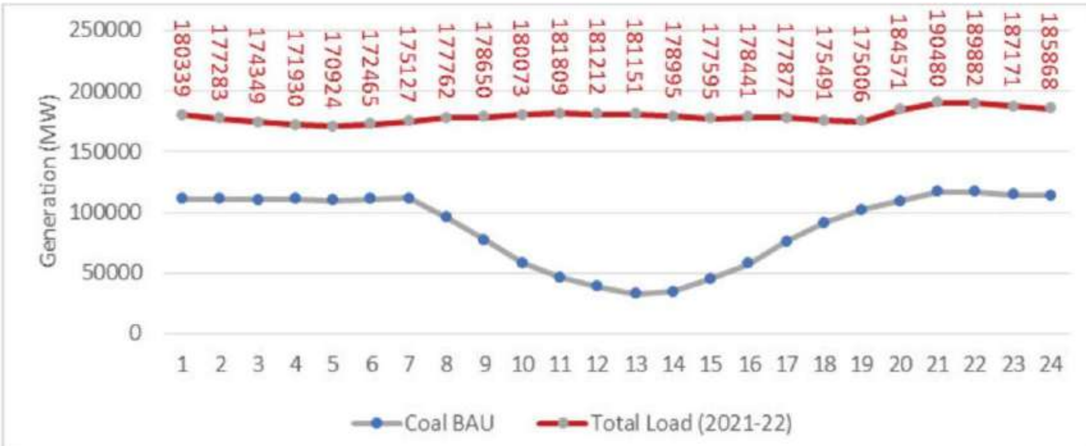


Figure 2.8

2.4.2 Maximun Ramp Down Rate

(422 MW/min when total demand = 185 GW)

Maximum ex bus generation required from thermal is 140GW. Considering 10% reserve and 7% APC, about 167 GW thermal capacity has to be synchronized. If we consider 1% ramp rate of each unit, then the system ramp capability comes out to be 1670 MW/min which is again substantially higher than the requirement on that day of 422MW/min. Hence, Indian grid is comfortably placed in case individual units maintain a basic ramping capability of 1%/min. Therefore, it may be concluded that ramp rates are not a challenge for integration of renewable generation from 175 GW RES into Indian grid.

However, the future ramp requirement may be increased to 1.5%- 2% considering 500GW renewable integration by 2030. The detail study is required to ascertain the figure in the light of 15-minute renewable generation time block.

3. STUDIES CONDUCTED

A number of flexibility studies in association with national/international partners (IGEF/VGB/GE/USAID/JCOAL/TEPCO/BHEL/Siemens) has been carried out at Central/State/Private plants. The flexible operational tests have been conducted at 40% load and higher ramps at number of stations in collaboration with OEM and others. These tests would add to the knowledge base and shall strengthen the understanding of the challenges involved in flexible operation of thermal units.

3.1 Pilot Tests/Studies

The pilot tests/studies conducted already under international cooperation and with the help of OEM are as follows:

1. Dadri TPS of NTPC in collaboration of IGEF, Germany
2. Mauda TPS of NTPC in collaboration of BHEL
3. Sagardighi TPS of WBPDCL in collaboration of BHEL
4. Ukai TPS of GSECL in collaboration of USAID, BHEL
5. RBTPS, JV of Tata Power, DVC in collaboration of IGEF/VGB, Germany
6. DSTPS of DVC in collaboration of IGEF/VGB, Germany

The results of concluded pilot tests at various power stations are as described below:

3.1.1 Dadri TPS, (NTPC), Dist. Gautambudh Nagar, UP

Test Date: 21 & 22/06/2018

Unit No.: 6

Unit Capacity: 500MW

Following tests were conducted:

	Test	Target	Achieved
a.	Minimum Load Test at 40%	200MW	200MW
b.	Ramp Up Test	3%/min	~ 1.5%/min
c.	Ramp Down Test	3%/min	~ 1.5%/min
d.	Ramp Up Test	1%/min	~ 0.86%/min
e.	Ramp Down Test	1%/min	~ 0.5%/min

The results are based on IGEF report dated 28/09/2018.

3.1.2 Mouda TPS, (NTPC), Dist. Nagpur, Maharashtra

Test Date: 16/02/2019

Unit No.: 1

Unit Capacity: 500MW

Following tests were conducted:

Test	Target	Achieved
a. Ramp up Test (3%)	3%/min	~ 2.04%/min
b. Ramp down Test (3%)	3%/min	~ 2.01%/min
c. Ramp up Test (1%)	1%/min	~ 1.04%/min
d. Ramp down Test (1%)	1%/min	~ 0.92%/min

Test Date: 29/05/2019
Unit No.: 2
Unit Capacity: 500MW
Following tests were conducted:

Test	Target	Achieved
a. Minimum Load Test at 40%	200MW	200MW
b. Ramp up Test (3%)	3%/min	~ 1.14%/min
c. Ramp down Test (3%)	3%/min	~ 1.68%/min
d. Ramp up Test (1%)	1%/min	~ 0.85%/min
e. Ramp down Test (1%)	1%/min	~ 0.9%/min

3.1.3 Sagardighi TPS, (WBPDCL), Dist. Musheerabad, West Bengal

Test Date: 27/06/2019
Unit No.: 3
Unit Capacity: 500MW
Following tests were conducted:

Test	Target	Achieved
a. Minimum Load Test at 40%	200MW	200MW
b. Ramp Up Test	3%/min	~ 1.6%/min
c. Ramp Down Test	3%/min	~ 2.6%/min
d. Ramp Up Test	1%/min	~ 1.1%/min
e. Ramp Down Test	1%/min	~ 0.67%/min

The flexibilisation test was conducted by BHEL team and was also witnessed by representative from TPRM Division, CEA.

3.1.4 Ukai TPS, GSECL, Gujarat

Test Date: 3rd to 7th March, 2020
Unit No.: 6
Unit Capacity: 500 MW
Following tests were conducted:

Test	Target	Achieved
Minimum Load Test at 40%	200 MW	200 MW
Ramp Test (3%)	3%/min	1.6%-2%/min
Ramp Test (1%)	1%/min	~1.0%/min

3.1.5 RBTPS, (Tata Power, DVC JV), DIST. Dhanbad, Jharkhand

Test Date: 22/07/2021 to 27/07/2021
Unit No: 2
Unit Capacity: 525MW
Following tests were conducted:

Test	Target	Achieved
Minimum Load Test (40%)	210MW	210MW 190MW (36%)* *achieved for short duration of 10min.
Ramp Up/Down Test	1%/min	

The ramp rates achieved were as follows:

	Upward direction	Downward direction
290 MW – 525 MW	0.95%/min	1.52%/min
MW – 290 MW	do	0.95%/min
210 MW – 225 MW	do	0.38%/min

3.1.6 DSTPS, (DVC), Andal, West Bengal

Test Date: 28/03/2022 to 31/03/2022
Unit No: 2
Unit Capacity: 500MW
Following tests were conducted:

Test	Target	Achieved
Minimum Load Test (40%)	200MW	201MW 173MW (34.6%)* *achieved for duration of over 2hrs.
Ramp Up/Down Test	1%/min	

The ramp rates achieved were as follows:

	Upward direction	Downward direction
From 55% – 72% Load	2.26%/min	
From 82% – 62% Load		1.54%/min

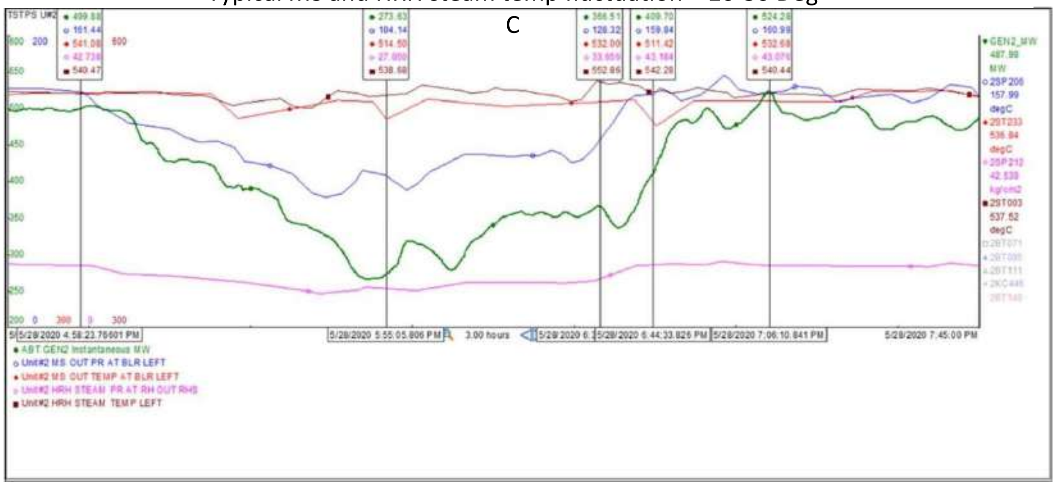
3.2 Observations from the Pilot Studies

Following were the observations for pilot project at

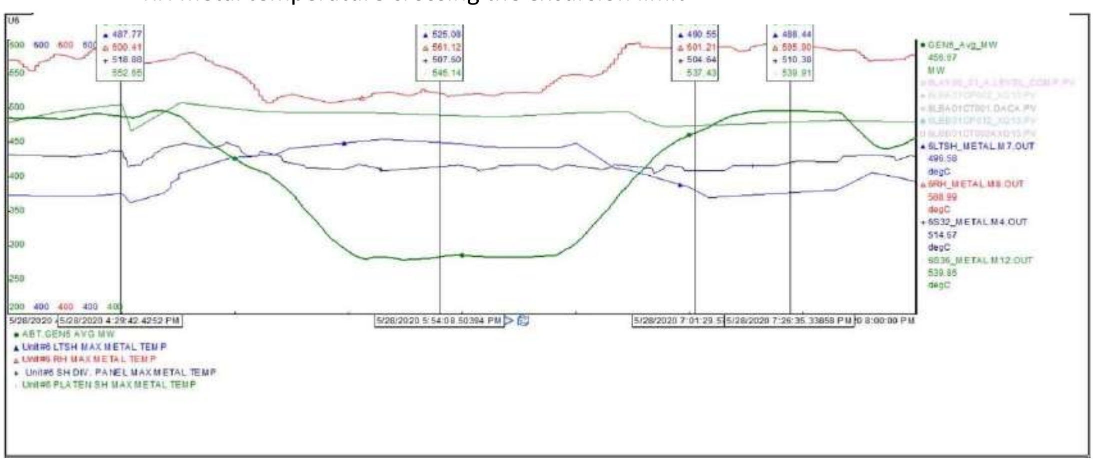
3.2.1 Excessive fluctuations in Steam temperatures- MS and HRH.

Steam temperature control becomes difficult as fuel flow rate and feed water flow rate decrease.

Typical MS and HRH steam temp fluctuation ~ 20-30 Deg C



RH metal temperature crossing the excursion limit



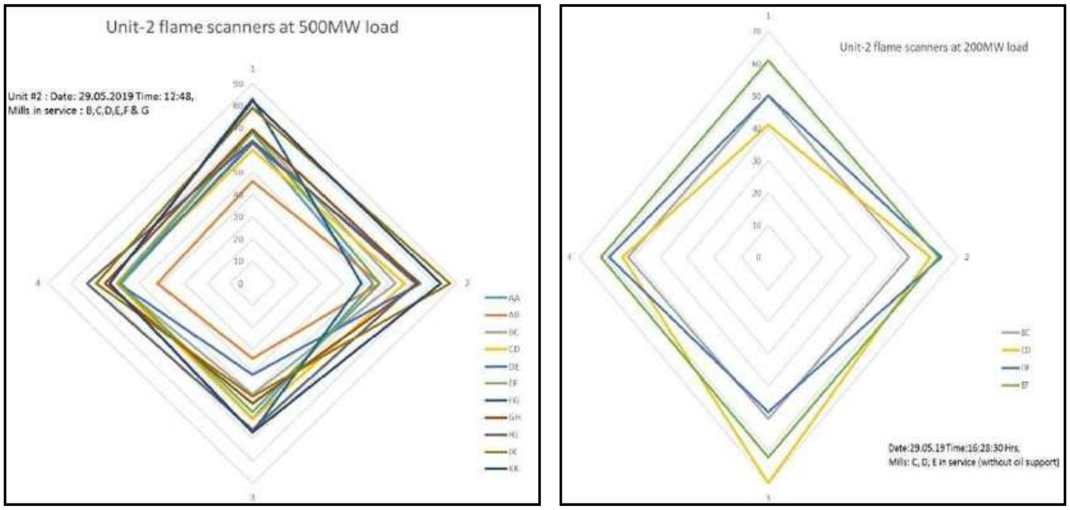
3.2.1 High Drum level swings during ramping.

Drum level fluctuation

3.2.2 Flame disturbance during ramping and at MTL.

Fuel flow and air flow decrease, and balance of fuel and air sometimes collapses at some space in furnace of boiler, and combustion becomes unstable.

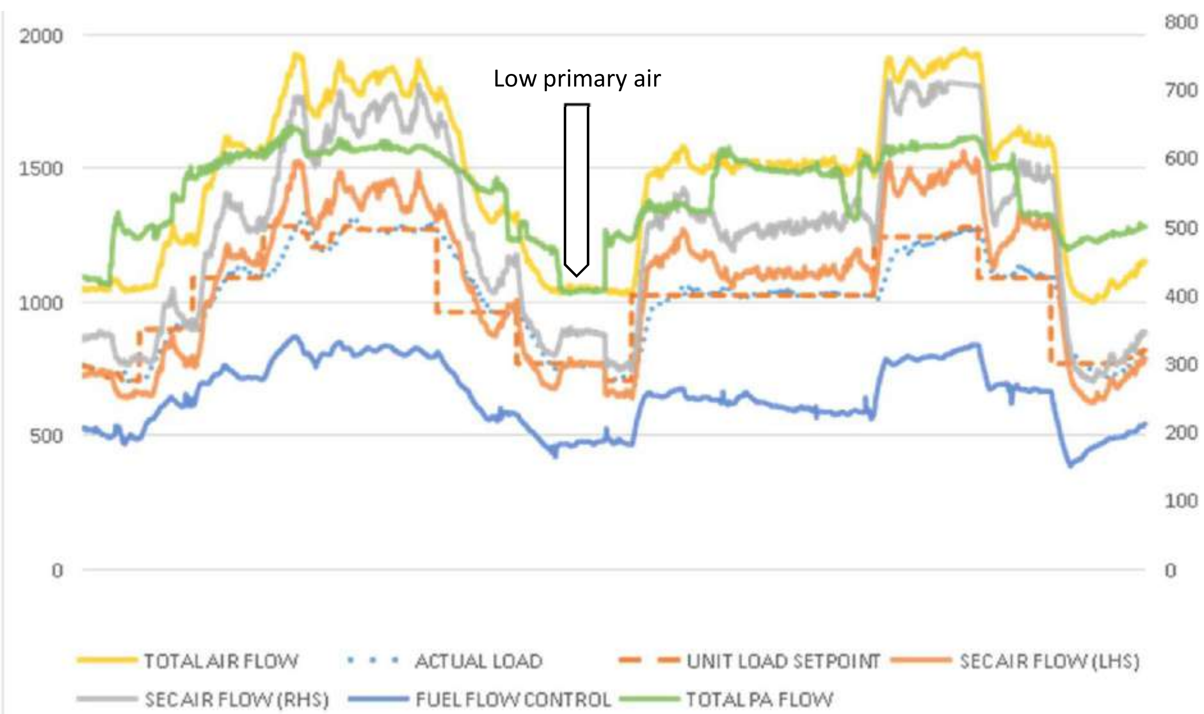
Flame scanners at 100% vs 40% load- Mouda U#2



3.2.3 Occasional furnace pressurization.

3.2.4 Chances of Stalling of Primary Air fans at low loads

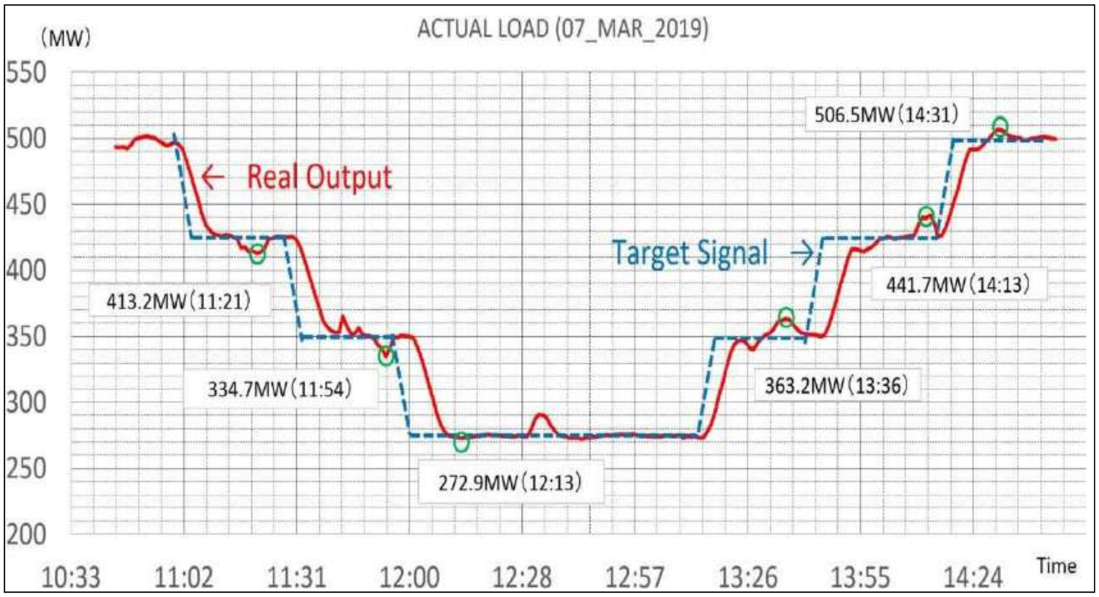
Low primary air flow can lead to stalling- Mouda U#2



3.2.6 Low boiler flue gas exit temperature, leading to acid corrosion?

3.2.7 With 3% ramp commands, actual ramp rate achieved in full load range from technical min. loading to full load was only 1.3% due to manual milling system operation.

Typical Ramp rate – Target vs Actual achieved



4. CHALLENGES OF FLEXIBILISATION

The challenges being faced for flexibilisation of the coal fired power plants are mainly due to the operation of thermal power plants as base load stations in the past so as to cater to unceasing power shortages in the country. It has resulted in low automation levels, low optimization of plant operation beyond the rated load and low ramping capability. The studies have generally found that on design basis, the units have enough flexibility of operation, but as a matter of fact, lack of some control logics and lack of enough tuning at test operation, actual flexibility of operation is limited. Further, the inferior quality of coal has added to the challenges of flexibilisation which impacts the stabilization of flame at low loads. After the introduction of new emission norms for thermal power plants in Dec, 2015, the compliance of SO2 and NOx limits are mandatory. Meeting NOx limits at low operating loads shall be a matter of concern needs to be tackled. The various roadblocks faced in flexibilisation of coal fired power plants and the possible mitigation strategies are discussed in details below:

4.1 Plant Capabilities

The flexing capability of a unit depends on the following factors

- Design- Thin-walled components/special turbine design will be better at flexing, shorter start-up time, higher ramp rate.
  - Boiler drum in Sub-critical units can pose challenges during flexible operation.
  - Super-critical units are better for load ramping operations but flexible operation at lower minimum load is challenging below benson point. However, operating the super-critical units on sub-critical mode has a very high impact on efficiency.
- Vintage- In older units the damage will be faster
- Coal- Poor coal quality will restrict flexible operation. (Discussed in the next section)
- Milling System- The start-up time and load ramp-up depend on the time to start the mills. It can vary from 10 minutes to 15 minutes.
- Control system- A good control system offers a huge advantage for maintaining proper parameters during flexible operation and to reduce the operational delays.

4.2 Impact on fuel quality

There is a large variation of quality amongst the different regions. Boilers are designed to burn coal of specified quality and any changes to the specified quality will significantly impact the performance and controllability of boilers. Change in coal from the design coal to a lower quality coal affects boiler operation and performance and particularly during low load operation with poor coal quality, the combustion stability of the boiler is severely affected and require additional support of secondary fuel (fuel oil). Challenges with poor coal quality include:

- Boiler slagging and fouling
- Increased corrosion and erosion
- Boiler tube metal temperatures excursion

- Lower boiler efficiency
- Overloading ash handling system
- Overloading of dust removal system and increased emissions

It is important to understand, how the different constituents in coal influence the performance during flexible operation and what improvements can be made. There is a wide variation in Indian coal fed to power stations from different sources. GCV varies from 2500 to 6000 Kcal/kg, Moisture - 8% to 15%, Volatiles- 18 to 30%, Ash- 25 to >50%.

4.2.1 Moisture – Part load efficiency is an important consideration of flexible operation and moisture affects unit efficiency by impacting thermal performance. Moisture has a flame quenching tendency and absorbs latent heat. High coal moisture content will lower the coal's gross calorific value (GCV), which means that that more fuel quantity will be required to be fired for the same heat input to the unit. The increased moisture in the fuel reduces boiler efficiency. Moisture also affects the pulveriser capacity and along with increased fineness in a coal adversely affects the coal handling capability. Coal moisture affects the following:

- Boiler efficiency
- Mill drying/ Tempering air requirements
- Gas velocities through the unit
- Choking in coal pipes
- Flame stability
- Precipitator efficiency

4.2.2 Ash -The challenges include, loss of reliability and availability, boiler slagging, fouling, high-temperature metal wastage, cold-end corrosion, stack emissions, increased deterioration in APH performance, duct leakages, increased water consumption, increased maintenance costs and lower unit efficiency. The quantity, chemical composition, and size of the ash are the variable that affect unit performance as well asthe marketability of ash & disposal. Ash quality affects the following:

- Mill wear
- Erosion
- Slagging and fouling
- Ash handling equipment performance
- APH performance
- SH/RH steam temperatures
- ESP Performance & Particulate emissions
- Capacity of CHP, bunkers, mills, boiler hoppers, ESP etc.

4.2.3 Volatile Matter - The volatile matter is an index of the gaseous fuels produced upon heating of the coal as it enters the furnace, mainly hydrogen and hydrocarbons that sustain ignition. Typical range of VM is 18% to 30%. Higher VM coals generally produce less NOx and are also easier to control in the combustion system, especially in low load operation.

Some of the Indian coals have VM of around 15% and stable combustion becomes extremely difficult, even at higher loads. There have been increased occasions of unit trips on flame failure (even during base load operation) at stations burning low VM coal. The problem gets aggravated further when coal fineness, A/F ratio and/or distribution of A/F is non-optimal, low volatile fuel results in furnace imbalances and increased amounts of de-volatilized carbon char seeking oxygen in the upper furnace and resulting in secondary combustion.

4.2.4 Sulphur Content - Sulphur in coal determines the degree of expected corrosion in the high/low temperature regions of the boiler. The amount of SO_2 that will be produced depends on the Sulphur content of the coal. A small part (2-3%) of the Sulphur in coal converts to SO_3, and the amount of SO_3 produced and retained in the flue gas determines the dew point of the flue gas and the collection efficiency of the precipitator. Sulphurcontent affects APH corrosion, duct & ESP corrosion. The problem is further aggravated during flexible operation when maintaining the flue gas temperature above the dew point becomes challenging.

4.2.5 Nitrogen Content- Nitrogen content (in volatile and fixed carbon) causes NOx formation. Fuel NOx ranges from 60–80% of the total NOx in pulverized coal units. The NOx formation can be reduced with staged combustion. During flexible operation, without sufficient automation for air flow control and combustion optimization NOx control becomes challenging.

4.2.6 Gross calorific Value (GCV) - The heat produced by combustion of unit quantity of a solid or liquid fuel when burned at constant volume in an oxygen bomb calorimeter under specified conditions, with the resulting water condensed to a liquid. There is alarge variation of GCV in Indian Coal, typically varying from 2500-6000Kcal/kg. The GCV of the fired coal is one of the key determinants of the technical minimum level.

4.2.7 Ash fusion temperatures

Ash fusion temperatures can be exacerbated by reducing atmospheres that are related with penthouse or convection pass air in-leakage that is upstream of the boiler O_2 probes. This can be a serious problem in Indian power stations with increased flexing and combined with high ash Indian coals.

4.3 Impact on Plant life

Flexible operation increases the creep-fatigue damage caused by thermal stresses, especially in units originally designed for base load operation. The creep-fatigue is a dominant failure mode for damage and failures of many fossil plant components. Creep-fatigue damage mostly occurs at stress concentration points like header bore holes, ligaments, rotor grooves, etc. due to large plastic strain. Accelerated Corrosion fatigue damage during flexible operation is another common factor. Maintaining optimum water and steam chemical parameters is challenging during frequent cycling. Almost all components of the Boiler, turbine and generator are affected ranging from severe to moderate. Following are some of the severely affected components:

Thick wall components	▪ Casting such as turbine valves and casings ▪ Turbine Rotor ▪ Thick-walled vessels ▪ MS, CRH, HRH headers (especially Y-piece section)
High temperature component	▪ Superheater, Reheater ▪ Ties used to support SH, RH tubing ▪ Tube to header joints etc. ▪ Gas duct work
Corrosion and scaling prone component	▪ Water wall tubing at attachments (wind box, corner tubes, wall box opening, buck stay) Heater tube ▪ APH - cold end ▪ Condenser tube ▪ Welded joints
Degeneration of insulation due to thermal transients	▪ Generator insulation ▪ Transformer insulation ▪ Insulation of HV drives (FD, ID, PA fans, mills motor)

The pilot studies carried out in the Indian power stations revealed the following deviations/damage mechanisms during flexible operation.

1) High exhaust hood temperatures
2) High steam seal temperatures
3) High rate of change of metal temperatures
4) Last stage blade vibration
5) Solid particle erosion
6) Main steam and reheat steam temperature differential
7) Internal corrosion and oxygen pitting of waterwall tubes
8) Higher rates of internal corrosion of steam tubing due to increased exfoliation
9) Accelerated creep damage to steam (superheater and reheater) tubing
10) Chemistry upsets/excursions resulting in hydrogen damage
11) Fatigue corrosion due to cycling stresses on waterwall tubes
12) Furnace subcooling resulting in external tube failures
13) Overheating during low load operation by improper burner configuration
14) Steam line quenching
15) Higher risk of furnace explosion due to low turn down of fuel capabilities
16) Economizer inlet header thermal fatigue cracking

These damages impact the thermal units by:

1) Increased life consumption leading to increased maintenance, operation (excluding fixed costs), and overhaul capital expenditures.
2) Increased time-averaged replacement energy and capacity cost due to increased Equivalent Forced Outage Rate (EFOR).
3) Efficiency loss- Increased cost of heat rate changes due to low load and variable load operation.
4) Increased cost of start-up fuel, auxiliary power, chemicals, water, and extra manpower for start-ups.
5) Environmental Impacts

4.4 Impact on Environment

4.4.1 ESP

At low loads, there can be instances when the temperature in the ESP falls below the dew point and there is a built up of ash due the moisture, which becomes difficult to remove. Moreover, with high Sulphur coal there can be severe acid corrosion due to maintaining lower flue gas outlet temperature. During frequent start-ups, the ESPs ate kept out ofservice during oil firing. During this period, maintaining the particulate emissions becomes challenging. Due to lower efficiency of the thermal units during minimum loads, the specific CO_2 emissions increase.

4.4.2 FGD operation during flexibilization

During flexible operation, there can be many issues with the FGD operation, which would need precise controls and modified operation procedures. Frequent start-up can have issues of solidification of slurry and accumulation of start-up oil on the linings. Long period of shutdown will require proper lay-up and flushing of slurry in order to ensure that lime slurry does not solidify. During load variations and frequent low loads, the operation of different streams and circulating pumps need to be optimized through automated controls.

A common problem observed during low load operation is reduction of inlet flue gas temperature, which is likely to impact the reaction rates. In some of the designs regenerative heat exchangers are used but in effect there may be a substantial decrease in exit temperature which in turn will reduce the gas buoyancy and induce dew point corrosion in the duct and chimney. Some FGD units bypass FGD plants (those with fluegas by-pass system), during start-up and low loads and charge the FGD after the temperatures stabilizes.

4.5 Impact on Efficiency

The loss on account of deterioration in efficiency of the unit at part loads is another major category of flexing costs. A typical deterioration of efficiency (net heat rate) for different categories (based on GE inputs is shown in figure-4(a). It may be noted that as per another study by NTPC this will vary from machine to machine and these losses will be significantly lower if the unit is run on sliding pressure (Figure-4(b)).

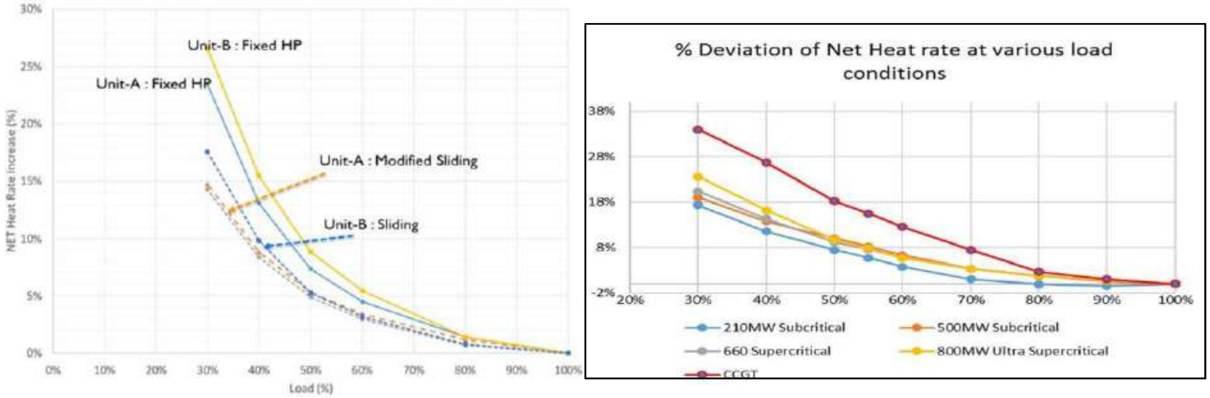


Figure-4(a): Net Heat rate Increase VS Loading Factor 4(b) NHR increase on fixed/slidingpressure

There is a good reason to put in extra efforts in modifying the operational practices for improvement in part load efficiency. Any plant modification/retrofits for improving the efficiency at part load will have a very short payback as degradation in efficiency is the biggest cost for low operation.

In a pulverized coal unit, there would be a less significant loss in efficiency if the unit operates on variable pressure mode. It is therefore worthwhile to make provision for sliding pressure operation for improved part load efficiency.

Combustion optimisation and reduced excess air, further improve the heat rate. Similarly, during test runs conducted at different units (500 MW coal fired of State Utilities, India), the heat rates were measured at different loads (90%, 55% and 40 %) under various conditions. One of the areas, where optimisation became difficult wasthe air flow requirements at 40% load which contributed to the increased stack losses. Otherwise at upper load conditions, significant improvement in heat rates were observed after optimization of air flow and operating the unit on sliding pressure. However, during varying load conditions, optimization is difficult and can interfere with the unit's ramping capability. Upgrading the C&I systems would be necessary for achieving the desired benefits.

Various auxiliaries in water and steam cycle of the unit have been designed with 2x50% configuration required at 100% TMCR for ensuring reliability. For low load operations at 40% TMCR, running both set of auxiliaries may not be required and thus single stream operation may be adopted which will allow for reduction in auxiliary power consumption. VFD installation may also be explored in units which operate on low loads for long duration.

A cautions decision would be required based on cost benefit analysis between APC reduction and controls and hardware modification cost for unit reliability.

4.6 Impact on Maintenance and unit Operators

As flexible operation leads to increased life consumption of plant components, increased outages and failures, it calls for revisiting the maintenance practices, increased inspection schedules and ensuring sufficient spares. Some of the components will have accelerated wear and failures during flexing operation (like mills, boiler pressure parts, valves) and would require increased maintenance. The maintenance strategy has to be devised, based on the extent of flexibilization. The frequency of significant load following, number of start-ups, coal quality, vintage of the machine.

Installing digital tools for online condition monitoring and damage assessment (like EOH/ EHS calculator) can be of great help in getting inputs of focused maintenance and on deciding the frequency of maintenance and component replacement.

Personnel safety is of first and foremost priority in operation and maintenance of coal based generating unit whether it is on flexible operation or on base load. Flexibilization of units adds to the safety risks and calls for added precautions. Sometimes serious and fatal injuries are caused by catastrophic equipment failure due to negligence and poor operation and maintenance practices.

In most of the cases, the boiler is often the most dangerous equipment, if not operated and maintained properly and in that case, it can act like a potential explosive.

Maintaining optimum chemical parameters is another challenge during flexible operation and the operating procedure must be modified to take care of the same. Moreover, flexible operation may require short of long shutdowns and adequate preservation needs to be ensured.

Some of the key takeaways from the field Tests for developing techniques for Low Load Operations:

4.6.1 For minimum load operation the mantra is sustaining stable combustion by manipulating the firing rates, maintaining even temperature distribution within the different zones of the boiler, managing the coordination between the boiler and turbine. Reducing the number of mills in service. At 40% load 3 mills were kept in service

4.6.2 **Optimisation of primary air flow**. The primary air flow in mills were reduced. A review of primary air flow curve should be considered for low load.

4.6.3 **Optimisation of secondary air flow**. Tertiary vanes of elevations that were not in service were reduced, ensuring just adequate flow for burners cooling. It was ensured that the wind box pressure did not collapse to zero. Measurement of secondary air flow was not available. This could have helped in further optimization of the process. It is therefore recommended to make provisions for SA measurements at individual burners.

4.6.4 **Measurement of excess air** for combustion /Flue gas O_2 measurement may be validated with CO measurement as CO is unaffected by air in-leakages. It is advisable to use both the measurements.

4.6.5 **Sliding pressure** induces a sluggish load response for drum boilers. But the advantages are far more. Modification of sliding pressure curve (increased slightly) in small steps is to be done to ensure that there is no steaming in economizer and no DNB.

4.6.6 **BFP recirculation valves** must be able to operate at intermediate positions (inching type). At 40 % load, one TDBFP can meet the feed water demands. The changeover of driving steam source must be ensured. Ensure readiness of MDBFP on hot standby.

4.6.7 During the test runs, a number of manual interventions were made in the presence and advice of the OEM. In particular, there were issues during fast load changes and manual intervention on the firing system raising the risk of combustion instability and boiler puffs. During such operation, the safe functioning of the burner management systems must be ensured. For severe demands during regular low load and ramping operation, enhancement of controls, monitoring and diagnostic systems is worthwhile and has been recommended in all the studied carried out, including the OEM's. As per the limitations encountered during the field tests, upgrades for automatic loading control and combustion management will be required.

4.6.8 The unit control system consists a number of loops and sub loops, with master controllers and coordinated by CMC. In older base load units, the C&I systems were designed to provide responsive control in the higher load range and oftenthe C&I specs aimed at automatic operation in the range of 60% to 100% MCR. The automatic control at lower loads becomes poor and sluggish mainly due to changing unit response characteristics.

4.6.9 Another limitation with low load operation is the improper sizing of many control valves for low load or low flows operation, causing poor control response and sometimes hunting of valves. All these control valves must be checked for correct operation at low load and necessary modifications be done. Replacement or placing additional valves may be necessary.

4.6.10 Additionally, for cyclic operation, review and modifications will be required for the alarms and protection logic. A review and evaluation of the alarms and protections setting is required as the unit would operate at different levels from those for which these were designed to operate. Before finalizing any changes, the opinion of the OEM must be taken. Examples include-minimum air flow, minimum mills loading, temperature setting, modification of sliding pressure curve, primary air flow curve, temperature settings etc.

4.6.11 When a base load unit is converted to operate on flexible mode, the operator's view of the process (displayed on LVS or other screen) needs to be modified to include the actions that may be needed during the particular operating regime. These screens can include the important or problematic processes along with trends to facilitate the operator to react fast in case of any process deviation during the cycling operations, for example, a screen for low load operation and for start-up (cold, warm & hot) and for shutdown.

4.6.12 The life of a steam turbine is directly related to thermal transients experienced over time. The typical steam turbine start-up ramp rate is well-defined by the OEM, as there are limits to the heating rates of the turbine parts.

4.7 Roadblocks & Mitigation strategies:

The pilot studies and subsequent operations presented some challenges which were taken up with international partners for suggestive mitigation plans. A brief of the roadblocks, mitigation plans and the retrofit requirements is given below:

S.no.	Roadblocks	Mitigation plan	Remedial measures
A	**Equipment Operating Mode:-**		
1	Achieving >1% Ramp rate (up and/or down); Increasing number of ramp~~s~~ up/down during the day.	Address excursions w/metal and steam temperatures, pressure swings, poor grid frequency response; condenser vacuum; limits on load range.	Advance process control loop tuning, Mill automation, providing additional tube metal sensors, heat flux sensors etc.
2	Minimum load program is not in place; Difficult to reduce load below 55% of MCR without oil support	Establish program; Implement a Systematic Approach to Minimum Load Reduction	Control loop tuning upto 40% MTL, mill automation, single fan/pump operation, implementation of hardwares like Variable Orifice in coal flow pipes-, coal pipe flow measurement, low load scanners.
3	Heat Rate at low operating loads w/ varying fuels; Net heat rate >2% deviation from design due to running at reduced loads; Influence on the Energy Charge Rate and overall production costs. Increase in Auxiliary Power	Benchmark performance; Evaluate controllable losses vs. fuel quality, Modified Sliding pressure operation during ramp up/down. Installation of VFDs for high energy drives.	Top heater installation, single drive operation pumps and fan, installation of VFDs for high energy drives.

S.no.	Roadblocks	Mitigation plan	Remedial measures
	Consumption at Part Load.		
B	**Pressure Parts and Life Availability**		
1	Flow Accelerated Corrosion (FAC) inEconomiser tube	FAC programintegration	Top heater installation, Automation in maintaining Boiler water pH
2	No thermal gradient measurement on economizers	Pegging/heating in deaerator and fillingof hot water in boiler filling during light up.	Installation of additional thermocouple in economiser tube
3	Thermal Fatigue	Possibility of inter connection of drains to hot fill the boiler tobe explored;	Interconnection of Deaerators among theunits. Thermal Fatigue can be minimized through maintaining the Startup/Shutdown curve provided by OEM. This can be done through plotting design Vs Actual curve during startup/ shutdown in the dashboard so that immediate correction canbe made in case of anomalies.
4	Steam Temperature control needs improvement following synchronization to mitigate reported excursions in major SH/RH/LTSH components; Mismatch in heat pick up in MS left & right.	Close monitoring of deviation of MS/HRH and metaltemp during ramping.	Advance process controlof steam/ water cycle and load control. Installation of additional metal temperature sensors.
			SH/RH spray controlvalves upgrade.

S.no.	Roadblocks	Mitigation plan	Remedial measures
C	**Operations**		
1	Operations team need overheat mitigation guidance	Better guidance to evaluate stress on boiler and turbine components	Control loop tuning and Boiler fatigue monitoring system
2	High Energy Drain / Boiler stop valve passing problem	Monitoring of high energy valves with temp gun in running condition	Replacement plan forthese valves during annual outages
3	Boiler insulation degradation impactsoperations	Insulation mapping in boiler in running condition	Phase wise replacementplan
4	No temperature sensorsin the furnace walls to assess overheating, heat flux, impacts of reduced load operation		Additional temperature sensors installation in S bend
5	APH gas temperature control; SCAPH not effective.	SCAPH to be made through for air heating.	Automation in SCAPH control to maintain APH gas temp. Increasing capacity of Steam Coil Air Preheater and APRDS System.
6	Drum level control challenges lead to load swings in drum level even with mild disturbance.	Auto loop tuning offeed water cycle	Single pump operation and installing regulating type recirculation Advance process controlof drum level
7	No simulators are available to carry out testof flexible operation to evaluate behaviour at varying load conditions.		Simulator to be upgraded with the measures of advance process control and withmore automation.
D	**Maintenance**		
1	High pressure control valves are passing e.g. sprays ,BFP recirculationvalves , high energy drains etc.	Integrate high pressure control valves modernisationplan.	Phased replacement. Changing on-off BFP re-circulation valve with modulating control valves.

S.no.	Roadblocks	Mitigation plan	Remedial measures
2	Frequent problem in PA fans as they run close to stalling zone.	Continuous tracking of PA fan characteristics curve and provisioning of alarm much before fan operating near the stalling zone.	Single PA fan operation, automated single drive control package to avoid stalling.
3	Thermal Fatigue and Creep Damage	Integrate thermal mitigation strategy.	Boiler fatigue monitoring system and Turbine stress monitoring system.
E	**Combustion and Boiler Performance**		
1	Furnace exit O2, Furnace Exit Temp measurement are not taken.	Furnace Exit O2 measurement and Furnace Exit Temp measurement to be done. Furnace Exit O2 measurement and Furnace Exit Temp measurement to be done.	Furnace exit O2% probe installation and Furnaceexit temperature measurement.
2	Mill Performance; No provision to measure fuel flow imbalance in mills; Frequent burner choking; Coal rejects from mill hoppers.	Mill performance mapping at various load & coal quality tobe done to identify best & worst mill; Need to establish mechanical blue-printideal for flexible operations. Mill performance evaluation, finesses measurement and coal flow balancing.	Milling system coal pipe measurement system installation. Installation of coal flow sensors and variable orifices* in coal pipes. (* may be only useful below 30% operation)
3	Implement program and strategy for low load and reduced mill operations	Optimize mill operations and/or identify roadblocks and/or issues during planned shut-downs (record observations)	Optimising no of milling operation with milling automation

S.no.	Roadblocks	Mitigation plan	Remedial measures
4	Poor flame stability and load response with 30% -50% high ash domestic Indian coal and/or low quality imported coals	Flame Quality Scanner Performance improvement- Explore application method to display both intensity and frequency; Identify opportunities to improve mill configurations for optimal A/F ratios	Flame scanner upgrade in control, repositioningof scanners and replacement of coal pipenozzles with low turn down of flame length, coal blending. Coal mill classifier upgrade for improving mill fineness, digital solutions for flame stability at low load operation and for achieving required ramp rates.
F	**Instrumentation and Controls**		
1	Control loops are not tuned at part loads.	Controls tuning.	Control tuning up to minimum load operation.
2	Water wall temp are not available.	Water wall metal temp. Monitoring.	Additional thermocouple installation.
3	No FEGT measurement.	Furnace Exit Gas Temp. Monitoring.	FEGT measurement installation.
G	**Environmental Controls**		
1	Dry ash evacuation Capacity is inadequate due to reliability issues.	ESP augmentation for dry ash evacuation.	Augmentation in Ash Handling System.
2	NOx control to achieve regulatory requirements	NOx controls	Implementation of NOx abatement system
3	Impact on NOx/SO2	NOx / SO2 controls	Implementation ofControl System
H	**Cycle Chemistry**		
1	Chemical dosing is mostly completed manually	Automation is needed.	LP Dosing automation with VFD drive.
2	Condenser tube leakage identification need modification.	Continuous monitoring of condensate cation conductivity.	Attending condenser tube leakages.
3	Deposits in HP turbine	Maintain Steam Purity	CPU installation

S.no.	Roadblocks	Mitigation plan	Remedial measures
4	Chemical parameters control at start-up (e.g. controlling DO)	Improve strategy for start-up and part load operations	Nitrogen purging in condensate storage system.
5	Maintaining Water Chemistry parameters at load less than 55% say at 40% will be challenging due to Absence of CPU in several stations.	Improving Water Chemistry for load load operation.	CPU installation
6	Some stations do not havea practice for Turbine/ Hot well/feed water/ Generator layup, recently Preparation of instrumentair connection is in progress for RH coil lay up; Common reserve shut-downs increased insome station from 1-2 weeks to 2 months.	Implement Layup program with required system equipment to managecorrosion when vacuum cannot be held.	Design Wet/Dry layup program & implement the same.
I	**Steam Turbine Generator**		
1	HPT heating takes 3-4 hrs time during cold start up;	Startup procedure need to be revisitedfor aligning with flexible operation.	Electric heater blanketingon HPT can reduce the time
2	Shaft Vibration / pedestal vibrations are important parameters which needs to be monitored in all operative conditions including low load operation.	TG vibration problemto be addressed for better load following and low load operation.	To be studied with OEMand solution to be implemented.
3	TDBFP recirculation - ”open/close” type and often leads to drum level disturbance	Replacement of TDBFP recirculationvalve with control valve type.	Replacement of On-off re-circulation valve with control valve.
4	Main Steam Temperature variation during Ramping (10-20^{0}C).	Improve control	Advance process control

S.no.	Roadblocks	Mitigation plan	Remedial measures
5	Creep/Fatigue damage mitigation on high-temperature components needs to understood	Installation of Turbine and BoilerStress Monitoring System	Equivalent Operating Hours (EOH) installation
6	At low load, both TDBFP operation is not possible as CRH source of motive steam for drive turbine is not lined-up.	Motive steam source from CRH shall be made operational.	Control Valve operationto be tuned higher parameter
7	Increase in cation conductivity at CEP discharge during minimum technical load operation.	Possibility of installing condensatepolishing unit shall be studied if not installed for improving condensate and feed water chemistry.	CPU Installation.
8	Drop in Main / ReheatSteam Temperature.	Load ramping to be limited	MS/RH Spray isolation valve internal checkingto be scheduled during shutdown/AOH. • Calibration of instrument for Spray Flow, Temperature Tx etc shall be planned on a scheduled timeline.

5. PROCEDURE FOR LOW LOAD TESTS

5.1 General

With increase in Renewable Energy Integration to grid, conventional thermal power plants would be required to cycle. The plant would then be required to operate below current technical minimum load and require faster ramp up and ramp down rates. In such a scenario the life of critical components such as Boiler, Steam Turbine & Pumps gets affected. The increased fuel cost also presents the challenge to utility to achieve optimum efficiency. In order to generate electricity economically utilities need to revisit the conventional operation and maintenance practices and, optimize their operation with advanced digital solutions. The typical operating modes of thermal power plants are undergoing changes especially as a result of the increasing percentage of renewable in electric power generation. The future trend comes along with expanding the grid, increasing power storage capacity, participation of renewable power generation in grid control and residual load generation by thermal power plants. Main challenges are the fast start-ups, fast load change rates as well as efficient low load operation and high demand of primary frequency response.

This chapter discusses procedures to be adopted for pilot testing of coal-fired power plants that serve the aforementioned circumstances without any additional measures.

The pilot test runs should be conducted after careful study of the unit beforehand and accordingly the test targets should be decided in consultation with OEM. Study should involve the evaluation of process limitations and an assessment of the impact of low load operation (temperature/pressure gradients) on the components. Any stretching of the targets during the test run should be avoided for the safety and security of the plant.

5.2 Good O&M Practices/Prerequisites for flexibilisation

It is essential that some basic practices are followed before preparing a unit for flexing. The below indicative list contains the broad preparation items and is not exhaustive.

a) All auto loops should be available and fine tuning of CMC must be carried out to minimize the deviation of parameters like MS/HRH steam temperature, throttle pressure, drum level, excess O_2% at economiser outlet and flue gas temperature at boiler outlet.
b) Attemperator system (isolating valves and control valves) and control valves are to be set tight and must give fast response to the changing system demand.
c) Optimise minimum coal loading in a mill by fine tuning primary air flow vs coal flow curve to avoid lean air mixture and possible flame failure tripping.
d) Dirty air flow test at regular interval to evaluate partially plugged coal pipes and burners
e) Burner tilts should be operational in full range in auto mode.

f) SADC damper operation should be checked any leakage from damper should be minimized and correct feedback must be made available. (Feedback is not available in DCS for BHEL units)
g) WWSB and LRSB operation scheduling should be done at higher load during such opportunity.
h) Air heater soot blowing must be carried out at least once in a shift
i) Air heater air leakages and other tramp air should be minimised.
j) Replacement or repairing of expansion joints if required and major duct revamping if any.
k) Water chemistry instrumentation (SWAS System) should be set right and linked with DCS.
l) SCAPH auto operation to be made through to contain flue gas temperature less than acid dew points
m) Check leakages in system under vacuum. Helium leak detection test may be conducted to identify leakages. Air Leakages above 20 kg/hr (observed in Rotameter installed in Vacuum Pump / Main Ejector exhaust) needs to be attended.
n) Boiler side high energy piping hanger indicator are to be marked and monitored.
o) Low load FRS (30% FRS) to be used to reduce deviation in or maintain flow rate in economiser during cold or warm start up.
p) Turbine stop and control valves to be inspected w.r.t valve position in control room.
q) Boroscopic inspection provisions shall be made available for LP turbine.
r) Ensuring availability of deaerator pegging / heating with auxiliary steam sources and from turbine extraction.
s) Feed water treatment with AVT(O) or AVT(R) is to be suitably deployed.

5.3 Procedure for low load tests

For a 500 MW unit, the test procedure for ramp down from full load **(500 MW)** to 40% load **(200 MW)** and vice versa is tabulated below: -

5.3.1 Test procedure for load ramp down tests from full load (500 MW) to 60% load (300 MW) at 1% (5 MW) per minute (Target Time: 70 minutes) and 3% (15 MW) per minute (Target Time: 13 minutes):

a) Stabilize the unit load at full load with 6 mills with CMC in service & APC ON.
b) Give the load set point of 450 MW.
c) Start reducing the mill loading of bottom most Mill gradually after putting in manual mode to meet firing demand.
d) Stabilize the unit around 450 MW for 10 mins.
e) Give the load set point of 400 MW.
f) Start reducing the mill loading of bottom most mill gradually till the mill is completely unloaded. Trip the bottom most mill.
g) Stabilize the unit around 400 MW for 10 mins.
h) Give the load set point of 350 MW.

i) Start reducing the mill loading of bottom most mill gradually to meet firing demand.
j) Stabilize the unit around 350 MW for 10 mins.
k) Give the load set point of 300 MW.
l) Start reducing the mill loading of bottom most mill gradually till the mill is completely unloaded. Trip the bottom most mill.
m) Stabilize the unit around 300 MW.

5.3.2 Test procedure for load ramp down tests from 60% load (300 MW) to 40% load (200 MW) at 1 % (5 MW) per minute (Target Time: 30 minute) and 15 MW per minute (Target Time: 37 minutes):

a) Stabilize the unit load at 60% load with 4 mills and CMC in service (APC On)
b) Give the load set point of 250 MW.
c) Start reducing the mill loading of all mills gradually with higher unloading of bottom most mill to meet firing demand.
d) Maintain both PA Fans in service if 3 or more mills are in service, if further load ramp down is taken up and fans are operating near to their stall zone then manually switchover to single PA Fan operation. Switchover to Single FD and ID fans can be done to optimize Aux power consumption.
e) Stabilize the unit around 250 MW. (for 10 mins)
f) Give the load set point of 200 MW.
g) Start reducing the mill loading of all mills gradually with higher unloading of bottom most mill to meet firing demand.
h) Stabilize the unit around 200 MW. 60%-40% load ramp rate of 3% will cause wide temperature fluctuations. It requires multiple iterations with different combination of mills.

5.3.3 Test procedure for load ramp up tests from 40% load (200 MW) to 60% load (300 MW) at 1% (5 MW) per minute (Target Time: 10 minutes) and 3% (15 MW) per minute (Target Time: 7 minutes):

a) Stabilize the unit load at 40% load with 3 mills and lesser loading in bottom most mill.
b) Give the load set point of 250 MW.
c) Start increasing the mill loading of all mills gradually with higher loading of bottom most mill to meet firing demand.
d) Stabilize the unit around 250 MW for 10 mins.
e) Give the load set point of 300 MW.
f) Start increasing the mill loading of all mills gradually with higher loading of bottom most mill to meet firing demand.
g) Manually take second BFP also in service, if not taken earlier, and balance both BFP.
h) Manually take second PA Fan in service, if not taken earlier, and balance both fans.
i) Equalize loading of all mills. FD & ID Fans as well
j) Stabilize the unit around 300 MW for 10 mins.

5.3.4 Test procedure for load ramp up tests from 60% load (300 MW) to full load (500 MW) at 1% (5 MW) per minute (Target Time: 40 minutes) and 3% (15 MW) per minute (Target Time: 13 minutes):

a) Stabilize the unit load at 60% load with 4 mills with CMC in service.
b) Take the fifth mill in service (preferably adjacent to mills already in service and topmost amongst the standby mills) with minimum loading and allow the mill to stabilize.
c) Give the load set point of 350 MW.
d) Increase the mill loading of fifth mill gradually to meet firing demand. Simultaneously adjust the mill loading of other four mills to meet firing demand and till the time fifth mill is sufficiently loaded and stabilized.
e) Stabilize the unit around 350 MW for 10 mins
f) Give the load set point of 400 MW.
g) Increase the mill loading of fifth mill gradually to meet firing demand. Simultaneously adjust the mill loading of other four mills to meet firing demand and till the time fifth mill is sufficiently loaded and stabilized.
h) Stabilize the unit around 400 MW and equalize the mill loading.
i) Take the sixth mill in service (preferably adjacent to mills already in service and topmost amongst the standby mills) with minimum loading and allow the mill to stabilize.
j) Give the load set point of 450 MW.
k) Increase the mill loading of sixth mill gradually to meet firing demand. Simultaneously adjust the mill loading of other five mills to meet firing demand and till the time sixth mill is sufficiently loaded and stabilized.
l) Stabilize the unit around 450 MW for 10 mins.
m) Give the load set point of 500 MW.
n) Increase the mill load of sixth mill gradually to meet firing demand. Simultaneously adjust the mill loading of other five mills to meet firing demand and till the time sixth mill is sufficiently loaded and stabilized
o) Stabilize the unit at full load and equalize the mill loading.

5.4 Critical Operating Parameters

- Generator Load
- Main Steam Pressure, Temperature, Flow
- Reheat Steam Pressure, Temperature
- Drum Level, Deaerator Level and Hotwell Level
- Oxygen % in FG at Economiser outlet
- Windbox pressure, SA flow, PA Flow, PA Header pressure, Furnace pressure
- SADC & Burner tilt positionFlame intensity
- Air Heater outlet temp – Flue gas
- Metal temperatures – SH, RH, Drum / Separator
- Condensate flow / FW Flow
- Condenser Vacuum

- Extraction Steam Pressure, Temperature
- Casing Metal temperatures of HP /IP Turbines
- Vibrations of HPT, IPT, LPT, Generator bearings and shafts.
- Chemical Parameters for Main Steam, Feed water, Condensate system, etc.

5.5 Data Logging

Following time stamp data from DCS should be recorded for further analysis and study.

a. Boiler load vs

- Feed water Temp at Economiser Inlet/Outlet
- Platen SH I/L Header Temp
- Final SH O/L Header Temp
- Separator Level
- Excess Oxygen
- Separator Metal Temperature

b. Turbine

- Turbine First Stage Pressure
- First Stage Temperature
- HP Control Valve Body Temperature
- IP Control Valve Body Temperature
- Turbine Inner Casing Temperature
- Turbine Outer Casing Temperature

The template for observing some of the important parameters are as indicated in the Table 5.1 on the following page.

Table 5.1 Template for Study of Minimum Load Operation

Load (MW) :
Coal Flow (TPH) :
Air flow (TPH) : **Date :**
O2 (%) : **Time :**

S.No.	System	Parameter Description	Unit	Value	Observation
1	Boiler	Main Steam Pressure Left	Kg/cm2		
		Main Steam Pressure Right	Kg/cm2		
		Main Steam Temp Left	°C		
		Main Steam Temp Right	°C		
		HRH Pressure Left	Kg/cm2		
		HRH Pressure Right	Kg/cm2		
		HRH Temp Left	°C		
		HRH Temp Right	°C		
		SH DSH SPRY WTR FLOW	TPH		
		RH DSH SPRY WTR FLOW	TPH		
		Seperator Level	M		
		BRP Status			
		Burner Tilt Position	%		
		Steam Flow	TPH		
		Secondary AiR Flow	TPH		
		DP across Windbox to Furnace	MMWC		
		RAPH outlet FG Temp	°C		
		RAPH Flue Gas Inlet Temp	°C		
		PRS Pressure & PRDS Pressure	Kg/cm2		
2	Flame Intensity	Eleveation wise Intensity	%		
		Furnace Draft	MMWC		
		Flue Gas Furnace Exit Temp	°C		
		Flame Position			
3	Boiler Tube Metal Temp	HRH Max Temp	°C		
		SH PLATEN Max Temp	°C		
		Right Spiral Temp	°C		
		Front Spiral Temp	°C		
		Left Spiral Max Temp	°C		
		Rear Spiral Max Temp	°C		
		Final SH Max Temp	°C		
4	Boiler Header Temp	SH Left OL Hdr Temp	°C		
		SH Right OL Hdr Temp	°C		
		RH Left OL Hdr Temp	°C		
		RH Right OL Hdr Temp	°C		
		RH Left IL Hdr Temp	°C		
		RH Right IL Hdr Temp	°C		
		Sep OL Metal Temp Left	°C		
		Sep OL Metal Temp Right	°C		
		Eco Link Header Temp 1	°C		
		Eco Link Header Temp 2	°C		

5	**Fans (PA/ID/FD)**	Pitch (Fan-A/ Fan-B)	%		
		Head (PA Fan)	**MMWC**		
		Current	**AMP**		
		Flow (Primary)	**TPH**		
6	**Milling System**	No of mills in Service	**NOS**		
		Mill loading (TPH)	**TPH**		
		Mill current	**AMP**		
		Mill vib	**MM/SEC**		
		Mill Inlet temp	**°C**		
		Mill Outlet Temp.	**°C**		
		Mill Bowl DP	**MMWC**		
		Air Fuel Ratio	**TPH**		
		PA Flow through Standby Mill			
7	**TDBFP parameters**	Recirculation valve position			
		Speed (A/B)	**RPM**		
		Flow (A/B)	**TPH**		
		Live Steam pressure (A/B)	**Kg/cm2**		
		No of BFP in service	**NOS**		
		Aux. Control Valve Position	%		
		Scoop position	**RPM**		
		TPBFP Exhaust Hood Temp (A/B)	**°C**		
8	**Turbine Parameter**	4th Stage Pressure	**Kg/cm2**		
		HP Exhaust Temp L-1	**°C**		
		Turbine HP Exh Ur/Lr casing inner meta	**°C**		
		Turbine HP Lower Casing Inner metal tem	**°C**		
		Turbine HP Upper casing Inner metal tem	**°C**		
		Turbine IP Exhaust Pressure	**°C**		
		Turbine IP Exhaust Temp	**°C**		
		Turbine LP Exhaust temp	**°C**		
		Turbine Gland Steam Seal Header Temp	**°C**		
		Gland steam temp	**°C**		
		Gland steam supply CV position	%		
		Gland steam leak off CV position	%		
		Turbine IP Exh Ur/Lr casing inner metal	**°C**		
		Turbine IP Lower Casing Inner metal tem	**°C**		
		Turbine LP Upper casing Inner metal tem	**°C**		
		Condenser Vaccum	**°C**		
		Heater Drain Pump Status	**bar(abs)**		
		Heater Drain Pump Status	**°C**		
		CEP Pump & Motor Vibration			
9	**Turbovisory System**	TG Shaft & Pedestal Readings			
10	**Turbine Bearing Metal Temp**	TG Bearing Temp Readings			
Note	**Based on initial discussion with Technical Teams,indicative problem areas are provided in Observation Cum Remarks cell. However actual issues/deviations faced during the trial shall be**				

Source: PPGCL

6. MODIFICATIONS REQUIRED

The previous chapters have analyzed and emphasized the need for thermal power plants to be flexible, to explore the capability to flex and limitations thereof. This chapter focuses on modifications needed and retrofit options for increasing operational flexibilityof coal fired units. For getting more flexibility, it does not require to retrofit the entire plant but retrofit only certain subsystem of power plant that are most effective in tackling plant flexibility. The technical measures shall depend on the levels of minimum load operation to be adopted (50%, 40% or below). The operation at 55-50% load may onlyneed reassessment of O&M practices, maintenance of critical components, automation/optimization of controls. However, lower load operation shall require additional measures like proper flame detection systems, efficient measures to optimize combustion process (A/F ratio), stable minimum mill operation, use of steam coil air preheater. Temperature measurements are crucial to optimize the startup and shutdown procedure. The technical solutions are primarily aimed at

- Ensuring safety & reducing the detrimental impact of the flexible operation on the life of the unit.
- Achieving flexibility with lowest cost.

Once there is a certainty that the unit can support flexible operation, then options of optimizing the costs and reducing lifetime impacts/improving reliable operation need to be exercised. Decreasing the technical minimum load (w/o oil support) is beneficial, because it provides a larger range of generation capacity. This helps plant operators maintain operation when power demand is low and avoid expensive start-up and shutdown procedures. Reducing the minimum load in hard coal-fired power plants is subject to certain technical limitations. These limitations are fire stability, flame control, ignition, unburned coal and CO emissions. In low load operations, the fire can become unstable when the hot flue gases do not completely ignite the inflowing pulverized coal and hence additional support from oil firing is needed to maintain flame stability and achieve complete combustion of the coal. There are several retrofit options that can be deployed for achieving stable technical minimum load operation of 40% and below (w/o oil support) and increasing ramps to 3%, while using Indian coal.

6.1 Measures for Minimum Load Operation

The operating data recorded during the minimum load test conducted at various plants indicated that several process limits were reached. The APH flue gas outlet temperature dropped below the dew point and the flame stability could not be assured. As these limits cannot be pushed further by means of controls, several technological changes would be required to achieve a stable minimum load operation. Using the test data, a thermal study of the boiler can be carried out in order to find and avoid damages to the boiler systems. Evaluation of the process limitations also need to be carried out. The most commonly used coal, as well as the potential range of coal, including coal with maximum problematic contents (ash, moisture, etc.) should be analyzed. Based on the thermal study findings, relevant remedial measures can be identified.

6.1.1 Control Optimization

Controls play a pivotal role in the operation of coal-fired power plants. It allows smooth transition between different operating loads and ensures stable operation by adjusting all relevant process variables. The control system monitors and controls the critical parameters viz. - temperature, pressure inside the boiler, the feed-water mass flow in the water-steam circuit, the loading of the coal mills and the turbine valve positions. Basedon the plant specific needs control modifications can be adopted for improving the flexibility. Based on assessment of individual units following improvements may be explored, some of which may require improvement by implementing modified controlsolutions and hardware (valves, etc.) as follows:

6.1.1.1 Drum Level Control

The pilot tests conducted showed that drum level controls were not tuned for the wide operating ranges (100%-40%). In this context the replacement of the feed water recirculation valves with modulating type valves will improve the drum level control. Currently, the opening of the valves causes large disturbances. Furthermore, an upgrade or implementation of new controls is necessary for the turbine-driven boiler feed water pumps when fed by auxiliary steam from another unit's. These controls are not generally working satisfactorily, thereby increasing the risk of a trip and demanding maximum operator attention– The BFPs would be run through a sequence control in auto mode.

6.1.1.2 Flue Gas Temperature Control

At 30% load APH outlet temperature is expected to be around 90 deg C, which is below the acid dew point temperature. On account of low APH cold end temperatures, corrosion on the APHs may occur. SCAPH should be deployed, which would enable the flue gas temperature to be controlled through the use of the steam APH. The SCAPH should be taken into operation automatically, whenever needed. This control combined with the upgraded temperature control would prevent corrosion in the APH. Economizer bypass system will also maintain the flue gas temperature above acid dew point to avoid corrosion. At low load, to meet required mill inlet temperature, economizer bypass system can improve flue gas temperature entering RAPH.

6.1.1.3 Automated Start/Stop of Mills

Automated start-up and shut-down sequences for the mills are necessary to enhance the flexible operation.

6.1.1.4 RH Steam Temperature Control

The RH steam temperature should be sufficiently high for the turbine for improving heat rate at part load operation. The RH steam temperature should be controlled using burner tilts as part of the automated control. Currently, burner tilts are operated manually and consequently RH steam temperatures are dropping during low load operation. This causes an avoidable loss of efficiency. The influence of the burner tilts needs to be further tested as well as the design and integration of the logics for the automated RH steam temperature control.

6.1.1.5 Measures for Ramp Rate Improvement

The thermal feasibility study of the boiler will also be useful for enhancing the ramp rates of the plant. With the help of the model study, it will be possible to explore measures to decrease SH and RH MTMs in cycling operation regimes, e.g. by effectively applying the burner tilts. The findings of the thermal study will also provide the basis for the optimization of various controls. The ramp rate improvements, as well as stable minimum load operation, strongly depend on a stable and optimized combustion. In addition to the control modification mentioned in 6.1.1 following may be required:

6.2.1 Control Optimization

6.2.1.1 Burner Tilt Controls

Burner tilts should be used to control RH MTMs in addition to RH steam temperatures. A feed forward from the load to burner tilts should be added, which needs to be validated through physical tests. Furthermore, an observer to both RH steam and RH MTM should be added, to predict where the temperature will be in few minutes based on actual temperature developments. This would make it easier to anticipate changes and enhance the control.

6.2.1.2 Furnace/Differential Pressure (Δp) Control

The set point should be given automatically depending on load. SADC passing should be minimized to make this control effective.

6.2.1.3 Furnace Pressure Control Upgrade

The secondary air is controlled is based on FD fan operation (blade pitch /VFD). Usually at part load since the air requirement reduces and because of passing of SADC windbox Δp is difficult to maintain, therefore SADC passing should be reduced by proper maintenance.

6.2.1.4 Unit CMC

These changes should enable the load to change sooner in the upward direction, and the pressure later. This would have two effects:

› Better cooling of RH tubes when steam flow increases, less MTM increase
› Better drum level stability

6.2.1.5 SADC Damper Control

Schedule check to be made for checking the DCS value and actual value at local for all the SADC dampers. Digitalization initiatives shall be taken for fine control of SADC dampers. Modifications in O_2 vs Load curve to be reviewed in consultation with OEM.

6.3 Measures for Startup Time Improvement

Decreasing start-up time enables a more rapid response to power demand. Start-up procedures are complex and expensive since they usually require auxiliary fuel, such asoil, during the ignition & stabilization period. There are various technical factors that limit the reduction of start-up time. Thick-walled components allow higher operating parameters (steam temperature and pressure, say) which increase efficiency. But quick temperature changes in thick-walled components induce thermal stress, which acts as a limiting factor for the start-up time. With “thinner” component designs, flexibility can be higher but efficiency is compromised. Since temperature changes induce thermal stress, each material is assigned a maximum allowable value. Exceeding this value reduces the materials lifespan. In general, reducing wall thickness increases the allowable temperature change rate. This translates into a faster start-up by boosting the ramp rate. Wall thickness can be reduced by using superior materials

6.3.1 Optimized Startup Control

An upgrade of control system with modified logics can improves precision, reliability and speed. For instance, it allows operation closer to the material limitations of important components, such as the boiler. This can mean operation at higher temperatures without significantly reducing the material lifespan, unlocking the available margins within the design limits of the system. Predictive digital solutions can be used to optimize several parameters to shorten boiler/turbine start-up time. Start up control system with modified logics can not only shorten the startup time but also improve repeatability & reliability of the startups.

6.3.2 Startup Curve

Design vs actual trending can be checked by using real time data source dashboard during start up for easy monitoring. With this immediate deviation of different start up parameter against corresponding design start up parameter can be corrected.

6.4 Other Measures

There are various other options available for increasing the flexibility aspects, some of the solutions are summarized below.

6.4.1 Boiler Combustion System

6.4.1.1 Minimum Mill Operation

In the direct firing configuration, reducing the net power of a power plant requires burners and coal mills to both run at part load. At a certain firing rate, the fire becomes unstable, requiring the power plant controller to limit the low load operation to avoid damaging pressure pulses that can occur inside the boiler. The fire stability typically represents the lowest threshold for the low load operation. At a certain lower net power output, it is feasible to shut down some of the mills and have the remaining mills operate closer to their design point. Since coal mills typically supply a single burner level, turning off a mill leads to a boiler operation with a reduced number of firing levels.

In the Indian context, with typical use of high ash content coal, one must take care of the minimum flue gas velocity in the system to avoid accumulation of ash within boiler/ducts and a 2-mill operation philosophy with related control system/logics modification is suggested. Further following are recommended for the mill operations

- Adjacent mill operation is recommended to achieve the stable flames and fire ball.

- With bottom mills steam temperatures cannot be achieved and hence bottom mill operation is not recommended.
- Mills shall not be operated below 60% of mill rated capacity or 50% of feeder speed to maintain uniform air & fuel mixture.
- Modification of the control philosophy to control primary & secondary air flow.
- Modification/ change in Mill outlet temperature control set point.

6.4.1.2 Firing System

The aspect of flame stability is particularly important at lower loads for safe operation of the boiler. It's important to have physically healthy flame. It is evident that burner redesign modification is an important for achieving lower technical minimum load without oil firing support. The re-design focuses on stabilizing the near field conditionsof the burner by manipulating the entry velocity, turbulence and therefore flame stability at low load, while minimizing changes to the balance of the burner system and maintaining the full load capability. The major issue with firing system is to stabilize coalflame and detection of low intensity flames inside furnace.

6.4.1.3 Combustion/Flame monitoring

In low load operation, complete combustion of fuel/fireball condition & stability is of utmost importance from safety point of view. Improved control over fireball stability is required. Due to lean air/fuel mixtures and less number of mills/firing levels in operation, flame stability may be an issue. At lower loads, the pressure drop in the coal piping can negatively affect fuel-air distribution between burners and thereby reduce flame stability. With only two to three mills in service it is more important that stable combustion be maintained locally as well as in the fireball and that the flame scanners detect properly when a stable flame is established. At full load operation, flame scanners see a bright flame; whereas at low load operation the devices see a dim flame. The combustion monitoring flame scanners sensors should have a wide dynamic range that can prove flame at full load as well as at the lowest loads without recalibration. These features help avoid "nuisance" trips where a scanner may not "see" a still stable flame.

6.4.2 Condensate Throttling

Condensate throttling is a proven measure for primary control to enable fast increase of turbine power in case of grid frequency deviations. In this case the main condensate control valve is throttled to a calculated position allowing a reduced condensate mass flow flowing through the LP feed water heaters. Considering a certain response time, the extraction steam mass flows of the LP feed water heaters and the deaerator/feed water tank are reduced. The surplus steam remains in the turbine and generates additional power. A sketch of the system is shown in Figure 6.1. This condensate throttling compensates the transient time behavior of the boiler. The accumulated condensate is stored in the condenser hotwell or a separate condensate collecting tank. Parallel to the above mentioned measures the firing rate of the boiler has to be increased to meet the load requirements.

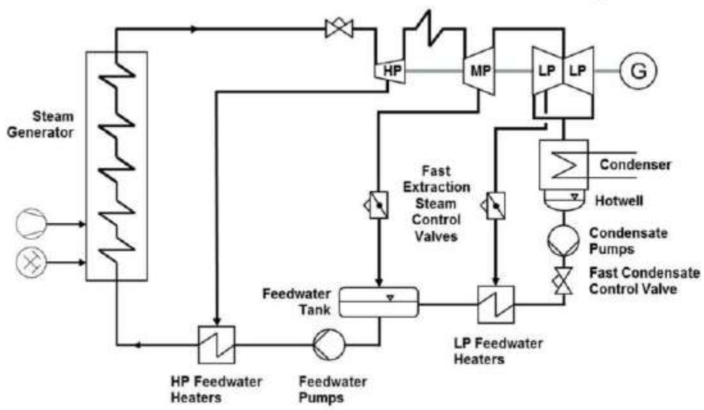


Figure 6.1 Condensate Throttling

6.4.2.1 Response time

The response time of condensate throttling depends on the time required for reduction of condensate mass flow. Therefore, normally a fast acting main condensate control valve is used. By means of additional fast acting valves in the extraction steam lines the response time behavior can be optimized. The response time of 20s for 7% power at 100% load has been achieved through condensate throttling and main steam valve throttling at NTPC Dadri. Standalone, condensate throttling is able to provide 3-4% power at 100% load. The results of tests conducted by BHEL at Unit-1 of 2x600 MW SCCL plant with valve wide open condition are 2.9% at 30secs to 4.0% of running load in 120 secs.

6.4.2.2. Capacity

The resulting turbine power increase depends on the amount of throttling of the main condensate control valve and the actual unit load. The higher the unit load, the higher is the amount of additional turbine power which can be generated by condensate throttling.

6.4.2.3 Duration

Duration of condensate throttling operation depends on the amount of buffer volumes provided for condensate and feed water. The slower the boiler, the larger the buffer volumes have to be.

6.4.3 Heat Conservation System

Steam turbine heat conservation systems can support in reducing the startup time by eliminating cold startups by keeping the unit in warm condition.

6.4.4 HP Turbine Deactivation

Few advanced supercritical turbines have feature of HP deactivation. At very low load there are chances of HP turbine exhaust temperature reaching material limits and causing windage. To prevent this usually turbine trip is initiated if the temperature reaches to 510^{0}C. With HP deactivation, instead of tripping the entire turbine, only HP turbine is tripped and protecting the unit to operate at lower load to bring back to grid again quickly. Advanced supercritical turbines are benefitting from this feature and the same could also be implemented in existing 210MW and 500MW units with suitable in measurement.

6.4.5 Co-Start

To enable faster hot startup time, turbines can be rolled via IP turbines. In the Co-Start sequence the steam turbine already starts to accelerate from turning gear speed when the reheat steam temperature exceeds the IP component temperature. In the standard start- up sequence the steam turbine starts to accelerate from turning gear speed when both,the main and reheat steam temperature exceed the HP and IP component temperature. With the Co-Start feature the steam turbine start-up under hot conditions is up to 90 minutes earlier compared to a standard hot start. The exact time saving depends on several boundary conditions e.g. boiler temperature gradients, initial component and steam temperatures.

6.5 Measures for Efficiency Improvement (Heat rate)

6.5.1 Sliding Pressure Control (Modified)

- Achieving lower minimum load with relatively higher efficiency levels.
- For a cycle operating with constant boiler pressure, the efficiency of the unit at part load will be better by adopting sliding pressure control than it is by throttling to control the power on machine.
- For a cycle operating with sliding boiler pressure, it may be very useful to have an overload arc available to respond to fast changes in power demand. This would support better frequency response and short peak needs.
- Turbines that feature partial arc can be readily adapted to the specific requirements of a utility by careful selection of appropriate admission arc areas.

6.5.2 Top Heater

Usual steam turbine power plants have regenerative feed water heating cycles to increase the feed water temperature and thereby improving the cycle efficiency. This optimization is carried out in consideration that units are running in base load operation. In part load scenario, the final feed water temperature starts dropping and leading to more thermal stress on boiler and many a times limiting the NOx devices to operate. Therefore, an innovative method of keeping the final feed water temperature constant irrespective of load can be achieved by having the additional feed water heater with controlled extraction. The top heater gets only activated in part load and could increase the heat rate upto 0.6% at corresponding 50% part load efficiency*. This additionally benefits the Boiler as then economizer temperature is not changing with load change thus saving the life consumption in Boiler components with less fatigue. A typical configuration of Top Heater arrangement is shown in Figure 6.2.

6.5.3 Optimization of Auxiliaries

The thermal power units are designed for high efficiency performance at rated load. Operating at lower loads deteriorates the efficiency of the unit. The efficiency of the unit can be improved by many means including reducing the auxiliary power consumption.

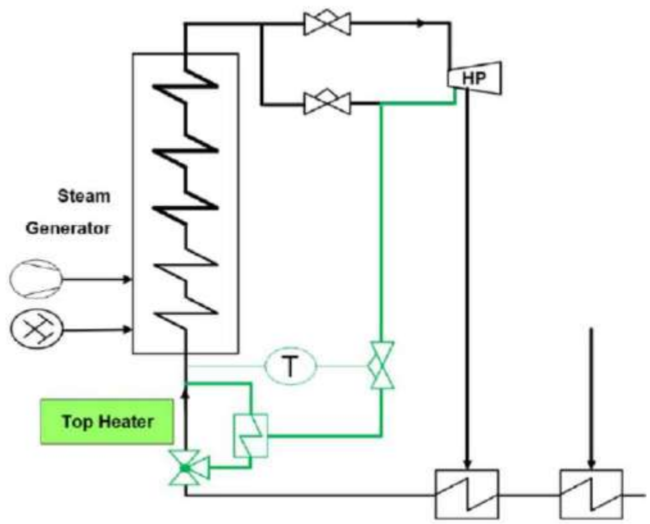


Figure 6.2: Typical arrangement of Top Heater

The plants have most of the auxiliaries rated for 2x50% which are both operated at any operating point. Hence to reduce the auxiliary power consumption at loads less than 50% the auxiliaries should be operated as 1x50% mode without affecting the safety and security of the plant. This will reduce the auxiliary power consumption at low loads.

Further, at variable load operation of the unit from 100% to 40% MCR, optimization of the auxiliary load for lower power consumption can be achieved by utilizing variable frequency drives.

6.6. Measures for Condition Monitoring

Part load operation leads to changes in main and reheat steam temperature. Usually conventional operating hours' calculations are based on normal operating hours and sometimes accounting for startup. With frequent load changes resulting in temperature changes which leads to changes in thermal stresses of high temperature rotors and casings, thick-walled components like Boiler drum & headers. Therefore, conventional maintenance intervals may not be sufficient. Now with possibility of real time monitoring, it is possible to account for both load changes and equivalent operating hours (EOH) based on actual thermal stresses. This helps utilities for better maintenance planning by clearly identifying the need of inspections based on the actual operation. Also this helps utilities identifying which operating modes are causing higher damages to component life therefore mitigating/avoiding such operations. The primary requirement for long term reliable operation is to adapt operation and maintenance for the new operation regime. Few of the solutions presented in this chapter are to enhance monitoring health of the plant.

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*The solution is implemented in Wai Gao Qiao, 1040 MW unit, China).
(https://www.energyforum.in/fileadmin/user_upload/india/media_elements/misc/20200000_Misc/20200515_lr_Fast_Ramping_VGB_Webinar/3_Improved_Ramp_rates_Chittora_Rev1_komp.pdf).

Condition monitoring systems monitor components like boiler and piping for creep and fatigue. It monitors the temperature differences, pressure, and sends alarms when the allowable limits during load changes have been exceeded. It is integrated into the existing C&I system. Condition monitoring leads to effective life cycle asset management. Condition Monitoring for flexibilisation should include the following modules.

- Fatigue Monitoring System
- Vibration Monitoring System including Blade Vibration
- Generator Monitoring System

6.6.1 Fatigue Monitoring System

In today's environment only very few power plants can operate in the pure base load mode. Continual output/ load changes shall be common, this means stressing the boiler and turbine components far beyond the traditional operational levels. The boiler and turbine maintenance has to meet these new requirements. The fatigue monitoring provides the power plant maintenance and the operating personnel with a tool that contributes to better scheduling of maintenance. Further the operational conditions and procedures (e.g. start up, load changes) can be optimized based on the results of the monitoring system.

By computing the creep and low-cycle fatigue the residual life of the boiler and turbine, which is dependent on the operating mode of the power plant, can be recalculated time and again. For the power plant operator, the implementation of FMS provides a continuous overview of the service life utilization of the major equipment's, so that

- The time for a necessary inspection can be selected optimally and thus the operating time between two inspections maximized,
- Power plant safety can be increased,
- Operating modes causing heavy wear can be detected and if possible prevented,
- Components can be operated close to the material limits, so that the operating time of the plant can be maximized and operating costs minimized.

6.6.2 Vibration Monitoring System

Availability of steam turbine in a power plant depends on its performance in all operating conditions. In recent past, there has been couple of Low Pressure Turbine free standing stage blades failure experienced. LP turbine blades due to highest centrifugal forces and operation in wet region are susceptible for failures. Operational risks for blade failure could be monitored through non-contact type blade vibration monitoring system. While the system can provide the useful insight on vibration behavior, it is even more important to get it monitored by experts.

Apart from all the above solutions, some digital solutions can be leveraged to monitor health of key components of the turbine and help reduce the negative impact on flexible operation & avoid unforeseen forced outages. Simple solutions like the following can provide advance notice to take corrective actions. Valve monitoring can avoid unplanned outage due to valve failures. Torsional vibration monitoring system can avoid rotor cracking due to Grid excitations. Turbine monitoring can alert about the excessive lifetime consumption of the critical ST parts and helps avoid unplanned outage.

6.6.3 Generator Monitoring

Although from capability point of view, generator may not pose serious constraints for flexible operation, it is important to monitor its health and take utmost preparatory care of generator going to be subjected to cyclic operation. Real time monitoring of certain generator key parameters goes long way in identifying impending problems and helps users to prepare and take corrective actions much in advance. Moving to condition-based maintenance (instead of regular preventive maintenance) by monitoring key parameters like partial discharge (PD), rotor flux, rotor shaft voltage, end winding vibrations, stator temperature etc. are important.

Following impacts of flex operation need to be observed/anticipated for and suitable timely corrections need to be done to avoid unplanned generator failures.

i. Possible relative movements between bars and core.
ii. De-cohesion between bars and between bars and supporting rings.
iii. Deformation and crack of pole to pole connection.

6.7 Recommendation

The utilities shall conduct detailed study/tests and cost benefit analysis for finding the most optimal solutions to improve the flexibility of plants as the measures required are plant specific and shall depend on the level of flexibilisation. This may be done in consultation with OEM/main plant (BTG) manufacturer /BTG designer.

7. COST OF FLEXIBLE POWER

As discussed in earlier chapters, the flexible operations for coal power plants are technically feasible by upgradation of controls, etc. The pilot tests conducted at various plants is the proof that Indian plants are capable to flex. Converting the baseload coal fired power plants into flexible plants would most likely incur costs, which would require compensation. To improve the availability of flexible power in the grid by conversion of baseload coal fired power plant into flexible power plants, it should be economically feasible for the generating companies. In this chapter, we shall discuss some indicative costs involved for converting a baseload coal plant into a flexible plant. Since majority of the energy transacted is through the long-term power purchase agreements, the discussion shall be centered on the cost based approach.

7.1 Factors Influencing Cost

a) The cost of undertaking flexibilisation in the plant is dependent on the following factors:
b) Automation levels in the plant.
c) Coal quality.
d) Age & size of units.
e) Type of machine, component material composition and design philosophy.
f) Maintenance philosophy, lay-up practises and water chemistry controls.
g) Operational expertise and practises adopted.
h) Extent of cyclic operation - depth, breadth and frequency.

7.2 Cost Components

The impact of thermal power plant flexibility on the costs are mainly exhibited through *Capital Expenditure (CAPEX)* - one-time expenditure incurred in the installation /retrofitting of various equipment required to make the plant capable of low load operation, and *Operational Expenditure (OPEX)* - the recurring cost of flexible operation due to decreased efficiency, loss due to the reduced life of the plant, increased O&M cost, increased forced outages, increased oil consumption. Increased spends on water, chemicals, manpower and other miscellaneous activities. Increased chances of non-conformance to grid regulations leading to financial losses.

7.3 Studies with International Partners

Cost related studies have been conducted with international agencies having vast experience in the field of flexibilisation. The studies were conducted from year 2016 to 2018. The details of the scope are summarized in Table 7.1. The cost implication has been brought out by the various studies under the heading of capital and operational expenditure.

Table 7.1 Studies conducted by International partners

Associates	Owner/ Plant	Study	Scope
IGEF/VGB	NTPC: Dadri Unit 2 (200MW) Simhadri Unit 1 (500MW)	Dec 2016-June 2017	Special Task Force on Flexibilisation. Flexibility assessment
USAID/Intertek	NTPC: Ramagundam Unit 2 (200MW), Jhajjar Unit 1 (500MW)	Jan-July 2018	Cost of flexing due to start up and load following
USAID/Intertek	GSECL: Ukai Unit 4 (200MW), Ukai Unit 6 (500MW)	Aug- Nov 2018	Cost of flexing due to start up and load following
Engie Lab	Dadri Unit 4 (200MW) Farakka Unit 6 (500MW)	Nov 2018-Sept 2019	Capital Cost estimation to enable flexibility & increase in running cost due to load ramping and start up.
Siemens	NTPC Simhadri (500MW) Dadri (490MW)	Feb-Aug 2018	Technical and Commercial Proposal for interventions after study
GE	NTPC Talcher Kaniha (500MW)	Feb-Aug 2018	Technical and Commercial Proposal for interventions after study

7.3.1 Capital Expenditure (Capex)

Capital expenditure is required at plant level for the various interventions to meet the demands of flexible operation. The type of interventions required would vary from plant to plant depending on the unit age, etc. as detailed in item 7.1 and accordingly scope of work shall vary. The outcome of various studies conducted are detailed as below:

7.3.1.1 IGEF Study. The special Task Force on flexibilization with the support of IGEF provided an estimate of the Capex. The VGB studies at NTPC Dadri (210MW) and Simhadri (500MW) provided one-time cost required for preparing units for low minimum load operation and indicated the cost of interventions below 40% load will be significantly higher. The estimates are summarized in the following table:

Table 7.2 Capital Expenditure

S.no.	Intervention	Rs. Crore / Unit
1	For 40% Technical Minimum Load	3.9 to 7.8
2	Start-up Optimization	2.25 to 7.8
3	To manage the consequences of cycling	0.65 to 1.95

(Source: IGEF Task Force Sub-Group1 Committee Report on Flexibilisation of Thermal Plants Oct, 2017)
(**S***ource: NTPC)*

It is important to understand the cost difference between the actual costs required to guarantee flexible operation (one-time Capex) and the provision of Capex to be able to repair the damages that occur due to flexible operation and reclaim back the machine to normal. The damages get accumulated till the breakdown of components, which may need replacement to be able to run again.

7.3.1.2 Siemens Study Based on Siemens proposal for the implementation of flexibilization measures at Dadri and Simhadri NTPC stations, approximately Rs.20 to Rs.50 crores is estimated considering the measures required in the units. The proposal consisted of implementations of the following:

- Temperature Optimizer
- Fatigue Monitoring System
- EOH Counter
- Optimization of Control Loops
- BFP Recirculation Valve
- Auto ON/OFF of Fans and Pumps
- Mill Scheduler

7.3.1.3 GE Study. Based on the proposal for the implementation of flexibilization measures at Talcher NTPC station, approximately Rs.20 to Rs.50 crores is estimated based on the measures required in the units.

7.3.1.4 Engie Study. As per the study done for Dadri and Farakka NTPC stations the cost of capital expenditure is estimated:

- Between Rs.3.2 crore and 5.6 crore for extended load following with P_{min} 40%.
- Between Rs.4.1 crore and 8.0 crore for frequent warm starts.

7.3.1.5 Capex at Dadri

The order for retrofit work for flexible measures at Dadri 500MW unit to reduce the minimum load operation to 40% was placed by NTPC in 2019. The retrofit work included the implementation of following measures-

a) Predictive MS Temperature Control
b) RH Temperature control
c) Installation of Modulating Recirculation Valves in BFPs
d) Automation in Milling System
e) Flue Gas Temperature Control
f) Single Drive Operation- Automated Start/Stop of ID/FD/PA Fans.
g) Condition Monitoring System- Boiler Fatigue Monitoring System and Equivalent Operating Hours.

Total capex implication of the above retrofits for Dadri unit is around rupees five and half crore. The results of the retrofit works undertaken are awaited.

7.3.2 Operational Expenditure (OPEX)

The increase in OPEX is clubbed in the following three broad categories:

a) Cost due to increase in Net Heat Rate.
b) Cost due to increase in O&M due to reduction in life of components.
c) Cost due to increase oil consumption for EFOR

Generally, units are designed to be operated on a base load condition and all the components are accordingly designed for operation for certain creep life hours and certain fatigue life in terms of no. of starts. As the operation regime changes and moves away from base load operation to cycling operation, the component life gets consumed at a faster rate. Life consumption, Increase in Equivalent Forced Outage (expressed in terms of increased O&M costs have been derived based on the costs on assessment studies at Ramagundam, Jhajjar and Ukai plants conducted by USAID GTG-RISE with technical support from Intertek AIM, US.

7.3.2.1 Cost due to increase in Net Heat Rate

It has been observed that the extent of deterioration in Net Heat Rate depends on the percentage unit loading. The estimates are based on combustion engineering boiler design and GE make turbines. For a typical 200/210/500/660 MW unit the increase in tariff due to increase in Net Heat Rate at different loading factors is as given in table below. The base Energy Charge Rate (ECR) has been assumed to be 200 paisa/kWh based on the average ECR of NTPC stations from April 2018 to October 2018.

Table 7.3 Increase in Variable Costs due to HR deviation

S.no.	Unit loading %	200/210 MW		500 MW		660 MW	
		Increase in NHR (%)	Addl. Paisa/ Kwh	Increase in NHR (%)	Addl. Paisa/ Kwh	Increase in NHR (%)	Addl. Paisa/ Kwh
1	90%	NIL	0	1.0%	1.1	1.0%	1.6
2	80%	0%	0	1.7%	3.4	1.7%	3.5
3	70%	1.1%	2.1	3.3%	6.7	3.3%	6.6
4	60%	3.8%	7.5	6.3%	12.6	5.7%	11.5
5	50%	7.5%	15.0	10.0%	20.0	9.2%	18.4
6	40%	11.6%	23.2	13.8%	27.6	14.4%	28.7
7	30%	17.3%	34.6	19.0%	38.0	20.4%	40.8

(**S***ource: NTPC)*

7.3.2.2 Cost due to Increased Life Consumption (Damage costs)

Flexible operation leads to a higher rate of deterioration of components. This is observed in increased failure rate and more frequent replacement of components. The impact on life of components increases with increase in no. of start stops the unit undergoes in a year. As a result, the operation and maintenance cost are significantly higher in units operated on a daily or weekly start-stop basis.

USAID-Intertek Study: An estimate of the increase in O&M Cost due to reduction in life of components is given below. It is based on study conducted under USAID GTG-RISE program with technical support from M/s Intertek AIM, USA at Ramagundam, Jhajjar TPS of NTPC and Ukai of GSECL. The study was based on the five to ten-year historical cost data of the units (all the costs are at 2017 levels for NTPC & 2018 for GSECL Units). The corresponding level costs 28.7 Lakhs/MW for 210 MW unit and 19.22 Lakhs/MW for 500 MW unit is based on the CERC normative O&M cost for year 2016-17.

As per estimates by USAID-Intertek study, the cost of flexibilization at two stations is summarised below. These costs are as per defined typical cycle. Most of the wear-and-tear cycling costs are owing to the O&M and capitalized maintenance costs and the increased Equivalent Forced Outage Rates (EFOR) costs. The table below provides the best estimates of the costs which includes forced outages. There is a variation in cost estimates of similar type of units at NTPC and GSECL. In fact, no two units will have the same costs due to variation in factors affecting the costs like coal, age of plant, operating practices, operator's skill and design. The incremental cost due to each event is expressed as percentage of the normative O&M costs.

Table 7.4 O&M Cost Impacts on 200 MW & 500 MW Units

MW	Event	NTPC- O&M Cost (INR-Lakh)				GSECL- O&M Cost (INR-Lakh)			
		Per Event	Per MW	Per MW (Current level) As allowed by CERC 2017	% Addl. / event	Per Event	Per MW	Per MW (Current level) As allowed by CERC 2017	% Addl. / event
200	Cold Start	91.3	0.46	28.7	1.59%	42	0.21	28.7	0.73%
	Warm Start	51.4	0.26		0.90%	28.9	0.14		0.49%
	Hot Start	38.0	0.19		0.66%	20.6	0.1		0.35%
	Significant load following	0.5	0.00		0.01%	0.2	0.001		0.003%
500	Cold Start	262.2	0.52	19.22	2.73%	174.9	0.35	19.7	1.78%
	Warm Start	151.6	0.30		1.58%	127.7	0.26		1.32%
	Hot Start	123.0	0.25		1.28%	78.4	0.16		0.81%
	Significant load following	2.7	0.01		0.03%	2	0.004		0.02%

(**S***ource: USAID GTG-RISE Pilot on Coal Flexibility, data furnished by NTPC)*

As per the estimates of Intertek (table above), the per event impact ranges from 0.01% to 2.73%. Surely, the actual costs will depend on the number of such events.

Engie Lab estimates that on a yearly basis, the capital expenditures and additional maintenance result in a 0.3% to 4.3% cost impact versus the total costs of a unit, or expressed in rupees per kWh produced on such a unit: 0.01 to 0.15Rs/kWh. The absolute non-fuel costs over a 10-year period are approximately (not discounted over 10 years with a weighted average cost of capital). But this estimate is based on the current level of flexibilization, where units are operating on 55% and above without much load following. There can be a significant variation, based on the level of flexibilization (number of events in a year).

7.3.2.3 Cost due to additional oil consumption due to increased EFOR

As per studies carried out by EPRI based on global data, there is a significant increase in EFOR due to varying operational modes and on units ageing. The norms for specific oil consumption had been fixed at 0.5ml/kWh as per CERC norms for 2014-19. Based on the increased EFOR (as per EPRI) the norms for specific oil consumption may be allowed as per the Table 7.5. The loading factor calculation is done with on-bar availability i.e. Reserve Shut Down (RSD) is to be ignored.

Table 7.5 Oil Consumption due to increased EFOR

S. No.	Operation Mode	EFOR	Increase in EFOR	Sp. Oil Consumption
1	Base Load	5	-	0.5
2	Load Following (Loading Factor <60%)	7.06	2.06	0.70
3	Minimum Load (Loading Factor 40 % to 50%)	7.19	2.19	0.72
4	Minimum Load (Loading Factor 30-40%)	>7.19	>2.19	0.8
5	Minimum Load (Loading Factor 30-40%) with provisions for varying coal			1.0

(**S***ource: NTPC)*

In the Indian context, with varying coal quality, providing for additional secondary oil for low load operation will positively impact the safety and reliability of the units.
Assuming the cost of oil at Rs. 45,000/kL, the impact on ECR due to oil is shown in Table 7.6 below:

Table 7.6 ECR Impact due to increased Oil Consumption

S. No.	Specific Oil Consumption	Increased ECR (p/kWh)
1	CERC Norms (Present): 0.5 ml/kWh	2.5
2	At 0.7 ml/kWh	3.5
3	At 0.8 ml/kWh	4.0
4	At 1.0 ml/kWh	5.0

In addition to the above costs, the increase in fixed costs/unit due to lower PLFs of units providing flexibility needs to be recovered. Due to flexible operation there would be loss of availability due to increased maintenance requirements and increased EFOR which will make it difficult for the generator to recover full capacity charges.

7.4 Efficiency Studies/ Tests

To arrive at the plant efficiency, the efficiency of turbine is multiplied by the boiler efficiency. Turbine generator cycle heat rate (TGCHR) is defined as the heat supplied to the steam divided by the electric power generation. It does not include losses in the combustion or heat losses in flue gases and therefore represents the efficiency of a part of the process. The heat supplied to the cycle is calculated as

$$Q=Q_{MS}+Q_{RH}+Q_{SHspray}$$

Where, Q heat supplied to the cycle Q_{MS} heat supplied to main steam Q_{RH} heat supplied to RH steam $Q_{SHspray}$ heat supplied to SH spray. The heat is calculated as mass flow multiplied by difference of specific enthalpy. The mass flows of main steam and SH spray are measured, the RH steam mass flow is calculated as main steam flow minus extraction flow. The extraction flows are calculated from heat and energy balances of preheaters.

For determining the heat rate degradation at low operating load of 40%, it was decided by CEA to conduct the efficiency performance tests in thermal units at various thermal plants in collaboration with international partners, IGEF, Germany and TEPCO, Japan. Further, CEA entrusted the OEMs (BHEL/GE/Siemens) to conduct heat rate degradation computational studies based on heat balance.

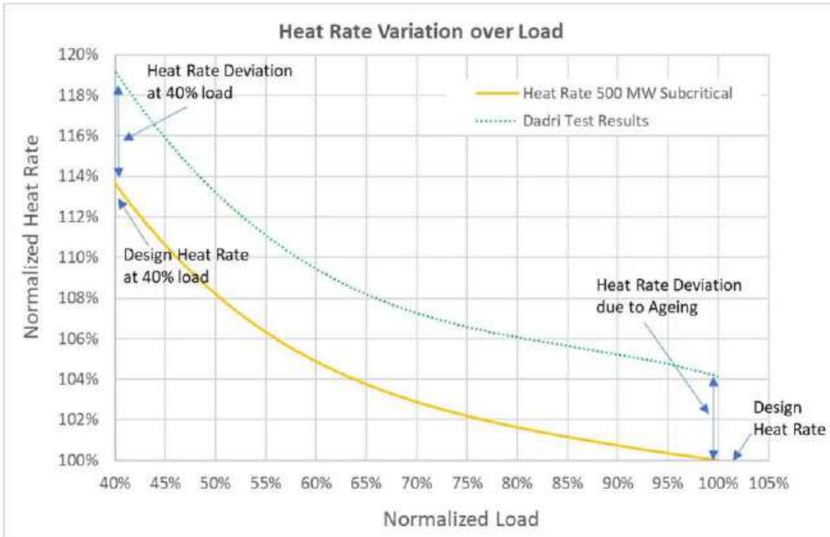
7.4.1 Efficiency Tests at Low Load

The efficiency tests were conducted at Dadri TPS, Maithon RBTPS, DSTPS, Andal and Mouda TPS in collaboration with IGEF, Germany and TEPCO, Japan, respectively. The data collected from these tests has been analysed to understand the performance deterioration at part loads. To analyse the data, NTPC Dadri 490MW (subcritical), NTPC Mouda 660 MW (supercritical), DSTPS, DVC and Tata power Maithon 525MW (subcritical) have been considered.

In order to study the effect, the load and heat rate are normalized i.e. load has been normalized to rated capacity of unit and heat rate has been normalized to rated heat rate at 100% TMCR conditions. The results of the heat rate and load are as represented in following figure.

7.4.1.1 Dadri Efficiency Test

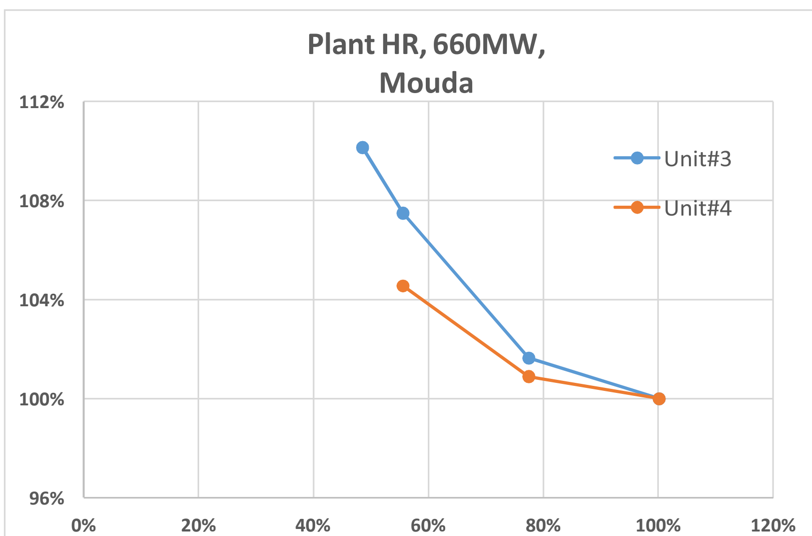
For part load efficiency assessment of 490MW Dadri Unit 5 of NTPC, data was analysed by Siemens. The TGCHR was done during the minimum load test on while the average load was 195MW.



(**S***ource: Siemens)*

7.4.1.1 Mauda Efficiency Test

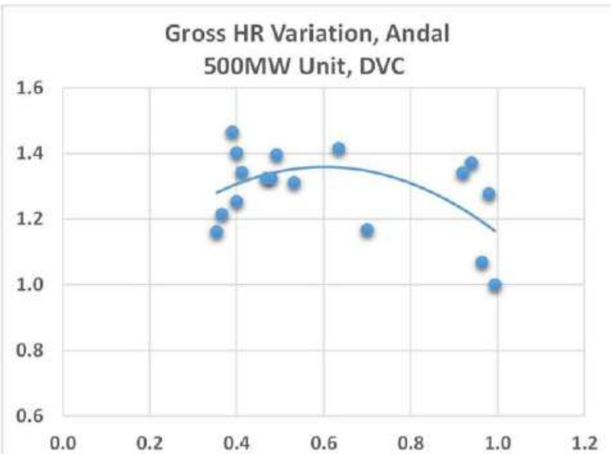
The tests were conducted from Jan 6 to 9, 2020 at Mouda STPS, NTPC on unit 3 and 4 of rated capacity 660MW.The tests were conducted in collaboration with TEPCO/JERA, Japan. The test results of the heat rate degradation with respect to loading is given in the chart below. The tests could not be conducted at low load of 40% due to theapprehensions of the owner, however, on unit 3 test could be completed at 49% load condition.



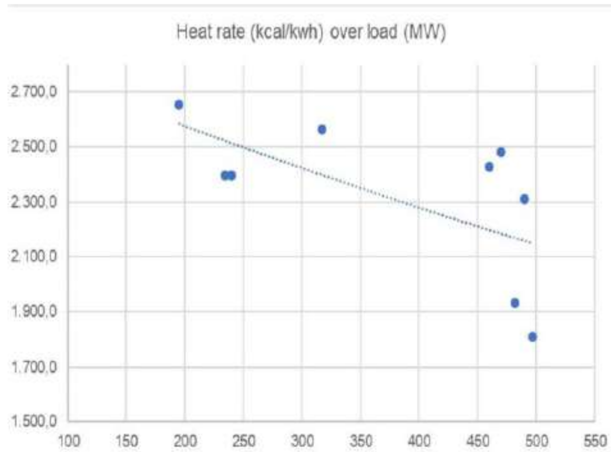
(**S***ource: JCOAL Report)*

7.4.1.3 Andal Efficiency Test

The efficiency test was conducted on unit 2 of rated capacity 500MW in collaboration with IGEF/VGBE, Germany. The heat rate has been calculated at around fifteen load points, however, the results are not showing normal trend of deterioration, refer plot above (left side). These results as such cannot be effectively used for assessing the impact at low loads. However, it needs to be considered that the coal quality variation was very high, GCV was in a range between 3,545 kcal/kg to 5,640 kcal/kg. Excluding the datawhich have the highest coal variations, the graph changes accordingly (right side). It reflects the deterioration in heat rate with respect to the loads. From the revised plot (rightside) the heat rate deterioration can be estimated as 20% at a low load of 40% when compared at rated load (100%).



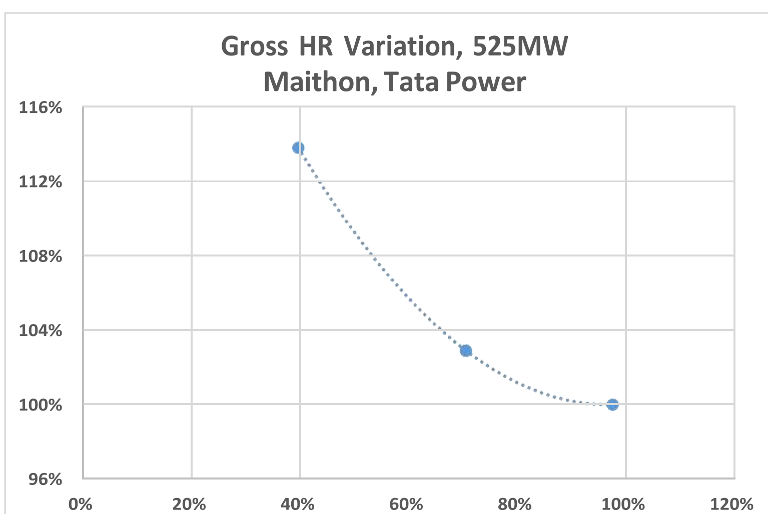
(**S***ource: IGEF Report)*



(**S***ource: VGBE/IGEF)*

7.4.1.2 Maithon Efficiency Test

The Maithon efficiency test was conducted on unit 2 of rated capacity 525MW in collaboration of IGEF Germany. The TGCHR was done during the minimum load test on 22 July, 2021 between 14:30 and 15:30 while the average load was 211 MW. Boiler efficiency was assumed as 88%, the overall plant HR was calculated from the TGCHR.



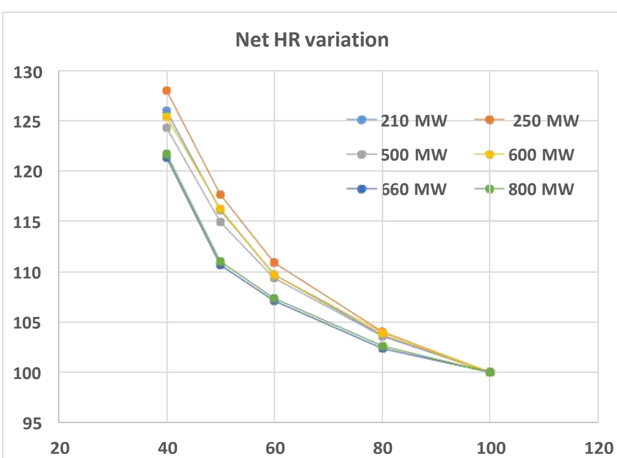
(**S***ource: IGEF Report)*

7.4.1.4 Summary- Efficiency Tests

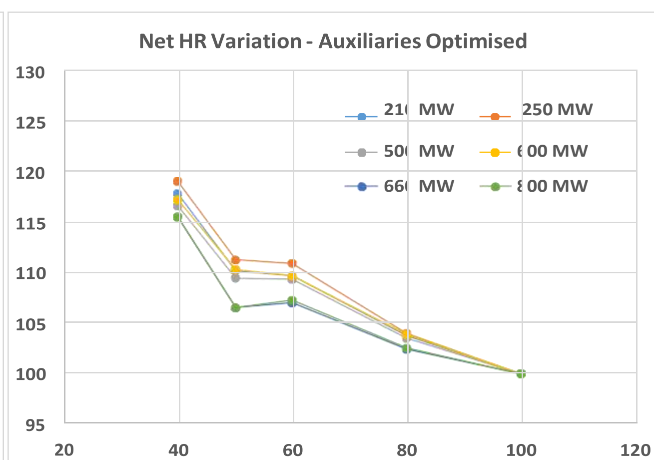
In Maithon, DVC TATA JV the efficiency tests were carried at three load points (515MW, 373MW and 211MW) and it is seen from the test report that the gross HR degradation is 14% at 40% load from 98% load. Similarly, in the case of Mauda, NTPC the efficiency test was carried on supercritical unit at four loading points (660.8 MW/511.3 MW/366.8 MW/320.4MW) and it is seen from the test report that the gross HR degradation is about 10% at 49% load from the full load. In the case of Andal, DVC, as discussed above the gross heat rate deterioration is predicted as 20% at a load of 40%. It is seen in the case of Dadri, the overall plant HR behavior was found to follow the same pattern as of original HBD calculations. The deviation from design heat rate at 100% and at 40% is found to be same and this deviation can be attributed to ageing of the plant as per standard ASME degradation curves. Therefore, HBD calculations with applied ageing can predict the performance at part load with reasonable accuracy. However, to confirm the HR degradation, efficiency tests needs to be conducted as per the prescribed standard procedures on sufficient number of units of different unit sizes to arrive at HR deterioration figures.

7.4.2 Heat Balance Studies

The heat rate degradation studies were performed by OEMs (*BHEL/GE/Siemens*) for various unit sizes at different loading conditions based on heat balance. The heat balance calculations done by *BHEL* indicates the heat rate (gross) degradation from full load to 40% load is in the range of 13.5% to 16.5% and heat rate (net) degradation in the range of 21.3% to 27.9%. However, when considering *modified* auxiliary power scheme at 50% to 40% load, the heat rate (net) degradation is drastically reduced (about 30%). Hence, it is obvious that the scheme of auxiliary control needs to be modified for low load operationat 50% and below to get the significant performance benefits.



(*Source: BHEL HB Study)*



(*Source: BHEL HB Study)*

GE, India has also conducted study for the heat rate deterioration at different loads levels for different unit sizes of thermal units. The heat rate (net) degradation is found to be in the order of 12% to 14% for different unit sizes at a load of 40%. The degradation of HR is found to be very low when compared to BHEL study (estimated) which is in the range of 21.3% to 27.9%. Similarly, *Siemens, India* conducted the heat balance study details of which are tabulated in Table 7.9.

Table 7.8 Heat Balance Study (GE)

% Load	% Deviation NHR			
	210MW	500MW	660MW	800MW
100%	0%	0%	0%	0%
90%	0%	1%	1%	1%
80%	0%	2%	2%	2%
70%	1%	3%	3%	3%
60%	4%	6%	6%	6%
55%	6%	8%	8%	8%
50%	7%	10%	9%	10%
40%	12%	14%	14%	16%
30%	17%	19%	20%	24%

Table 7.9 Heat Balance Study (Siemens)

% Load	% Deviation NHR			
	210MW	500MW	6600MW	800MW
100%	0%	0%	0%	0%
90%	1.1%	0.8%	1.0%	0.8%
80%	2.3%	1.4%	2.0%	1.3%
60%	6.1%	4.5%	4.2%	3.0%
50%	7.3%	7.7%	6.2%	4.8%
40%	9.5%	10.0%	8.9%	7.0%
35%	13.0%	15.0%	14.0%	13.8%

7.4.3 Impact of low load on Tariff

The impact of low load operation on HR was studied by major OEMs (BHEL/GE/ Siemens) while conducting heat balance for various unit sizes. As there was sizable variation in the HR deterioration among the studies, the deterioration in HR was considered by the committee based on the heat balance study report of BHEL, SIEMENS, GE and actual efficiency tests to study its impact on tariff. Further, the impact of capital cost for upgradation of controls has been considered as six to ten crores and the amount may increase upto 30 crores for older units commissioned before 2010. The increase in O&M cost has beenconsidered based on the loading levels of the units and at 40% loading it has been assumed as 20%.

The study conducted by CEA indicates the impact of low load operation at 40% on variable part of tariff is around 15% whereas the impact on fixed part of tariff is around 2.77%-7.63% depending on the unit size. The summary of the study conducted is given inTable 7.10 below and the assumptions considered are given in Annexure-I.

Table 7.10 Possible Impact of Low load Operation on Tariff

(a) Impact in Paisa/kWh

Capacity (MW)	Loading	NHR (% Increase)	Variable Tariff (Increase in Paisa/kWh)	Fixed Tariff (Increase in Paisa/kwh)						
				Due to O&M	Capex (Rs 6 cr./ Unit)	Total	Capex (Rs 10 cr./ Unit)	Total	Capex (Rs 30 cr./ Unit)	Total
200	50%	10.0	13.74	5.14	1.71	6.85	2.85	7.99	8.56	13.70
	45%	13.0	17.86	7.99	1.71	9.70	2.85	10.84	8.56	16.55
	40%	16.0	21.97	11.42	1.71	13.13	2.85	14.27	8.56	19.98
500	50%	10.9	14.60	3.42	0.68	4.11	1.14	4.57	3.42	6.85
	45%	13.6	18.30	5.33	0.68	6.01	1.14	6.47	3.42	8.75
	40%	16.0	21.50	7.61	0.68	8.29	1.14	8.75	3.42	11.03
660	50%	8.7	11.10	3.08	0.52	3.60	0.86	3.95	2.59	5.67
	45%	11.9	15.30	4.79	0.52	5.31	0.86	5.66	2.59	7.39
	40%	14.6	18.70	6.85	0.52	7.37	0.86	7.71	2.59	9.44
800	50%	8.6	10.66	2.74	0.43	3.17	0.71	3.45	2.14	4.88
	45%	12.0	14.86	4.26	0.43	4.69	0.71	4.97	2.14	6.40
	40%	15.0	18.58	6.09	0.43	6.52	0.71	6.8	2.14	8.23

(b) Impact in Percentage terms per kwh

Capacity (MW)	Loading	NHR (% Increase)	Variable Tariff (% Increase)	Fixed Tariff (% Increase)						
				Due to O&M	Capex (Rs 6 cr./ Unit)	Total	Capex (Rs 10 cr./ Unit)	Total	Capex (Rs 30 cr./ Unit)	Total
200	50%	10.0	9.82	1.96	0.65	2.62	1.09	3.05	3.27	5.23
	45%	13.0	12.76	3.05	0.65	3.71	1.09	4.14	3.27	6.32
	40%	16.0	15.70	4.36	0.65	5.02	1.09	5.45	3.27	7.63
500	50%	10.9	10.60	1.41	0.28	1.69	0.47	1.88	1.41	2.82
	45%	13.6	13.29	2.19	0.28	2.48	0.47	2.66	1.41	3.61
	40%	16.0	15.61	3.14	0.28	3.42	0.47	3.61	1.41	4.55
660	50%	8.7	8.44	1.29	0.22	1.51	0.36	1.65	1.09	2.38
	45%	11.9	11.63	2.01	0.22	2.22	0.36	2.37	1.09	3.09
	40%	14.6	14.22	2.87	0.22	3.08	0.36	3.23	1.09	3.95
800	50%	8.6	8.39	1.17	0.18	1.35	0.30	1.47	0.91	2.08
	45%	12.0	11.70	1.81	0.18	1.99	0.30	2.12	0.91	2.72
	40%	15.0	14.63	2.59	0.18	2.77	0.30	2.89	0.91	3.50

Note:

1. Increased tariff = increased fixed tariff + increased variable tariff
2. Increased fixed tariff = due to increase capex + increase O&M expenses

7.4.4 Recommendations

7.4.4.1 Modifications (Retrofit)

For achieving minimum technical load (40%) and higher ramp rate, the primary focus of the utility shall have to be on optimizing the existing control system. Improvements in some of the areas shall be essential, like achieving automated control operation whichshall include proper tuning of operation so as to avoid temperature and pressure excursions. Control optimization shall include main/reheat steam temperature control,boiler feed water recirculation control, flue gas temperature control. Better combustion control shall include, optimum fuel to air ratio, fuel to load coordination, furnace pressure control, burner tilt control and proper flame monitoring at low loads. Condition monitoring of boiler and turbine, flame monitoring is essential from the safety point of view. To reduce the running cost of the unit at low loads, the optimization of auxiliariesis essential for improving heat rate. The above measures are essential for a unit and may require a capital investment of around six to ten crores. In case of very old units which have not upgraded their plant control and instrumentation system previously, the capital investment will be about 30 crores depending on the retrofit.

7.4.4.2 Compensation Mechanism

i) Cost of modification/retrofit shall form part of the capital investment, and wherever applicable, this shall be recoverable through fixed part of tariff separately in 5 to 7 years' time periods as done in case of R&M.

ii) Costs due to increase in O&M expenses, shall have to be compensated as part of the fixed tariff. The increase in O&M costs shall depend on level of flexibilisation and in the study conducted by CEA (refer Table 7.10) the increase in annual O&M cost has been considered as 9%, 14% and 20% at 50%, 45%, 40% loading, respectively.

iii) Below 55% technical minimum load, the heat rate deterioration becomes even steeper and thermal power plants are not compensated for this deterioration. Units running technical minimum load below 55% can be additionally compensated in ECR to the extent of heat rate deterioration. As per the study conducted by TPRM Div., CEA, unit operating at loads lower than 55% technical minimum load can be suitably compensated in their variable tariff as summarized in Table 7.10, initially, which can be modified suitably after receiving sufficient data.

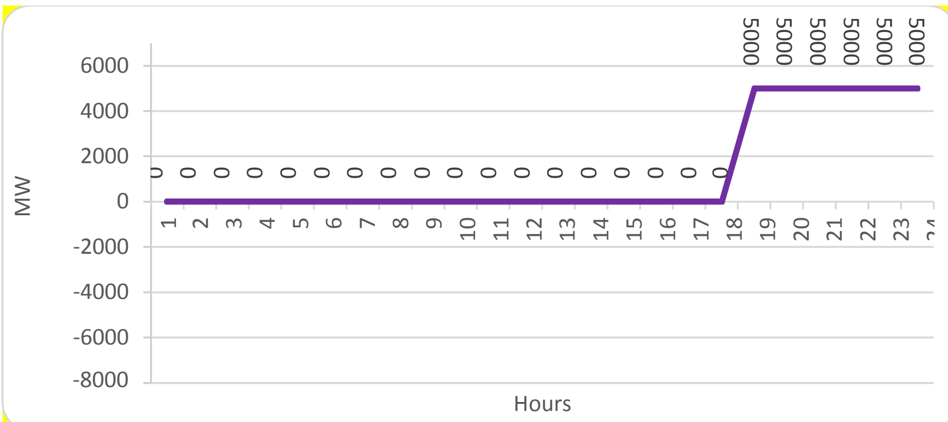
iv) Further, the compensation on account of forced outage due to operation at lower loads may have to be compensated as per the details indicated in Table 7.5.

v) There may be scenarios, wherein the flexible capabilities may have been created, however, the opportunity or the schedule to flexibilise may not become available to the particular unit. Hence, increased O&M cost may not be considered as part of fixed cost whereas the increased capital cost on account of retrofit shall continue to be recovered. The variable costs related to flexibilisation should be reimbursed for the cycling period by way of increase in the tariff.

vi) The Compensation on account of EFOR may be allowed 1.0 paisa/kWh initially as specific oil consumption may increase from 0.5 to 0.7 ml/KWh. It is also suggested to review after one year considering actual start/stop due to low load operation.

8. TWO-SHIFT OPERATION

CEA's 2019 report, "Flexible operation of thermal power plants for integration of renewable generation" suggested to run 5000 MW out of 10000 MW old small size (151 MW or less) units for six hours in the evening peak hours for integration of generation from 175 GW RES. Most of these units are more than 25 years old and have high Energy Charge Rating (ECR).



CEA reports, 2019 - Two shift Operation of thermal units

8.1 Classification of Two-Shift Operation

Category 1 - Operate during Peak Demand period: these plants will have to deliver the peak loads with full available capacity during the peak hours (about 6 to 7 hrs.), with increased demand and reduced or no solar, After the peak hours are over, these plants will not be required to deliver any power and therefore would be put on hot standby. Plants in this category are likely to have an annual PLF of 30% or lower.

Category 2 - Shutting down during Peak Solar Generation Period**:** In this category plants will be under shut down during of solar peak generation period (10 am to 4 pm or 10 am to 5 pm) and units will generate in the evening peak with hot startup. The PLF of plants will be better than plants under category-1.

Two-shift operation is a costly mode of operation because of lower PLF and accelerated equipment life consumption due to daily start stop and increased forced outages. In the Indian market context, it will make economic sense for the older plants (with near-zero fixed costs/fully depreciated capital costs) to be retrofitted for a two-shifting mode of operation. As these plants would be on bar for a limited duration, the overall emissions will be much lower, compared to the plants operating on lower loads for a longer duration.

The start-ups in daily two-shifting operations will mostly be hot start-ups, which are less damaging (equipment life consumption) than warm or cold start-ups. These plants are best placed, economically to deliver the peaking power (which can be opted as an Ancillary service product or suitable compensation mechanism to be installed). More study regarding startup optimization, minimization of equipment damage is required for two shift operation of thermal power plants.

8.2 Two-Shift Operating Experience

8.2.1 CESC Limited is operating the 2x67.5MW, BHEL make units of Southern Replacement TPS, commissioned in 1990 and 1991 respectively, in single/two shift mode for last 5 to 6 years, depending on merit order and system/network requirement. Running hours varies from 6 to 18 hours per day and type of start is hot or warm or cold depending on the number of hours of shutdown. No retrofitting (hardware/software) was done for single/two shift operation.

8.2.2 Another example of two-shift operation is of TANGEDCO, Tamil Nadu which is classified under category 2. The two shift mode operation was started in April 2022 and is being continued to accommodate the renewable generation as and when required. The units are at full load during evening peak hours and mostly units are operating for 16 hrs. in a day from 5pm to 11am, daily in hot startup mode. About all 210 MW units of the TANGEDCO are being operated in two shift mode which are more than 30 years old and 3 of which are more than 40 years old. The unit operated in two shift mode are given in table 8.1.

The following have been experienced during two shift operation of the units by M/s.TANGEDCO.

1. Oil consumption is more and the generation cost & Auxiliary power consumption percentage have increased.
2. Heat rate, Specific Coal Consumption, Specific Oil consumption have increased. Overall efficiency is under study. The operational issues, equipment condition and other safety related issues are being monitored meticulously during the two shift operation periods. The details of outcome of the study by TANGEDCO shall be available after monitoring the two shift operation for a longer period.

Table 8.1 TANGEDCO Units Operated in TwoShift Mode

S.no	Station	Unit	Commissioning Date
1	TTPS, 5x210 MW	I	07.09.1979
		II	17.12.1980
		III	16.04.1982
		IV	11.02.1992
		V	31.03.1991
2	MTPS, 4X 210 MW	I	07.01.1987
		II	01.12.0987
		III	22.03.1989
		IV	27.03.1990

Source : TANGEDCO Ltd.

8.3 Recommendation

It is proposed to initiate study by an expert committee for two shift operation of thermal power plants considering integration of 500 GW non fossil fuel capacity by 2030. The technical feasibility and recovery of cost system of two shift operation need to be elaborated by the committee. Further, the committee may also explore the possibility of exemption of FGD installation in these power plants considering the limited hours of operation and daily/ monthly average SO2 emission will be within prescribed limits.

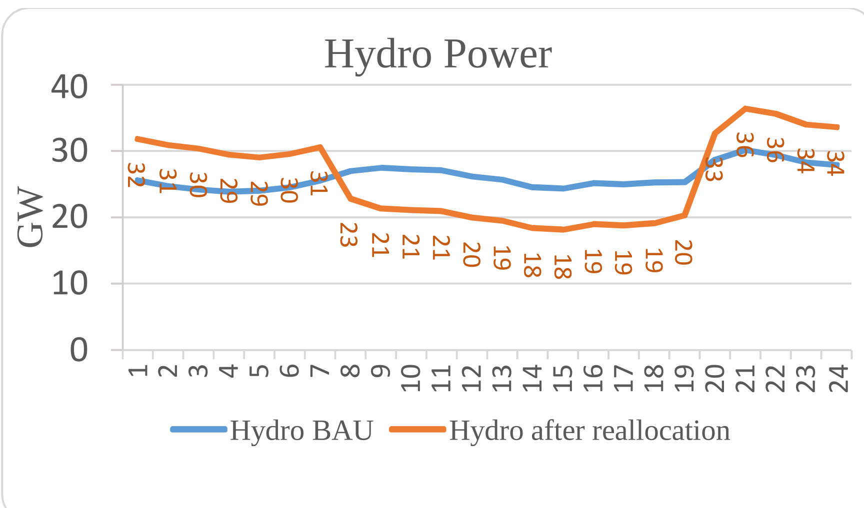
9. FLEXIBLE POWER FROM DIFFERENT SOURCES

Flexible power required for the balancing of grid may be available from following sources:

- Reallocation of hydro generation
- Gas flexing
- Pump Storage
- Low load operation of thermal power plants
- 2-shift operation thermal power plants
- Demand Side Management
- Battery Storage

9.1 Reallocation of Hydro Generation

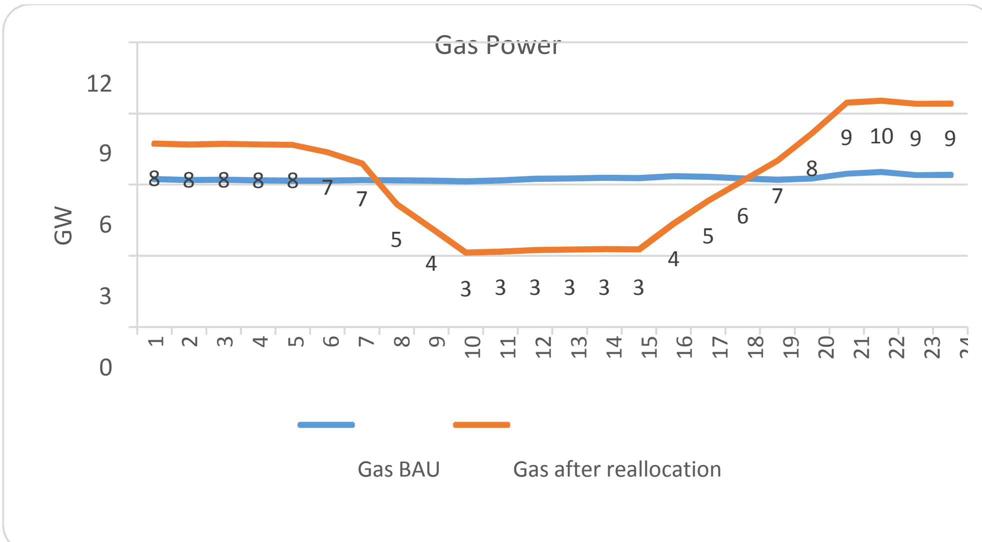
Present hydro generation is shown in blue colour in fig. below. Proposed reschedule is shown as in brown colour where reduced generation during day time and higher generation during peak demand hours is proposed. To achieve the target, the coordination with central and state hydro generator is essential. It has been observed that states hydro plants are operating continuously to meet the demand of states and states do not draw power from grid during day time because of their very cheap hydro power compared to grid power.



It is suggested to implement separate tariff for flexible hydro power which will be higher than cost of peak grid power and cost of solar power may be reduced specially from 11 am to 4 pm. If the tariff is revised as above, many hydro rich states will draw power from grid during day time and operate hydro plants during peaking hours for financial benefit of the organization. The minimum tariff of flexible hydro power should be greater than the off-peak grid power.

9.2 Gas Flexing

Presently installed Gas Power Plant capacity is about 25GW but about 9 GW is operating due to low availability of gas. Out of 9 GW, a few cannot operate intermittently as they are directly connected to oil fields. There is possibility of flexible operation of gas power plant which are connected with the gas grid. Present generation and proposed generation of the gas power plants are shown in blue and brown colour in the fig below.



9.3 Pump Storage

We have enormous potential for small pump storage with a cost of 3-4 cr/MW,it is possible to develop PSS by identifying the location in consultation with Hydro wing, CEA, NHPC or state hydro sector. In fact, development of pumped hydro storage schemes is a precursor to integrate renewable power generation.Central/State/Private Pump Storage plants should operate in pumping mode during the solar generation period and generating mode during peak demand period. They can be utilized for meeting the peak demand of the grid or balancing the grid only.

9.4 Flexibilisation of Thermal Power Plants

9.4.1 Low Load Operation of Thermal Power Plants

About 70 percent of the country's energy demand is being met from thermal generation thus it is essential that maximum flexible power will be available from thermal power plants. The maximum and minimum gross thermal capacity of 232GW and 148GW are required in 2029-30 as specified in CEA's report on "Optimal Generation Capacity Mix for 2029-30". If required measures shall be implemented for operation of TPPs at 40% load instead of present 55 percent minimum load, then it shall be possible to achieve about 21GW additional flexible power from the thermal fleet. The details are as under:

Max. Gross Coal Capacity Required (as per Optimal gen. report)	= 232 GW,
Max. gen. (75% units)	= 174 GW
Spinning reserves (7%)	= 12.18 GW
Auxiliary consumption (7%)	= 11.32 GW
Ex-bus gen.	= 150.49 GW
55% min. load (aux. 7.5%)	= 76.56 GW
40% min. Load (aux. 8%)	= 55.38 GW

21.18 GW (76.56-55.38) more Renewable integration is possible by lowering the min load from 55% to 40%.

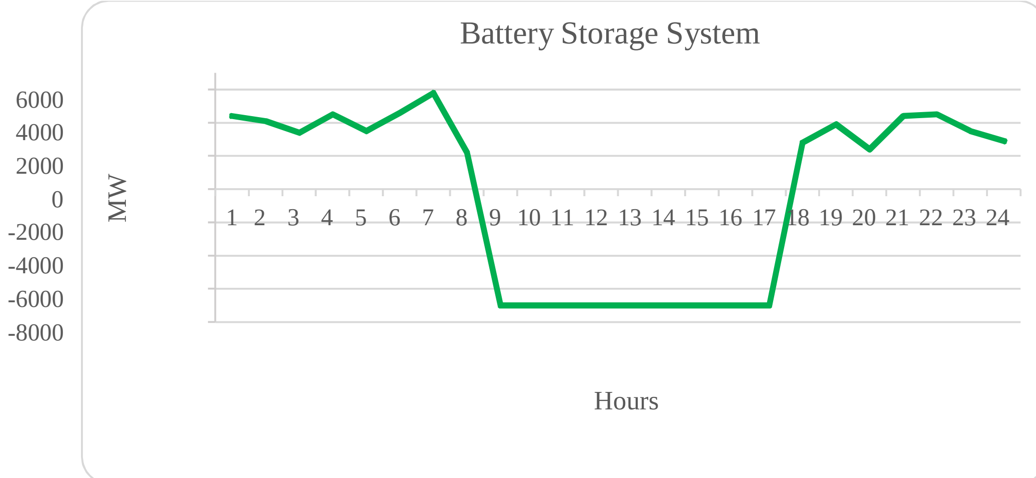
Capex = 10 Crore per unit (average)
Total no. of Units = 600
Total investment = 600X10 = 6000 Crore

9.4.2 Two-Shift Operation of Thermal Power Plants

After implementing low load operation up to 40% at thermal generating units, iffurther flexible power is required it can be available from 2-shift operation of old& small size thermal generating units. These units may run 6 to 7 hrs only duringpeak grid demand period or 6 to 7 hrs. shutting down during peak solar generation period.

9.5 Battery Storage System

The cost of battery energy storage system is assumed to be reducing uniformly from 7 Crore in 2021-22 to 4.3 Crore in 2029-30 for a 4-hour battery system which also includes an additional cost of 25% due to depth of discharge. If we consider 27GW BSS with an average cost of 5.65 Crore/MW, total cost shall be more than one lakh fifty thousand crore. Thus BSS shall be costly, which shall have to be imported, having less life about 9-10 years and disposal issues. Considering the above it is suggested to reduce BSS capacity accordingly.



9.6 Demand Side Management

Demand side management (implementing TOD metering) including measuretargeted at domestic, agricultural, industrial and e-mobility sector and hydrogengeneration would enable more rational consumption pattern of electricity. The cost of grid power will be of least during high solar period and highest in evening/morning peak. It shall encourages consumption of energy during day time than in the peak hours.

Supply of electricity to agriculture sector by dedicated feeders

Agricultural consumption = 211,295 MU
Agricultural consumption = 16.94 %

Shifting of 1000MW load from night hours to peak solar hour will improve about 1% technical minimum load of thermal generating units.

9.7 Recommendation

It is suggested that existing capacity of hydro, pumped storage, gas and thermal available for flexibilisation in the system should be utilized first in a safe and secure manner before adopting newer options such as Battery storage system, etc. on a large scale.

10. ROADMAP

The conduction of low load study/test run is essential for each unit to find the measures required to be implemented for flexible operation, as has been discussed in earlier chapters of the report. To implement measures in a unit as identified in low load test/study, it shall require a minimum six months' time. Hence, it is necessary to formulate a time frame for achieving flexibilisation of a very large fleet of 600 thermal units. It is expected that non-pithead thermal power plant shall be given minimum technical generation schedule in first stance and thereafter pithead based plants if required. This section deals with devising a phasing schedule based on the age of units andinputs received from the major OEMs.

10.1 Phasing Plan

On accomplishing 175GW RES capacity in the December, 2022 (may be in 2023), there shall be grid requirement of the operation of thermal units at 40% minimum load on an average as per the findings of CEA 2019 report. So far to the knowledge of committee, work has been awarded for the upgradation/flexibilisation of one unit in central sector in 2019. The final outcome of the flexibilisation work carried out has to be established. CEA consulted three major OEMs (BHEL, Siemens and GE) and also tried to consult others for their capabilities to carry out the flexibilisation work. The data provided by one of the vendors already conducting the flexibilisation work on one of the units seemed tobe more realistic than the other two vendors. There has been no response from the othersub vendors. Based on the present vendor capabilities, the following preliminary phasing plan has been drawn up by TPRM Div. CEA.

More than 24.64% thermal capacity is newly commissioned, January 2016 onwards (refer Table 9.1). These new units should necessarily be having advanced digital controls and features which shall help in faster adoption of the 40% load following operational regime. It shall be obligatory that such units numbering 101 units are brought under the purview of flexibilisation operating regime first.

Table 10.1

Commissioning Period	Units	Capacity(MW)
Since 2016 to till date	101	52,152
Between 2012 & 2015	160	80,384
Between 2001 & 2011	143	34,840
Upto 2000	196	44,143.5
Total	**600**	**211,519.5**

In the pilot phase, it is proposed that 11 units of central/state/pvt sector which were commissioned from Jan 2016 to December 2022 shall be taken for refurbishment (refer

Table 9.2). It is estimated that the refurbishment shall be completed in a period of one year, which shall be followed by performance evaluation and rectification period of six months. The experience gained in pilot phase shall be useful for future planning. The complete phasing plan as proposed is given in the Table 10.2. A minimum estimated time period of 8 years' may be required to make these units compliant of flexibility upto 40% load following and having higher ramp rates. The complete refurbishment work is estimated to end by December 2030, considering the work starts in January 2023. This phasing will help in proper identification and planning.

Table 10.2 Phasing Plan

Phasing	Sector	No. of Units	Time Period (Year)	Unit commissioned
Pilot Phase Jan,2023-Dec,2023	Central	4	1	Jan,2016 to Dec,2022
	State	3	1	
	Private	4	1	
Jan,2024-Jun,2024	Performance analysis and modification, if required.			
1st Phase July,2024-Jun,2026	Central	32	2	Jan,2016 to Dec,2022
	State	26	2	
	Private	32	2	
2nd Phase July,2026-Jun,2028	Central	24	2	Jan,2012 to Dec,2015
	State	30	2	
	Private	106	2	
3rd Phase July,2028-Dec,2029	Central	41	1.5	Jan,2001 to Dec,2011
	State	52	1.5	
	Private	50	1.5	
4th Phase Jan,2030-Dec,2030	Central	67	1	up to December,2000
	State	111	1	
	Private	18	1	
Total		**600**	**8**	

In the 1st phase, the plants commissioned between January 2016 and December 2022, about 22.64% capacity (~15% Units) shall be considered and two years' time shall be required to complete the refurbishment.

Units commissioned between January 2012 and December 2015 shall be taken in 2ndphase (~27% Units) and unit commissioned January 2001 to December 2011 (~24% Units)shall be considered in 3rd phase and a shorter period one and half years' time is considered to be required due to the experience gained in earlier phase.

In the last 4th phase, remaining units (33%Units) commissioned up to December 2000 shall be considered requiring one year's time period for refurbishment. The details of all the phases including timeline is summarized in Table 10.2. The phasing may have to be reviewed considering the actual progress achieved on site.

10.2 Study/ Test Run of Each Unit

The conduction of low load study/test run is essential for each unit to find the measures required to be implemented for 40% low load operation without oil support. The measure shall also be identified for achieving minimum 1% ramp rate particularly in the lower load range 40% to 55%, 2% ramp rate in the load range of 56 to 70% and 3% in higher load range of 71 to 100%.

10.3 Measures Implementation

To implement measures in a unit as identified in low load test/study, it shall require a six months' time (approximately). (Refer Chapter-6 and Section 7.4.3.2.1 of Chapter 7)

10.4 Operator Training

Flexibilization of units adds to the safety risks and calls for added precautions. Equipment failure can take place due to negligence, poor operation and maintenance practices and low operator confidence due to the operation of plants for base load. For safe and efficient plant operation at very low load and frequent load cycling, there is an essential need for trained personnel. Training curriculum for trainer and power plant operators shall have to be prepared in association with major power plant operator and NPTI.

The training simulators provide a strong base for ensuring the right operational procedures and practices which need to be followed by operators. The existing training simulators may need to be upgraded for low load/high ramp rate operation at 40% load, which shall need to be ascertained. The training of personnel needs to be scheduled in advance before the units are put in high flexible mode of operation.

11. CONCLUSION AND WAY FORWARD

11.1 Conclusion

11.1.1 Low load operation (40%) of coal fired power plants is primarily required to fulfil theneeds of integration of renewables in the grid. Flexible power plants in the system enable the integration of more renewables, avoid wasteful curtailment, leading to a more efficient power system. Although, there maybe many options of flexible power for integrating renewables, coal fired plants is thebest option considering its availability, proportion and low cost.

11.1.2 The existing capacity of hydropower, pumped storage and gas-fired generation having good peaking performance is too small to meet the balancing requirements. It is of importance that the existing thermal resources available for flexibilisation in the system should be utilized first in a safe and secure manner before adopting newer options such as Battery storage system, etc. on a large scale.

11.1.3 Flexible operations for coal power plants are technically feasible by upgradation, tuning of controls, etc. The pilot tests conducted at various plants is the proof that Indian plants are capable to flex. Converting the base load coal fired power plants into flexible plants would most likely incur expenditure.

11.1.4 To assess the flexible capability, the thermal units need to be tested from safety, security & stability point of view and quantification of available flexible power, ramp rate, etc. These tests are also essential for accessing the need for retrofits which are plant specific. The low load test runs should be conducted after careful study of the unit beforehand and accordingly the test targets should be decided in consultation with OEM. Any stretching of the targets during the test run should be avoided for the safety and security of the plant.

11.1.5 The technical measures shall depend on the levelsof minimum load operation to be adopted. Lower load operation (40%) shall require measures like automation/optimization of controls, proper flame detection systems, efficient measures to optimize combustion process, stable minimum mill operation, reassessment of O&M practices, etc.

11.1.6 Indian power sector has got large fleet of subcritical coal fired units of capacity 500 MW and less, which are considered suitable for flexibilisation. Super-critical units are better for load ramping /flexible operation and more care is required around benson (dry/wet) point.

11.1.7 To ensure the security of the grid and safety of plants, presently the low load operation of coal-fired power plants should not be less than 35–40% of ratedpower due to Low VM and high ash content of Indian coal.

11.1.8 The coal-fired power units shall remain the main source of flexible power. However, there are many commercial issues like cost of retrofit, increased O&M cost, heat rate degradation cost, increased EFOR which would need to be compensated by the central and state regulators.

11.1.9 There is low operator confidence for flexibilisation due to operation of thermal plants as base load plants. Low load operation of units at forty percent calls for added precautions. Catastrophic equipment failure can take place due to negligence and poor operation and maintenance practices. Hence, operator training is essential for the implementation of flexibilisation.

11.1.10 Two shift operation of old thermal generating units is being carried out in some parts of the country in a piecemeal manner to meet the load generation balance. The need arises for carefully planning of two-shift operation countrywide.

11.2 Way Forward

11.2.1 Immediate action needs to be taken for preparing thermal generating units flexible as per the road map discussed in the report. Initially, the pilot phase of flexibilisation/refurbishment of 11 units of Central/State/Private sector may be carried out for performance evaluation (refer para 7.4.4.1). For funding some of the units under pilot phase, INDC *Technology Development & Transfer/ Fund Mobilization* or Govt. funding like PSDF may be utilized.

11.2.2 Availability of training simulators need to be ensured for the trainingof operators at 40% low load operation.

11.2.3 Regulation should be introduced for 40% minimum technical load operation of thermal generating units.

11.2.4 Suitable regulatory mechanism, should be introduced in central and state level, wherever applicable, for the compensation as discussed in the report (refer para 7.4.4.2).

11.2.5 Keeping in mind the requirement of flexible power in future, design of new thermal units should be such that it can be possible to operate these with optimized auxiliaries, at loads lower than 40% (say 30%) without oil support and, at higher ramp rates of 2-3% in lower load range.

11.2.6 Study should be initiated for finding the possibility of two shift operation of existing thermal generating units as per the grid requirement (refer para 8.4). Design of new thermal units should be such that it can be possible to operate in 2 shift mode on a regular basis.

ANNEXURE - I

Assumptions:

1. **Unit size 200 MW**
   BAU Mode:
   Capital Cost 6Cr/MW, O&M Cost 30lakh/MW, Coal Cost Rs 2000/ton, Heat rate 2430 Kcal/Kwh.
   Flexible Mode:
   Capital Expenditure w.r.t Flex. of 6/10/30 Cr./Unit, Increase in O&M Cost- 9% for 50%loading, 14% for 45% loading, 20% for 40% loading.

2. **Unit size 500 MW**
   BAU Mode:
   Capital Cost 6Cr/MW, O&M Cost 20lakh/MW, Coal Cost 2000Rs/ton., Heat rate 2390 Kcal/Kwh
   Flexible Mode:
   Capital Expenditure w.r.t Flex. of 6 /10/30 Cr./Unit, Increase in O&M Cost- 9% for 50%loading, 14% for 45% loading, 20% for 40% loading.

3. **Unit size 660 MW**
   BAU Mode:
   Capital Cost 6Cr/MW, O&M Cost 18lakh/MW, Coal Cost 2000Rs/ton., Heat rate 2280 Kcal/Kwh.
   Flexible Mode:
   Capital Expenditure w.r.t Flex. of 6/10/30 Cr./Unit, Increase in O&M Cost- 9% for 50%loading, 14% for 45% loading, 20% for 40% loading.

4. **Unit size 800 MW**
   BAU Mode:
   Capital Cost 6Cr/MW, O&M Cost 16lakh/MW, Coal Cost 2000Rs/ton., Heat rate 2200 Kcal/Kwh.
   Flexible Mode:
   Capital Expenditure w.r.t Flex. of 6/10/30 Cr./Unit, Increase in O&M Cost- 9% for 50%loading, 14% for 45% loading, 20% for 40% loading.

Annexure-A.VII

Progress Report regarding achievement of 55% MTL

S. No	Details	Unit 1	Unit2	Unit3	-------
1	Name of Utility				
2	Plant Name and Address				
3	Capacity, MW				
4	Date of Commissioning				
5	Type of Unit: Supercritical/Subcritical/....				
6	Net Heat rate: Design/Actual				
7	Coal Quality (i) GCV (ii) Volatile matter (iii) Ash Content				
8	Maximum Generation (last 2 years) MW				
9	Minimum Generation (last 2 years) MW				
10	Maximum Ramp Rate Up (last 2 years)				
11	Maximum Ramp Rate Down (last 2 years)				
12	Whether 55% Minimum load Achieved (YES/NO) (i) If YES, specify the duration and time (ii) If NO, specify the reason for the same				
14	Any other details				

Annexure-A.VIII

Progress Report regarding achievement of 40% MTL

S. No	Details	Unit 1	Unit2	Unit3	-------
1	Name of Utility				
2	Plant Name and Address				
3	Capacity, MW				
4	Date of Commissioning				
5	Type of Unit: Supercritical/Subcritical/....				
6	Net Heat rate: Design/Actual				
7	Coal Quality (i) GCV (ii) Volatile matter (iii) Ash Content				
8	Maximum Generation (last 2 years) MW				
9	Minimum Generation (last 2 years) MW				
10	Maximum Ramp Rate Up (last 2 years)				
11	Maximum Ramp Rate Down (last 2 years)				
12	Whether 40% Minimum load Achieved (YES/NO) (i) If YES, specify the duration and time (ii) If NO, specify the reason for the same (iii) Whether low load test conducted at 40% (YES/NO) (a) If YES, measures identified/implemented for achieving the same. (b) If No, any action taken in this regard				
14	Any other details				

Annexure-A.IX

Chief Engineer
(SLDC)

U.P. State Load Despatch Centre Ltd.
VibhutiKhand – II, Gomti Nagar,
Lucknow - 226010
Phone: 0522-2722866
E-mail: cepso@upsldc.org

No: - 61 /CE(PSO)/SE(R&A)/EE-II/Jawaharpur SPS Dated: - 08 Apr, 2024

Member Secretary, NRPC,
18 – A, SJSS Marg, Katwaria Sarai,
New Delhi, 110016.

Subject – Agenda for the 218th OCC meeting to review SPS at Jawaharpur TPS.

As you are already aware that System Protection Scheme (SPS) for safe evacuation of power from Jawaharpur TPS was approved in 66th NRPC meeting held on 30th May 2023. Scheme was commissioned on 20th September 2023.

In this regard it is to inform that 660 MW unit – 01 of Jawaharpur TPS tripped on SPS at 09:49 hrs on 07.04.2024. At present SPS is in disabled condition to avoid generation outage. System Protection Scheme needs to be reviewed on the basis of load flow study of sub-stations connected with Jawaharpur TPS.

It is therefore, requested to kindly include agenda item for review of SPS installed at Jawharpur TPS in the forthcoming 218th OCC meeting scheduled on 16.04.2024. Detailed load flow study shall be put up before the forum in the above meeting.

08.4.24

(Arshad Jamal Siddiqui)
Chief Engineer (PSO)

No: - 61 /CE(PSO)/SE(R&A)/EE-II/Jawaharpur SPS Dated: - 8, Apr, 2024

Copy forwarded via e-mail to following for kind information and necessary action:-

1. Director (SLDC), UPSLDC, Vibhuti Khand – II, Gomti Nagar, Lucknow.
2. Director (Operation), UPPTCL, 11th Floor, Shakti Bhawan Extn., Lucknow.
3. Director (Technical), UPRVUNL, 8th Floor, Shakti Bhawan Extension, Lucknow.
4. General Manager, NRLDC 18-A, SJSS Marg, Katwaria Sarai, New Delhi–110016.
5. SE (System Control), UPSLDC, Vibhuti Khand – II, Gomti Nagar, Lucknow.

(Arshad Jamal Siddiqui)
Chief Engineer (PSO)

Annexure-A.X

उत्तर प्रदेश राज्य भार प्रेषण केन्द्र लि०
यू०पी०एस०एल०डी०सी० परिसर, विभूति खण्ड–।।,गोमती नगर, लखनऊ–226010
ई–मेल : sera@upsldc.org

U.P. State Load Despatch Centre Ltd.
UPSLDC Complex, Vibhuti Khand – II
Gomti Nagar, Lucknow- 226010
E-mail: sera@upsldc.org

No: - 1222 /CE(PSO)/SE(R&A)/EE-II/ Dated: - 10-04 2024

Member Secretary, NRPC,

18 – A, SJSS Marg, Katwaria Sarai,

New Delhi, 110016.

Subject – Agenda for revision of SPS for safe evacuation of power from Anpara Complex in view of commissioning of 2X1000MVA ICT at Obra C.

In view of the commissioning of 2X1000MvA ICT at Obra C TPS, SPS installed at Anpara DTPS for safe evacuation of power from Anpara Complex need to be reviewed. The expected date of commissioning of ICT-I & II is April, 2024 and September, 2024, respectively.

Based on above, the revised proposed logic is enclosed for the discussion in 218th OCC meeting of NRPC to be held on 16.04.2024.

It is therefore, requested to include the agenda for the revised SPS logic for Anpara in the 218th OCC meeting.

Encl: - Base Case
SLD
Proposed Logic
Old SPS Logic

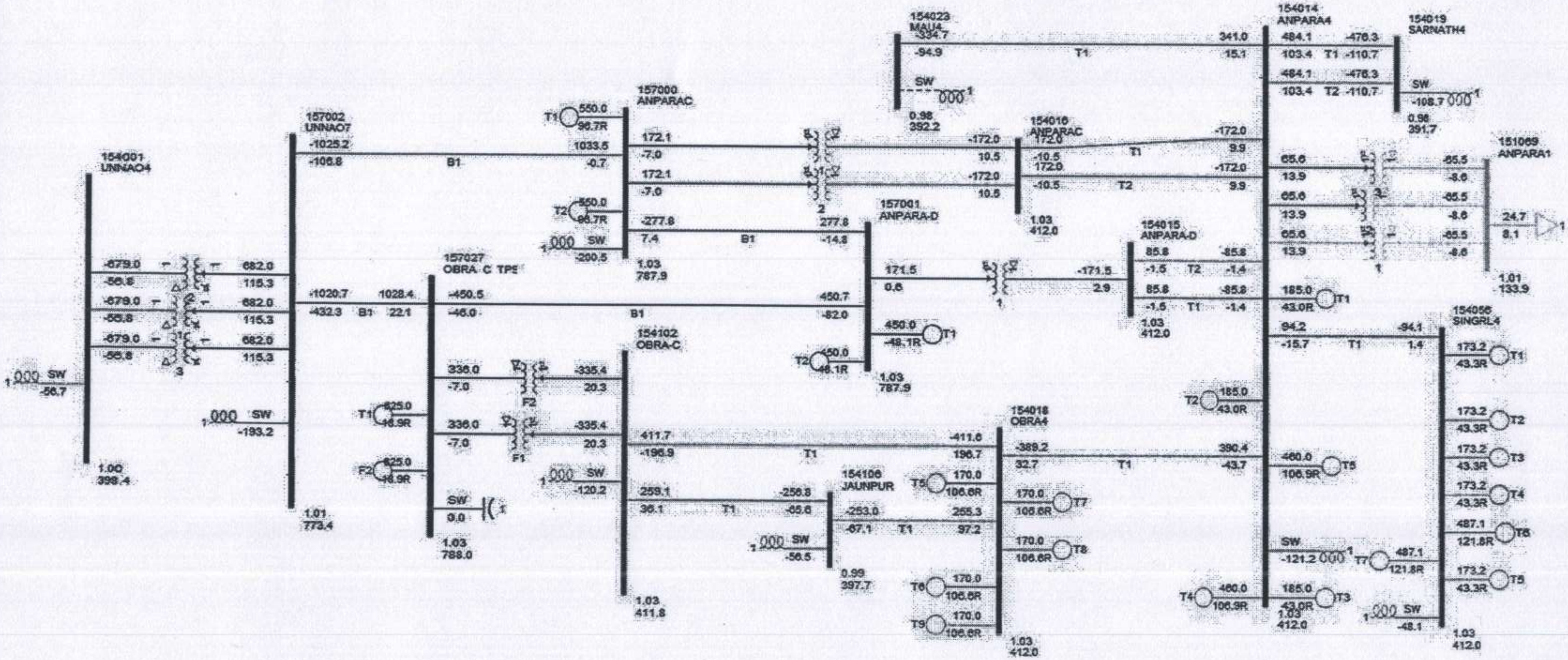
(Arshad Jamal Siddiqui)
Chief Engineer (PSO)

No: - /CE(PSO)/SE(R&A)/EE-II/ Dated: - 2024

Copy forwarded via e-mail to following for kind information and necessary action:-

1. Director, UPSLDC, Vibhuti Khand – II, Gomti Nagar, Lucknow.
2. Director (Operation), UPPTCL, 11th Floor, Shakti Bhawan Extn., Lucknow.
3. Director (Technical), UPRVUNL, 8th Floor, Shakti Bhawan Extension, Lucknow.
4. General Manager, NRLDC 18-A, SJSS Marg, Katwaria Sarai, New Delhi–110016.
5. Chief General Manager, Anpara, Thermal Power Station, Anpara, Sonbhadra.
6. Chief General Manager, (Obra) Thermal Power Station, Obra, Sonbhadra Pin code-231219.
7. Superintending Engineer (System Control), UPSLDC, Vibhuti Khand – II, Gomti Nagar, Lucknow.

(Arshad Jamal Siddiqui)
Chief Engineer (PSO)



154001
UNNAO4
157002
UNNAO7
157000
ANPARAC
157027
OBRA-C TPS
154102
OBRA-C
154023
MAU4
154010
ANPARAC
157001
ANPARA-D
154015
ANPARA-D
154106
JAUNPUR
154018
OBRA4
154014
ANPARA4
154019
SARNATH4
151069
ANPARA1
154056
SINGRL4

Revised SPS logic for safe evacuation of power from Anpara Complex

S.N.	Contingency	Constraints	Action
1	**Two ICT OR Three ICT Trip at 765 kV S/S Unnao OR 765kV Obra C -Unnao line & 765kV Anpara D-Obra C line trip OR 765kV Obra C-Unnao line & 765kV Anpara C-Unnao line**	400kV Obra B-Obra C line	Tirpping of one unit at obra C **If loading of 400kV Obra B-Obra C line is more than 900 MW**
2	**765kV Anpara C-Unnao line & 765kV Anpara D-Obra C line Trip OR Both ICT trip at Obra C**	400kV Anpara - Obra B line	One unit trip each at Anpara D and Anpara C simultanrously along with automatic back down on remaining units **If loading of 400kV Anpara - Obra B line is more than 1100 MW**
			One unit trip at Anpara D or Anpara C alternatively along with automatic back down on remaining units **If loading of 400kV Anpara - Obra B line is less than 1100 MW but more than 900 MW**

Existing SPS for Anpara Complex

Logic for SPS Scheme in tabular form:

a) **Tripping of 1 ICT at 765kV S/S Unnao-** No action required

b) **Tripping of 2 ICTs at 765kV S/S Unnao-**

Sr.No.	Real time flow on 765kV Anpara Unnao line (X) (MW) prior to tripping	Action to be taken through SPS
1.	1200<X≤ 1400	Tripping of one unit at Anpara-C or Anpara –D shall be carried out through SPS.(The logic shall be built such that in one such event tripping of one unit shall take place at Anpara –C and in next such event at Anpara –D and so on).
2.	X>1400	One unit each shall be tripped simultaneously at Anpara C and Anpara D. In addition to it for the safety of the power grid, load shedding of 600 MW shall be carried out in UP power system.

c) **Tripping of all the three 765/400kV ICTs at 765KV S/S Unnao or 765KV Anpara – Unnao line loading less than 50MW or Tripping of 765kV Anpara-Unnao line –**

Sr.No.	Real time flow on 765kV Anpara Unnao line (X) (MW) prior to tripping	Action to be taken through SPS
1.	X≤1100	SPS scheme shall not include logic of automatic backing down of power at Anpara- C or/and Anpara – D. However, UPSLDC shall be vigilant and issue immediate action of backing down of the running units at Anpara- C & Anpara – D so as to bring power flow on the 400KV lines emanating from Anpara complex, within limit.
2.	1100<X≤ 1400	Tripping of one unit at Anpara-C or Anpara –D shall be carried out through SPS.(The logic shall be built such that in one such event tripping of one unit shall take place at Anpara –C and in next such event at Anpara –D and so on). Further backing down of 200 MW shall be carried out in each of the running unit at Anpara – C and Anpara-D to be achieved as soon as possible.
3.	X>1400MW	One unit each shall be tripped simultaneously at Anpara C and Anpara D. Further load shedding of 600 MW shall be carried out in UP system.

S. No.	Task Name	Total Scope		Start Date	Likely Completion Date	Partial Shutdown						Complete Shutdown					
						Apr'24				May'24				Jun'24			
		Unit	Qty.			W-1	W-2	W-3	W-4	W-1	W-2	W-3	W-4	W-1	W-2	W-3	W-4
1	**Work during Partial Shutdown Period (1st April 24 to 15th May 24)**																
A.	**Balance work of BAFFLE WALL CONSTRUCTION AT HPP – TRT OUTLET**																
1	Construction of approach road up to El.611.00m	Rm	70.0	4/1/2024	4/20/2024	40	30										
2	Upstream and downstream ramp construction	Cum	2450	4/1/2024	5/15/2024	300	350	400	400	500	500						
3	Drilling and Grouting at center portion of baffle wall	Rm	280	4/1/2024	5/15/2024	45	45	45	45	45	55						
4	Partial Micro piling work in front of 3A & 3B.	Nos	58	4/1/2024	5/15/2024		18		22		18						
5	Slope Protection work (Left Bank)	Sqm	2640	4/1/2024	5/15/2024	440	440	440	440	440	440						
6	Slope Protection work (Right Bank)	Sqm	1110	4/1/2024	5/15/2024	185	185	185	185	185	185						
B.	**Approach road construction PSP – TRT OUTLET**																
1	Construction of access road upto Baffle wall at EL 603.0m.	Rm	90	4/15/2024	5/6/2024			30	30	30							
C. a	**TRT OUTFALL –** Breaking of Flood Protection Wall upto EL 609.00m	Cum	8000	4/1/2024	5/15/2024	1000	1000	1500	1500	1500	1500						
b.	Extension of raft (Upto EL 598.50m)	Cum	450	4/15/2024	5/7/2024			200		250							
c.	Curtain Grouting from EL 598.00 m			4/24/2024	5/14/2024				200	200	200						
2	**Work during Complete Shutdown Period (16th May'24 to 30th June'24)**																
	WORKS OF TRT OUTFALL																
1	The entire dismantling of FPW from EL 609.00m to EL 596.50m.	Cum	19000	5/16/2024	6/30/2024							1500	1500	4000	4000	4000	4000
2	Extension of approach from baffle wall to flood protection wall at EL 598m.	RM	20	5/16/2024	5/30/2024							10	10				
3	Balance micro piling (200 Nos Approx.)	Nos	70	5/25/2024	6/15/2024								22	24	24		
4	Extension of raft (Upto EL 598.50m)	Cum	650	5/16/2024	6/24/2024							200		250	200	200	
5	Extension of U/s & D/s Guide wall up to river. (about 30m each from EL 598m to EL616m)	Cum	800	5/16/2024	6/30/2024										250	250	300
6	Construction of access road at left bank, reaching up to the River bank	RM	60	5/16/2024	6/30/2024							10	10	10	10	10	10
7	BAFFLE WALL,Construction of access road from El 603.0m to EL598.0m & RAMP CONSTRUCTION PSP – TRT OUTLET	Cum	2970	5/16/2024	6/30/2024							470	500	500	500	500	500
8	Concrete in U/S and D/s Guide wall extension	Cum	800	6/8/2024	6/30/2024										250	250	300
9	Curtain Grouting from EL 598.00 m	RM	1400	5/16/2024	6/30/2024							200	200	250	250	250	250
10	Slope Protection work (Left Bank)	Sqm	2640	5/16/2024	6/30/2024							440	440	440	440	440	440
11	Slope Protection work (Right Bank)	Sqm	1110	5/16/2024	6/30/2024							185	185	185	185	185	185

National Load Despatch Centre
Import Capability of Punjab for May 2024

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Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	9500	500	9000	5497	3503		https://www.punjabsldc.org/ATC_TTC.aspx
Limiting Constraints		N-1 contigency of 400/220KV ICTs at Rajpura, Ludhiana, Jalandhar Loading close to N-1 contingency limits of 400/220kV Patran, Malerkotla, Moga and Patiala ICTs 220 kV underlying network at Jalandhar, Ludhiana and Amritsar						

National Load Despatch Centre
Import Capability of Uttar Pradesh for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	16100	600	15500	9779	5721		https://www.upsldc.org/documents/20182/0/ttc_atc_24-11-16/4c79978e-35f2-4aef-8c0f-7f30d878dbde
Limiting Constraints		N-1 contingency of 400/220kV Azamgarh, Allahabad(PG), Gorakhpur (UP), Sarnath, Lucknow (PG) ICTs						

National Load Despatch Centre
Import Capability of Haryana for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	9100	250	8850	5418	3432		https://hvpn.org.in/#/atcttc
Limiting Constraints	N-1 contingency of 400/220kV ICTs at Deepalpur and Panipat(BBMB)							

National Load Despatch Centre
Import Capability of Rajasthan for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	7600	600	7000	5689	1311		https://sldc.rajasthan.gov.in/rrvpnl/scheduling/downloads
Limiting Constraints		N-1 contingency of 400/220kV Heerapura, Jodhpur, Bikaner, Ajmer, Merta, Hindaun and Bhinmal ICTs						

National Load Despatch Centre
Import Capability of Delhi for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	7300	300	7000	4810	2190		https://www.delhisldc.org/resources/atcttcreport.pdf
Limiting Constraints		N-1 contingency of 400/220kV Mundka, HarshVihar and Bawana (bus-split) ICTs.						

National Load Despatch Centre
Import Capability of HP for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	1680	100	1580	1130	450		https://hpsldc.com/mrm_category/ttc-atc-report/
Limiting Constraints		High loading of 220kV Hamirpur-Hamirpur D/C. Overloading of 2*200MVA Kunihar transformers						

National Load Despatch Centre
Import Capability of Uttarakhand for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	1700	100	1600	1402	198		https://uksldc.in/ttc-atc
Limiting Constraints		N-1 contingency of 400/220kV Kashipur ICTs. High loading of 220kV Roorkee-Roorkee and 220kV CBGanj-Pantnagar lines						

National Load Despatch Centre
Import Capability of J&K for May 2024

Issue Date: - Issue Time: 1600 Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	2500	100	2400	1977	423		
Limiting Constraints		N-1 contigency of 400/220KV ICTs at Amargarh 220 kV underlying network at Amargarh, Wagoora						

National Load Despatch Centre
Import Capability of Chandigarh for May 2024

Issue Date: -　　　　Issue Time: 1600　　　　Revision No. 0

Date	Time Period in IST (hrs)	Total Transfer Capability (TTC) (MW)	Reliability Margin (MW)	Available Transfer Capability (ATC) (MW)	Approved General Network Access (MW)	Margin Available for Temporary General Network Access(MW)	Changes in TTC w.r.t. Last Revision	Comments
1st May 2024 to 31st May 2024	00-24	400	20	380	342	38		
Limiting Constraints		N-1 contigency of 220kV Nallagarh-Kishengarh						

Generating Unit Outage Report 03-04-2024

A. Planned Outages

S.No	Station	Location	Owner	Unit No	Capacity MW	Reason(s)	Outage		Expected Revival Date
							Date	Time	
	Central Sector (CS)								
1	Parbati III HEP	HP	NHPC	3	130	Maintenance work in Upstream . Emptying of Power Station Reservoir for purpose of re	10-01-2024	10:15	15-04-2024
2	Parbati III HEP	HP	NHPC	1	130	Maintenance work in Upstream UNIT IS UNDER PLANNED OUTAGE DUE TO ANNUAL MA	13-01-2024	17:00	03-04-2024
3	Tanakpur HPS	HP	NHPC	3	31	Annual Maintenance Unit#3 under shutdown due to Annual maintenance	26-02-2024	09:15	03-04-2024
4	Dehar HPS	HP	BBMB	2	165	Annual Maintenance Capital maintenance since 07:00 Hrs of dated 27.03.2024 till 31.05	27-03-2024	07:00	31-05-2024
5	Dulhasti HPS	J&K	NHPC	3	130	Turbine Problem . Shutdown for replacement of seal in MIV of U#3.	27-03-2024	09:00	07-04-2024
6	Karcham Wangtoo HPS	HP	JSW	3	250	Annual Maintenance Unit#3 under shutdown for annual maintenance from Dated 01.04	01-04-2024	00:00	12-04-2024
7	Bhakra HPS	PUNJAB	BBMB	3	126	Annual Maintenance Annual maintenance during less irrigation demand upto 22.04.202	01-04-2024	16:05	22-04-2024
	State Sector (SS)								
1	Jhajjar(CLP)	HARYANA	HVPNL	2	660	Over hauling	11-02-2024	22:32	08-04-2024
2	Harduaganj-C TPS	UP	UPPTCL	7	110	Reserve Shutdown hand tripped due to RSD	01-04-2024	15:37	-
3	Panipat TPS	HARYANA	HPGCL	6	210	Reserve Shutdown PTPS unit 6 boxed up at 01:18 hrs dated 02-4-2024 due to reduction	02-04-2024	01:18	-
4	Panipat TPS	HARYANA	HPGCL	7	250	Reserve Shutdown due to Less demand	02-04-2024	10:44	-

B. Forced Outages

S.No	Station	Location	Owner	Unit No	Capacity MW	Reason(s)	Outage		Expected Revival Date
							Date	Time	
	Central Sector (CS)								
1	URI HPS	J&K	NHPC	2	120	Generator Fault . Unit taken out maintenance of generator winding.	09-03-2024	20:34	09-04-2024
2	Rihand-II STPS	UP	NTPC	2	500	Turbine Bearing Temperature High	28-03-2024	09:45	15-04-2024
3	RAPS-A	RAJASTHAN	NPCIL	2	200	Hunting Problem . Unit tripped due to disturbance at Sakatpura.	29-03-2024	20:24	05-04-2024
4	Sainj HEP	HP	HPSEB	2	50	Over loading ON DATED -29.03.2024, UNIT 2 GOT TRIPPED DUE TO OVER CURRENT .	29-03-2024	22:10	15-04-2024
	Sub Total (CS)				870				
	State Sector (SS)								
1	Giral (IPP) LTPS	RAJASTHAN	RRVPNL	1	125	Bed Material Leakage Unit was out on bed material leakage and it is likely to be scrappe	11-07-2014	08:20	-
2	Giral (IPP) LTPS	RAJASTHAN	RRVPNL	2	125	Bed Material Leakage Unit was out on bed material leakage and it is likely to be scrappe	27-01-2016	15:27	-
3	Delhi Gas Turbines	DELHI	DTL	9	34	STG Governor oil leakage	12-02-2022	20:00	-
4	Delhi Gas Turbines	DELHI	DTL	5	30	Due to tripping of associated STG at 20:00Hrs.	12-02-2022	21:04	-
5	Guru Hargobind Singh TPS (Lehra Mo	PUNJAB	PSPCL	2	210	ESP breakdown. Rectification works under progress as confirmed by SLDC-PS.	13-05-2022	21:36	31-12-2024
6	Ramgarh GPS	RAJASTHAN	RRVPNL	2	38	Due to fire accident in GT - 2	04-06-2022	01:17	20-06-2024
7	Ramgarh GPS	RAJASTHAN	RRVPNL	5	50	GT trip Due to SEF Protection Operated	21-09-2023	00:22	25-07-2024
8	Obra TPS	UP	UPPTCL	9	200	Leakage in Condenser Pump	12-03-2024	04:56	08-04-2024
9	Rajwest (IPP) LTPS	RAJASTHAN	RRVPNL	1	135	Bed Material Leakage	16-03-2024	03:27	05-04-2024
10	Guru Gobind Singh TPS (Ropar)	PUNJAB	PSPCL	6	210	Boiler Tube Leakage	30-03-2024	21:00	05-04-2024
11	Guru Hargobind Singh TPS (Lehra Mo	PUNJAB	PSPCL	1	210	Boiler Tube Leakage DUE TO BTL	01-04-2024	20:57	05-04-2024
12	Rajwest (IPP) LTPS	RAJASTHAN	RRVPNL	2	135	Bed Material Leakage . Due to heavy bed material leakage.	02-04-2024	07:04	06-04-2024
13	Suratgarh SCTPS	RAJASTHAN	RRVPNL	8	660	Oil Leakage . Shutdown to attend problem in oil supply of HP Bypass.	02-04-2024	09:14	04-04-2024
14	Kawai TPS	RAJASTHAN	RRVPNL,APL	1	660	Boiler Tube Leakage . Condenser tube leakage.	02-04-2024	13:45	06-04-2024
15	Suratgarh TPS	RAJASTHAN	RRVPNL	5	250	GT trip due to furnance pressure high.	02-04-2024	21:01	03-04-2024
16	Barsingsar (NLC)	RAJASTHAN	RRVPNL	2	125	GT trip due to refractory failure	03-04-2024	00:04	-
17	VSLPP (IPP)	RAJASTHAN	RRVPNL	1	135	PA fan problem . PA Fan tripped on high vibration.	03-04-2024	00:07	09-04-2024
18	Rajwest (IPP) LTPS	RAJASTHAN	RRVPNL	1	135	Bed Material Leakage	16-03-2024	03:27	05-04-2024
19	Rajwest (IPP) LTPS	RAJASTHAN	RRVPNL	2	135	Bed Material Leakage . Due to heavy bed material leakage.	02-04-2024	07:04	06-04-2024
20	Barsingsar (NLC)	RAJASTHAN	RRVPNL	2	125	GT trip due to refractory failure	03-04-2024	00:04	-

Sr No	Element Name	Outage Date	Outage Time	Reason
1	132 KV Mahendra Nagar(PG)-Tanakpur(NH) (PG) Ckt-1	03-Mar-24	13:55	Over loading. As per DR of Tanakpur end, overcurrent protection operation. (phase currents:400A)
		03-Mar-24	17:28	Earth fault. As per DR of Tanakpur end, overcurrent protection operation. (phase currents:455A)
		03-Mar-24	23:40	Earth fault. As per DR of Tanakpur end, overcurrent protection operation. (phase currents:430A)
2	220 KV Agra(PG)-Tundla (UP) (UP) Ckt-1	07-Mar-24	15:37	PLCC maloperation. As per PMU, no fault is observed.
		30-Mar-24	12:30	Phase to earth fault B-N. As per PMU, B-N fault occured, unsuccessful autoreclsoing is observed.
		31-Mar-24	10:16	Phase to earth fault B-N. As per PMU, B-N fault occured, unsuccessful autoreclsoing is observed.
		31-Mar-24	12:22	Phase to earth fault B-N. As per PMU, B-N fault occured, unsuccessful autoreclsoing is observed.
3	220 KV RAPS_A(NP)-Sakatpura(RS) (RS) Ckt-1	02-Mar-24	23:10	Phase to earth fault R-N. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS
		03-Mar-24	23:39	Phase to earth fault R-N. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS
		14-Mar-24	03:32	Phase to earth fault R-N. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS
		29-Mar-24	20:20	Failure of CT. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS-A end.
4	220 KV RAPS_A(NP)-Sakatpura(RS) (RS) Ckt-2	01-Mar-24	01:21	Transient fault. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS-A end.
		01-Mar-24	06:35	Phase to Ground Fault R-N. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RA
		07-Mar-24	08:50	Transient fault. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS-A end.
		16-Mar-24	04:13	Phase to earth fault R-N. As per DR of Sakatpura end, R-N phase to earth fault is observed. DR not received from RAPS
5	220 KV RAPS_B(NP)-Sakatpura(RS) (RS) Ckt-1	12-Mar-24	04:49	Phase to earth fault R-N. As per DR of both ends, R-N phase to earth fault with unsuccessful A/R operation at Sakatpu successful A/R oepration at RAPS-B end is observed.
		13-Mar-24	03:32	Phase to earth fault R-N. As per DR of both ends, R-N phase to earth fault with unsuccessful A/R operation at Sakatpu successful A/R oepration at RAPS-B end is observed.
		27-Mar-24	13:24	Phase to earth fault R-N. As per DR of Sakatpura end, R-N phase to earth fault with unsuccessful A/R operation is obs received from RAPS-B end.
6	220 KV Sitarganj(PG)-CBGanj(UP) (PG) Ckt-1	05-Mar-24	12:11	Phase to Phase Fault R-Y. As per PMU, R-Y fault is observed.
		05-Mar-24	14:42	Phase to Phase Fault Y-B. As per PMU, Y-B fault is observed.
		19-Mar-24	10:53	Phase to earth fault B-N. As per PMU, B-N fault occurred and delayed clearance of 880ms with no auto-reclo
7	400 KV Ajmer-Bhilwara (RS) Ckt-2	01-Mar-24	15:29	Phase to earth fault B-N. As per PMU, B-N fault occurred and delayed clearance of 320ms with no auto-reclo
		16-Mar-24	06:56	PLCC maloperation. As per PMU, no fault is observed.
		22-Mar-24	14:50	Phase to earth fault B-N. As per PMU, no fault is observed.
		23-Mar-24	11:43	Phase to earth fault Y-N. As per PMU, B-N fault occured, unsuccessful autoreclsoing is observed.
8	400 KV Akal-Jodhpur (RS) Ckt-1	21-Mar-24	23:14	Transient fault. As per PMU, no fault is observed.
		24-Mar-24	09:14	Operation of Reactor protection. As per PMU, no fault is observed.
		25-Mar-24	14:17	Phase to earth fault R-N. As per PMU, B-N fault occured, no auto-reclosing is observed.
9	400 KV Bareilly-Unnao (UP) Ckt-2	04-Mar-24	09:59	Phase to earth fault B-N. As per PMU, B-N fault occured, no auto-reclosing is observed.
		11-Mar-24	01:56	LBB operated. As per PMU, R-N fault occured, no auto-reclosing is observed.
		31-Mar-24	17:25	Phase to Phase Fault Y-B. As per PMU, Y-B fault is occurred with no A/R operation and delayed clearance of Bareilly(UP) end.
10	400 KV Bikaner-Bhadla (RS) Ckt-2	01-Mar-24	17:18	Phase to earth fault Y-N. As per PMU, Y-N fault occured, no auto-reclosing is observed.
		02-Mar-24	17:19	Phase to earth fault B-N. As per PMU, Y-N fault occured, unsuccessful autoreclsoing is observed.
		02-Mar-24	18:10	Phase to earth fault B-N. As per PMU, Y-N fault occured, no auto-reclosing is observed.
11	400 KV Dehar(BB)-Panchkula(PG) (PG) Ckt-1	23-Mar-24	13:08	Phase to earth fault Y-N. As per PMU, multiple Y-N faults are observed. As per DR, no A/R operation at Deha not synced at Dehar end.
		28-Mar-24	12:07	Phase to earth fault B-N. As per PMU, multiple R-N faults are observed. As per DR, no A/R operation at Deha not synced at Dehar end.
		30-Mar-24	10:11	Phase to earth fault R-N. As per PMU, Y-N fault occured, no auto-reclosing is observed. As per DR, R-N fault A/R at Panchkula end and no A/R operation at Dehar end is observed. Time is not synced at Dehar end.

Grid Event summary for March 2024

S.No.	Category of Grid Disturbance (GD-I to GD-V)	Name of Elements (Tripped/Manually opened)	Affected Area	Owner/ Agency	Outage Date	Outage Time	Revival Date	Revival Time	Duration (hh:mm)	Event (As reported)	Energy Unserved due to Generation loss (MU)	Energy Unserved due to Load loss (MU)	Loss of generation / loss of load during the Grid Disturbance: Generation Loss(MW)	Loss of generation / loss of load during the Grid Disturbance: Load Loss (MW)	% Loss of generation / loss of load w.r.t Antecedent Generation/Load in the Regional Grid during the Grid Disturbance: % Generation Loss(MW)	% Loss of generation / loss of load w.r.t Antecedent Generation/Load in the Regional Grid during the Grid Disturbance: % Load Loss (MW)	Antecedent Generation/Load in the Regional Grid: Antecedent Generation (MW)	Antecedent Generation/Load in the Regional Grid: Antecedent Load (MW)	Fault Clearance time (in ms)
1	GI-2	1) 800 KV HVDC Kurukshetra(PG) Pole-2 2) 800 KV HVDC Kurukshetra(PG) Pole-4	Haryana	PGCIL	2-Mar-24	19:24	2-Mar-24	23:34	04:10	i)During antecedent condition, 800kV HVDC Champa-Kurukshetra was carrying total 600MW (approx. 150MW by each Pole). ii)As reported at 19:24hrs, 800 KV HVDC Kurukshetra (PG) Pole-01 and Pole-03 tripped due to DC differential protection operated at Kurukshetra(PG) end (further details yet to be received form PowerGrid). iii)Due to tripping of two poles (Pole-01 and Pole-03), power shifted to other two Poles(Pole-02 and Pole-04) and power order remained same 600MW. iv)As per PMU, fluctuation in voltage was observed. v)As per SCADA, no change in demand is observed in Haryana control area.	0	0	0	0	0.000	0.000	37364	46283	NA
2	GD-1	1) 220 KV Alusteng-Drass (PG) Ckt	Jammu and Kashmir	PGCIL, JKPTCL	3-Mar-24	00:19	3-Mar-24	01:21	01:02	i) 220/66kV Drass(PG) have double main bus arrangement at 220kV side. 220kV Drass is connected with 220/132kV Kargil which is further connected with Khalsti and Leh. Chutak HEP is connected at 66kV level at 220/66kV Kargil and Nimmo Bazgo HEP is connected at 66kV levl at 220/66kV Leh. ii) During antecedent condition (at 00:17hrs) approx. 23MW power was coming from Alusteng to Drass and approx. 22MW power was going out from Drass to Kargil. iii) As reported, at 00:19 hrs, 220 KV Alusteng-Drass (PG) Ckt tripped on B-N phase to earth fault. iv) Due to this tripping supply to 220 KV Drass (PG)-Kargil Ckt was lost and blackout occurred at 220/66kV Drass(PG), Kargil, Khalsti and Leh. v) 220 KV Drass (PG)-Kargil Ckt was charged at 01:31 hrs and supply was restored. vi) As per PMU at Amargarh, B-N phase to earth fault is observed with fault clearing time of 120ms. vii) As per SCADA, load loss of approx. 23MW at 00:19hrs is observed in J&K control area.	0	0.027	0	23	0.000	0.072	30649	31909	120
3	GD-1	1) 220 KV Alusteng-Drass (PG) Ckt	Jammu and Kashmir	PGCIL, JKPTCL	3-Mar-24	03:09	3-Mar-24	04:26	01:17	i) During antecedent condition (at 03:07hrs) approx. 04MW power was coming from Alusteng to Drass and approx. 03MW power was going out from Drass to Kargil. Chutak HEP was generating ~10MW. ii) At 03:19hrs, 220 KV Alusteng-Drass (PG) Ckt tripped on B-N phase to earth fault. This again resulted into blackout at 220/66kV Drass(PG), Kargil, Khalsti and Leh. iii) Due to this tripping supply to 220 KV Drass (PG)-Kargil Ckt was lost and blackout occurred at 220/66kV Drass(PG) S/s. iv) 220 KV Drass (PG)-Kargil Ckt was charged at 04:26 hrs and supply to Drass was restored. v) As per PMU at Amargarh, B-N phase to earth fault is observed with fault clearing time of 120ms. vi) As per SCADA, load loss of approx.14MW at 03:09hrs is observed in J&K control area.	0	0.018	0	14	0.000	0.051	29266	27567	120
4	GI-2	1) 400 KV Kankani-Jaisalmer (RS) Ckt-2	Rajasthan	RVPNL	3-Mar-24	14:01	5-Mar-24	17:54	03:53	i) On 03rd March, 2024, at 14:01 hrs, 400 KV Kankani-Jaisalmer (RS) Ckt-2 tripped on R-Y phase to phase fault. ii) As per PMU at Bhadla2(PG), R-Y phase to phase observed, which cleared within 100msec. iii) At the same time, drop in RE generation of approximately 2510 MW is observed as per SCADA data. Approx. 2200MW drop observed in ISTS RE geenration, ~60MW drop in Rajasthan wind generation and ~310MW drop in Rajasthan solar generation.	0	0	2510	0	5.612	0.000	44723	42911	80
5	GD-1	1) 400 kV Singrauli(NT)-Vindhyachal(PG) (PG) ckt-1 2) 70 KV Vindhyachal(PG) Pole-1 3) 70 KV Vindhyachal(PG) Pole-2 4) 400 KV Vindhyachal-North(PG) - Bus 1 5) 400 KV Vindhyachal-North(PG) - Bus 2 6) 93 MVAR Bus Reactor No 2 at 400KV Vindhyachal(PG) 7) 125 MVAR Bus Reactor No 3 at 400KV Vindhyachal(PG)	Uttar Pradesh	NTPC, PGCIL	7-Mar-24	12:12	7-Mar-24	13:57	01:45	i) During antecedent condition, 400 kV Singrauli(NT)-Vindhyachal(PG) (PG) ckt-2 was already under planned outage. ii) As reported, at 12:12 hrs, 400 kV Singrauli(NT)-Vindhyachal(PG) (PG) ckt-1 tripped due to maloperation of auto-recloser lock-out relay (86R2). As per DR, A/R lockout of main-1 CB is observed. iii) Due to tripping of 400 kV Singrauli(NT)-Vindhyachal(PG) (PG) ckt-1, there was no outgoing path available at Vindhyachal B-B(PG) and all other elements tripped at Vindhyachal B-B(PG) and complete blackout occurred at Vindhyachal B-B(PG). iv) As per PMU at Singrauli(NT), no fault is observed in the system. v) As per SCADA, no change in demand in UP control area and no generation loss at Singrauli(NT) is observed.	0	0	0	0	0.000	0.000	52783	52018	NA
6	GI-1	1) 220 KV Kishenpur(PG)- Salal(NH) (PG) Ckt-1 2) 220 KV Kishenpur(PG)-Salal(NH) (PG) Ckt-3 3) 220 KV Salal(NH)-Jammu(PDD) (PG) Ckt-2 4) 220KV Bus 1 at Salal(NH) 5) 115 MW Salal HPS - UNIT 5	Jammu and Kashmir	PGCIL, NHPC	10-Mar-24	22:35	10-Mar-24	23:15	00:40	i) During antecedent condition, only 115 MW Salal HPS - UNIT 5 was under running condition and it was generating approx. 115MW as per SCADA. ii) 220 KV Kishenpur(PG)- Salal(NH) (PG) Ckt-1 & 3, 220 KV Salal(NH)-Jammu(PDD) (PG) Ckt-2 and 115 MW Salal HPS - UNIT 5 were connected to 220KV Bus 1 at Salal(NH) and rest of the elements were connected to 220KV Bus 2 at Salal(NH). iii) As reported, at 22:35hrs, 220 KV Kishenpur(PG)- Salal(NH) (PG) Ckt-1 & 3, 220 KV Salal(NH)-Jammu(PDD) (PG) Ckt-2 and 115 MW Salal HPS - UNIT 5 tripped due to LBB operation. Hence 220KV Bus 1 at Salal(NH) became dead. iv) As per PMU at Kishenpur(PG), B-N phase to earth fault is observed with delayed fault clearing time of 360ms. v) As per SCADA, no load loss is observed in J&K control area. vi) As per SCADA, generation loss of approx. 115MW is observed at Salal(NH) HEP.	0	0	115	0	0.337	0.000	34098	39965	360
7	GD-1	1) 400/220 kV 315 MVA ICT -1 at Hindaun(Raj) 2) 400/220 kV 315 MVA ICT -2 at Hindaun(Raj) 3) 400 KV Hindaun(RS)-Chhabra(RVUN) (RS) Ckt 4) 400 KV Heerapura-Hindaun (RS) Ckt 5) 400 KV Alwar(ATIL)-Hindaun(RS) (ATIL) Ckt	Rajasthan	RVPNL, RVUNL, ATIL	11-Mar-24	05:08	11-Mar-24	06:51	01:43	i)As reported, at 05:08 hrs, interrupter of CB Pole (R-Ph.) blasted at the time of opening of CB of 125MVAR Bus Reactor at Hindaun(RS) on voltage regulation. ii)During the same time, 400 KV Hindaun(RS)-Chhabra(RVUN) (RS) Ckt, 400 KV Heerapura-Hindaun (RS) Ckt, 400 KV Alwar(ATIL)-Hindaun(RS) (ATIL) Ckt, 400/220 kV 315 MVA ICT -1 and 2 at Hindaun(Raj) also tripped (exact reason of tripping yet to be shared). Hence complete blackout occurred at 400/220kV Hindaun(Raj) S/s. iii)As per DR of 400 KV Hindaun(RS)-Chhabra(RVUN) (end) (RS) Ckt, zone-2 distance protection operated at Chhabra end. R-N phase to earth fault was observed with fault current of 1.676kA and delayed fault clearance time of ~355ms. (DR nomenclature & time sync issue in DR need to be corrected.) iv)As per SCADA SOE, 220kV Hindaun220-Sikrai(RS) Ckt, 220kV Hindaun220-Hindaun(RS) Ckt and 220kV Hindaun-Chokarwada(RS) Ckt-1 also tripped during the same time (exact reason of tripping yet to be shared). v)As per PMU at Bassi(PG), R-N phase to earth fault is observed with delayed fault clearing time of 360ms. vi)As per SCADA, load loss of approx. 265MW is observed in Rajasthan control area.	0	0.455	0	265	0.000	0.697	33592	38005	360
8	GI-2	1) 400 KV Bareilly-Unnao (UP) Ckt-2 2) 400 KV Agra-Unnao (UP) Ckt 3) 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-2 4) 400/220 kV 315 MVA ICT 1 at Unnao(UP) 5) 765/400 kV 1000 MVA ICT 2 at Unnao(UP) 6) 765/400 kV 1000 MVA ICT 3 at Unnao(UP) 7) 400kV Bus 1 at Unnao(UP)	Uttar Pradesh	UPPTCL, PGCIL	11-Mar-24	01:56	11-Mar-24	02:51	00:55	i)During antecedent condition, 400/220 kV 315 MVA ICT 1 & 6 and 765/400kV 1000 MVA ICT 1, 2 & 3 at Unnao(UP) were carrying 138MW, 140MW, 549MW, 551MW and 570MW respectively. 400/220 kV 315 MVA ICT 2 at Unnao(UP) was not in service. ii)As reported, at 01:56 hrs, R-N phase to earth fault occurred at 400 kV Bareilly-Unnao (UP) Ckt-2 with fault location of 85 km from Unnao(UP) end. But line CB at Unnao(UP) end of 400 kV Bareilly-Unnao (UP) Ckt-2 failed to clear the fault, hence LBB operated. iii)Due to LBB operation, 400 KV Agra-Unnao (UP) Ckt, 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-2, 400/220 kV 315 MVA ICT 1 at Unnao(UP), 765/400 kV 1000 MVA ICT 2 & 3 at Unnao(UP) also tripped and 400kV Bus 1 at Unnao(UP) became dead. iv)As per DR of 400 KV Bareilly-Unnao (UP) Ckt-2, zone-1 distance protection operated at Unnao end and fault was sensed in zone-1 (carrier-aided trip) at Bareilly end. Fault was cleared within 245ms at Unnao end and 170ms at Bareilly end. R-N phase to earth fault was observed with fault current of 6.329kA from Unnao end and 2.122kA from Bareilly end. v)As per DR of 400 KV Unnao(UP)-Jehta_Hardoi Road (UP) (PG) Ckt-2, DT received at Jehta_Hardoi Road end. vi)As per SCADA SOE, CB of FSC at Unnao(UP) end connected to 400kV Bareilly-Unnao (UP) Ckt-2 closed during the same time. (It is suspected that fault may have initiated due to this. Exact reason of fault need to be shared). vii)As per PMU at Agra(PG), R-N phase to earth fault is observed with delayed fault clearing time of 280ms. viii)As per SCADA, no load loss of is observed in UP control area.	0	0	0	0	0.000	0.000	31852	34021	280
9	GD-1	1) 400 KV Dulhasti(NH)-Kishenpur(PG) (PG) Ckt-1 2) 130MW Unit-2 at Dulhasti HEP 3) 130MW Unit-3 at Dulhasti HEP	Jammu & Kashmir	NHPC, PGCIL	13-Mar-24	18:49	13-Mar-24	21:18	02:29	i)During antecedent condition, 130MW Unit-2 & 3 at Dulhasti HEP were running (generating approx. 130 MW each) and total generated power of 260MW was evacuating through 400 kV Dulhasti(NH)-Kishenpur(PG) (PG) Ckt-1 only. 130MW Unit-1 at Dulhasti HEP and 400 kV Dulhasti(NH)-Kishenpur(PG) (PG) Ckt-2 were not in service. ii)As reported, at 18:49hrs, 400 kV Dulhasti(NH)-Kishenpur(PG) (PG) Ckt-1 tripped on R-Y-B-N 3-phase to earth fault. As per DR, fault was sensed in zone-1 at Dulhasti(NH) end and fault currents were Ir=~1.63kA, Iy=~1.18kA and Ib=~1.88kA from Dulhasti(NH) end. iii)Due to tripping of 400 kV Dulhasti(NH)-Kishenpur(PG) (PG) Ckt-1, 130MW Unit-2 & 3 at Dulhasti HEP also tripped due to loss of evacuation path on over-speed protection operation. iv)As per PMU at Kishenpur (PG), R-Y-B-N 3-phase to earth fault is observed with fault clearing time of 80ms. v)As per SCADA, generation loss of approx. 260MW is observed at Dulhasti HEP.	0	0	260	0	0.575	0.000	45219	52806	80
10	GI-2	1) 400/220 kV 315 MVA ICT 1 at Merta(RS) 2) 400/220 kV 315 MVA ICT 2 at Merta(RS) 3) 220kV Merta(RS)-Bhopalgarh(RS) Ckt 4) 220kV Merta(RS)-Kuchera(RS) Ckt 5) 220kV Merta(RS)-Jethana(RS) Ckt 6) 220/132kV 100MVA ICT-1 at Merta(RS) 7) 220/132kV 100MVA ICT-2 at Merta(RS) 8) 220/132kV 100MVA ICT-3 at Merta(RS)	Rajasthan	RVPNL	14-Mar-24	12:55	14-Mar-24	13:34	00:39	i)During antecedent condition, MVA power flows of 400/220 kV 315 MVA ICT 1 & 2 and 220/132kV 100MVA ICT-1, 2 & 3 at Merta(RS) were 275MVA, 261MVA, 60MVA, 55MVA and 54MVA respectively as per SCADA. 220kV Merta(RS)-Makrana(RS) Ckt was not in service. ii)As reported, at 12:55hrs, R-phase jumper of 220kV Merta(RS)-Bhopalgarh(RS) Ckt snapped and this broken jumper fell on conductor of ICT 1. As per DR, 400/220 kV 315 MVA ICT 1 at Merta(RS) tripped on O/C E/F protection operation with Ir=~5.2kA. iii)Due to tripping of ICT-1, 400/220 kV 315 MVA ICT 2 at Merta(RS) got over-loaded. As per DR, 400/220 kV 315 MVA ICT 2 at Merta(RS) tripped on phase directional O/C protection operation with Ir=~5.83kA. iv)During the same time, LBB of 220kV Merta(RS)-Bhopalgarh(RS) Ckt operated (exact reason for line CB at Merta(RS) end unable to clear the fault yet to be shared). v)Due to LBB operation, all the elements connected to 220kV Bus-1 & 2 at Merta(RS) tripped and both the buses became dead. vi)As per PMU at Merta(RS), R-N phase to earth fault is observed with delayed fault clearance time of 880 ms. vii)As per SCADA, change in demand of approx. 335MW is observed in Rajasthan control area.	0	0.218	0	335	0.000	0.623	53031	53777	880
11	GD-1	1) 400 KV Muzaffarnagar(UP)-Vishnuprayag(UP) (UP) Ckt 2) 400 KV Alakhnanda GVK(UPC)-Vishnuprayag(UP) (UP) Ckt 3) 110 MW Vishnuparyag HPS - UNIT 1 4) 110 MW Vishnuparyag HPS - UNIT 3	Uttar Pradesh	UPPTCL	15-Mar-24	02:49	15-Mar-24	05:19	02:30	i)Power of 4*110MW Vishnuprayag HEP evacuates through 400 KV Alaknanda GVK (UPC)- Vishnuprayag(UP) (UP) ckt and 400 KV Muzaffarnagar(UP)-Vishnuprayag(UP) (UP) ckt. During antecedent condition, 110 MW Vishnuparyag HPS - UNIT 1 & 3 were under running condition and were generating approx. 10MW and 46MW respectively. ii)As reported, at 02:49 hrs, 400 kV Alaknanda GVK (UPC)- Vishnuprayag(UP) (UP) ckt and 400 KV Muzaffarnagar(UP)-Vishnuprayag(UP) (UP) ckt tripped due to bus bar protection operation at Vishnuprayag end (exact reason of fault yet to be shared). iii)As further reported, fault distance was 120.7km from Alaknanda end. DT received at Alaknanda GVK (UPC) and Muzaffarnagar(UP) end. iv)As per DR of 400 KV Alaknanda GVK (UPC)- Vishnuprayag(UP) (UP) ckt, fault was sensed in zone-2 at Alaknanda(UP) end and fault current was 1.77kA from Alaknanda(UP) end; fault clearing time was ~58ms. v)With the tripping of both the evacuating lines, 110 MW Vishnuparyag HPS - UNIT 1 and 3 tripped due to unavailability of power evacuating path. vi)As per PMU at Muzaffarnagar(UP), B-N phase to earth fault with fault clearance time of 120 ms is observed. vii)As per SCADA, no change in demand in UP control area is observed. Generation loss of approx. 56MW is also observed at Vishnuprayag HEP. viii)After bus bar protection operation, an inspection was carried out and a foul smell was observed from B-phase CB at Vishnuprayag(UP) end of 400 kV Muzaffarnagar(UP)-Vishnuprayag(UP) (UP) ckt, hence the line was taken under shutdown.	0	0	56	0	0.154	0.000	36385	39522	120
12	GD-1	1) 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-1 2) 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-2	Rajasthan	PGCIL, AREPRL	18-Mar-24	13:32	18-Mar-24	15:53	02:21	i)Total power of 220/33kV AREPRL(IP) (i.e., 250MW=Azure:200MW and Renew:50MW) evacuates through 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-1 and 2. During antecedent condition, 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-1 and 2 were carrying approx. 118MW each. ii)As reported, at 13:32 hrs, 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-1 tripped on B-N phase to earth fault, occurred as conductor of 11kV line passing through the bottom of 220kV line snapped and fell on 220kV line. iii)After this, loading of 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-2 reached approx. 236MW. iv)Again at 13:38 hrs, 220 KV Bhadla(PG)-Bhadla Solar(Adani) (Adani) Ckt-2 tripped on B-N phase to earth fault. Complete blackout occurred at 220/33kV AREPRL(IP). v)As per PMU at Bhadla(PG), B-N phase to earth fault is observed with fault clearing time of 120ms. vi)As per SCADA, change in NR total solar generation of approx. 850MW @13:32hrs and approx. 550MW @13:38hrs are observed.	0	0	850	0	1.608	0.000	52873	53887	120
13	GI-1	1) 220 KV Amargarh (INDIGRID)-Ziankote(JK) (PDD JK) Ckt-1 2) 220 KV Amargarh (INDIGRID)-Ziankote(JK) (PDD JK) Ckt-2	Jammu & Kashmir	INDIGRID, PDD JK	18-Mar-24	04:15	18-Mar-24	06:15	02:00	i)220/132kV Ziankote S/s have two bus at 220kV side i.e., main bus & reserve bus. ii)During antecedent condition, 220kV Amargarh(INDIGRID) –Ziankote(JK) D/C (carrying 162MW each) was feeding Ziankote load. iii)As reported, at 04:15 hrs, 220 KV Amargarh(INDIGRID)-Ziankote(JK) (PDD JK) Ckt-2 tripped on B-N phase to earth fault from Ziankote end only. But as per DR at Amargarh end, current in R- and Y- phase increased upto ~0.89kA and ~1.43kA respectively. (Exact reason, nature and location of fault yet to be shared) iv)As further reported, at the same time, 220 KV Amargarh(INDIGRID)-Ziankote(JK) (PDD JK) Ckt-1 also tripped on B-N phase to earth fault from Ziankote end only. But as per DR at Amargarh end, current in B- phase increased upto ~1.02kA. (Exact reason, nature and location of fault yet to be shared) v)As per PMU at Amargarh(PG), rise in B-ph voltage is observed. vi)As per SCADA, change in demand of approx. 225MW is observed in J&K control area.	0	0.45	0	225	0.000	0.560	33379	40178	NA
14	GD-1	1) 220 KV Nallagarh(PG)- Uperlanangal (HP) (HPSEB) Ckt-1 2) 220 KV Nallagarh(PG)-Uperlanangal(HP) (HPSEB) Ckt-2 3) 220 KV Uperlanangal(HP)-Wardthman (HPSEB) Ckt 4) 220/66kV 80/100MVA ICT-1 at Uperlanangal(HP) 5) 220/66kV 80/100MVA ICT-2 at Uperlanangal(HP)	Himachal Pradesh	PGCIL, HPPTCL	19-Mar-24	19:18	19-Mar-24	21:26	02:08	i)220/66kV Uperlanangal(HP) S/s have double main bus scheme at 220kV level. ii)During antecedent condition, 220 KV Nallagarh(PG)- Uperlanangal (HP) (HPSEB) Ckt-1 & 2 were carrying 260MW each. 220 KV Baddi- Uperlanangal (HP) Ckt was not in service (as per SCADA). iii)As reported, at 19:18 hrs, 220 KV Nallagarh(PG)- Uperlanangal (HP) (HPSEB) Ckt-1 & 2 tripped on R-N phase to earth fault. (Exact reason, nature and location of fault yet to be shared) iv)As further reported, 220 KV Uperlanangal(HP)-Wardthman (HPSEB) Ckt, 220/66kV 80/100MVA ICT-1 & 2 at Uperlanangal(HP) also tripped during the same time (Exact reason, nature and location of fault yet to be shared). Complete blackout occurred at 220/66kV Uperlanangal(HP) S/s. v)As per PMU at Nallagarh(PG), R-N phase to earth fault is observed with fault clearing time of 120ms. vi)As per SCADA, change in demand of approx. 380MW is observed in HP control area.	0	0.81	0	380	0.000	0.693	45527	54798	120

S.No.	Category of Grid Disturbance (GD-I to GD-V)	Name of Elements (Tripped/Manually opened)	Affected Area	Owner/ Agency	Outage		Revival		Duration (hh:mm)	Event (As reported)	Energy Unserved due to Generation loss (MU)	Energy Unserved due to Load loss (MU)	Loss of generation / loss of load during the Grid Disturbance		% Loss of generation / loss of load w.r.t Antecedent Generation/Load in the Regional Grid during the Grid Disturbance		Antecedent Generation/Load in the Regional Grid		Fault Clearance time (in ms)
					Date	Time	Date	Time					Generation Loss(MW)	Load Loss (MW)	% Generation Loss(MW)	% Load Loss (MW)	Antecedent Generation (MW)	Antecedent Load (MW)	
15	GI-2	1) 800 kV HVDC Kurukshetra(PG) Pole-02 2) 800 kV HVDC Kurukshetra(PG) Pole-04	Haryana	PGCIL	21-Mar-24	18:19	21-Mar-24	19:33	01:14	i)During antecedent condition, 800kV HVDC Champa-Kurukshetra was carrying total 1440MW (Pole 01- 490MW, Pole 02- 490MW, Pole 03- 230MW, Pole 04- 230MW). ii)As reported at 18:19hrs, 800 KV HVDC Kurukshetra (PG) Pole-02 and Pole-04 tripped due to DC supply failure from Champa end (further details yet to be received form PowerGrid). iii)Due to tripping of two poles (Pole-02 and Pole-04), power order reduced from 1440MW to 1370MW and shifted to the other two Poles. iv)As per PMU, fluctuation in voltage was observed. v)As per SCADA, no change in demand is observed in Haryana control area.	0	0	0	0	0.000	0.000	44363	50373	NA
16	GD-1	1)220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-1 2)220 KV Hissar(BB)-Hissar IA(HV) (HVPNL) Ckt-2 3)220 KV Bhiwani-Hissar (BB) Ckt-1 4)220 KV Bhiwani-Hissar (BB) Ckt-2 5)220 KV Hissar-Sangrur (BB) Ckt-1 6)220 KV Hissar-Sangrur (BB) Ckt-2 7)220 KV Hissar(BB)-Jindal Steel(HR) (HVPNL) Ckt 8)220 KV Hissar(BB)-Chirawa(RS) (BB) Ckt 9)220 KV Barnala-Sangrur(BB) Ckt 10)220/132kV 100MVA ICT-1 at Hissar(BB) 11)220/132kV 100MVA ICT-2 at Hissar(BB) 12)220/132kV 100MVA ICT-3 at Hissar(BB)	Haryana	BBMB, HVPNL	23-Mar-24	00:58	23-Mar-24	02:45	01:47	i)220/132/33kV Hissar(BB) S/s has double main bus scheme at 220kV level. ii)As reported, at 00:58hrs, bursting of B-ph CT of 220/132kV 100MVA ICT-2 at Hissar(BB) occured. iii)During the same time, all the lines and 220/132kV ICTs connected at 220kV Hissar(BB) also tripped (Exact reason, nature and location of fault yet to be shared). iv)Due to tripping of all the elements connected to both the buses, both 220kV Bus-1 & 2 at Hissar(BB) and eventually the complete 220/132/33kV Hissar(BB) S/s became dead. v)As per PMU at Hissar(PG), two consecutive B-N phase to earth faults with fault clearing time of 80ms and 360ms (delayed) are observed. vi)As per SCADA, change in demand of approx. 170MW is observed in Haryana control area.	0	0.303	0	170	0.000	0.404	35356	42057	360
17	GI-2	1) 800 kV HVDC Kurukshetra(PG) Pole-02 2) 800 kV HVDC Kurukshetra(PG) Pole-04	Haryana	PGCIL	27-Mar-24	15:04	27-Mar-24	16:16	01:12	i)During antecedent condition, 800kV HVDC Champa-Kurukshetra was carrying total 1460MW (approx. 365MW by each Pole). ii)As reported at 15:04hrs, 800 KV HVDC Kurukshetra (PG) Pole-02 and Pole-04 were blocked due to unavailability of Lane-1 and 2 caused by software issue at Champa end (further details yet to be received form PowerGrid). iii)Due to tripping of two poles (Pole-02 and Pole-04), power order slightly reduced from 1460MW to 1400MW and shifted to the other two Poles. iv)As per PMU, fluctuation in voltage was observed. v)As per SCADA, no change in demand is observed in Haryana control area.	0	0	0	0	0.000	0.000	50774	50034	NA
18	GD-1	1) 400 KV Khetri (PKTSL)-Bhiwadi(PG) (PBTSL) Ckt-2 2) 220 KV Bhiwadi(PG)-Bhiwadi(RS) (RS) Ckt-1 3) 220 KV Bhiwadi(PG)-Bhiwadi(RS) (RS) Ckt-2 4) 220/132kV 160MVA ICT-1 at Bhiwadi(RS) 5) 220/132kV 160MVA ICT-2 at Bhiwadi(RS) 6) 220/132kV 100MVA ICT-3 at Bhiwadi(RS) 7) 220 KV Bhiwadi(PG)-Kushkhera(RS) (RS) Ckt	Rajasthan	PKTSL, PGCIL, PBTSL, RVPNL	29-Mar-24	17:22	29-Mar-24	18:54	01:32	i)220/132kV Bhiwadi(RS) has double main bus scheme at 220kV side. ii)As reported, at 17:10hrs, 400 kV Khetri (PKTSL)-Bhiwadi(PG) (PBTSL) Ckt-2 tripped on Y-N phase to earth fault during heavy wing storm with fault distance of 123.3km from Khetri and fault current of 2.34kA from Khetri and 39.7kA from Bhiwadi. iii)As per PMU at Bhiwadi(PG), at 17:10 hrs, Y-N phase to earth fault with unsuccessful A/R followed by R-N fault is observed with fault clearing time of 80ms and 80ms respectively. iv)As per SCADA SOE, 132 KV Bhiwadi(RS)-Bhiwadi132(RS) (RS) Ckt-2 tripped at 17:17hrs (exact reason, nature and location of fault yet to be shared). As per PMU, Y-N phase to earth fault with fault clearing time of 80ms is observed during the same time. v)Further, at 17:22hrs, bus bar protection operated at 220kV Bhiwadi(RS) due to failure of B-phase CVT of 220kV Main Bus -II. Due to this, both 220 KV Bhiwadi(PG)-Bhiwadi(RS) (RS) Ckt-1 & 2 tripped from Bhiwadi(RS) end only. vi)220/132kV 160MVA ICT-1 & 2 and 100MVA ICT-3 at Bhiwadi(RS) also tripped and supply to 132kV feeders connected to Bhiwadi(RS) lost. Complete blackout occurred at 220/132kV Bhiwadi(RS) S/s. vii)As per PMU at Bhiwadi(PG), at 17:22hrs, B-N phase to earth fault is observed with fault clearing time of 120ms. viii)Again, at 17:26 hrs, 220 KV Bhiwadi(PG)-Kushkhera(RS) (RS) Ckt tripped on R-N phase to earth fault with fault distance of 0.865km from Bhiwadi(PG) end. ix)As per DR at Bhiwadi(PG) end of 220 KV Bhiwadi(PG)-Kushkhera(RS) (RS) Ckt, fault current was 24.41kA from Bhiwadi(PG), fault was sensed in zone-1, line was successfully auto-reclosed from Bhiwadi(PG) end and tripped only from Kushkhera end. x)As per PMU at Bhiwadi(PG), at 17:26 hrs, R-N fault followed by R-N fault with unsuccessful A/R is observed with fault clearing time of 120ms and 80ms respectively. xi)As per SCADA, change in demand of approx. 120MW in Rajasthan control area is observed.	0	0.184	0	120	0.000	0.239	47653	50240	120
19	GI-2	1) 800 kV HVDC Kurukshetra(PG) Pole-02 2) 800 kV HVDC Kurukshetra(PG) Pole-04	Haryana	PGCIL	29-Mar-24	20:26	29-Mar-24	21:02	00:36	i)During antecedent condition, 800kV HVDC Champa-Kurukshetra was carrying total 1450MW (Pole 01- 725MW, Pole 02- 365MW, Pole 03- 0MW, Pole 04- 360MW). ii)As reported at 20:26hrs, 800 KV HVDC Kurukshetra(PG) Pole-02 and Pole-04 tripped due to unavailability of Lane-1 and 2 caused by software issue at Champa end. Further details yet to be received form PowerGrid. iii)Due to tripping of two poles (Pole-02 and Pole-04), power order reduced from 1450MW to 1370MW and shifted to the Pole-01. iv)As per PMU, fluctuation in voltage was observed. v)As per SCADA, no change in demand is observed in Haryana control area.	0	0	0	0	0.000	0.000	43682	53455	NA
20	GD-1	1)110 MW Kota TPS Unit-1, & 2 2)210 MW Kota TPS Unit-3, 4 & 5 3)195 MW Kota TPS Unit-6 & 7 4)220kV KTPS-Kota Sakatpura ckt-1 & 3 5)220kV KTPS-Beawar ckt 6)220kV KTPS-Bundi ckt 7)220kV KTPS-Heerapura ckt 8)220kV Kota Sakatpura-RAPP-A ckt-1 & 2 9)220kV Kota Sakatpura-Mandalgarh ckt 10)220kV Kota Sakatpura-RAPP-B ckt 11)220kV Kota Sakatpura-Anta ckt 12)220kV Kota Sakatpura-Ranpur ckt 13)220kV RAPP-C-Anta ckt 14)200MW RAPS-A Unit-2 15)220 MW RAPS-B Unit-4 16)220 MW RAPS-C Unit-5 & 6	Rajasthan	RVPNL, RVUNL, NTPC, NPCIL	29-Mar-24	20:22	29-Mar-24	21:58	01:36	i)As reported, at 20:22hrs, R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault converted into 3-ph fault with delayed clearance of 760msec is observed. ii)Bus bar protection is not available at Kota Sakatpura S/s and Z-4 time delay setting is kept as 160msec. Z-2 time delay setting of 220kV KTPS-Sakatpura ckt-1,2,3 & 4 are kept as 160msec. iii)On this fault, 220kV feeders to RAPS-A-I, Ranpur & Mandalgarh from Kota Sakatpura tripped on Z-4 distance protection at Kota Sakatpura end. 220kV KTPS-Sakatpura ckt-1 & 3 also tripped on Z-2 distance protection operation at KTPS end. 220/132kV ICT-1 at Kota Sakatpura also tripped on differential protection operation. iv)Due to tripping of aforementioned 220kV lines, loading of remaining 220kV lines at KTPS & Kota Sakatpura increased significantly. Within approx. 600-700msec of fault, 220kV KTPS-Heerapura ckt and 220kV KTPS-Beawar ckt tripped on Z-1 distance protection operation after power swing detection, 220kV KTPS-Bundi ckt & 220kV Bundi-Gulabpura ckt and 220kV Kota Sakatpura-Anta ckt tripped on distance protection operation suspected due to load encroachment. v)Further, 220kV RAPS-C-Anta ckt and 220kV RAPS-B-Kota Sakatpura ckt also tripped on Z-1 distance protection operation after power swing detection. vi)Further, at approx. 20:22:10hrs, SUT-4 at RAPS-B tripped on over frequency protection operation (setting: 51.5Hz with 200msec delay). Auto transfer initiated and load transferred to UT-4 however it failed after 1 sec, as per Auto transfer scheme, resulting in one - one PCP tripping and reactor trip on PHT pressure high. vii)At the same time, SUT-5 & SUT-6 at RAPS-C tripped on over frequency (51.5 Hz with 200 msec time delay). Auto transfer scheme initiated in both Unit-5 & 6 however it failed due to frequency mismatch. Subsequently reactors of RAPS-5&6 tripped on PHT pressure high. Highest frequency recorded was ~53.16Hz. viii)After aforementioned trippings, only RAPS-A unit-2 was available which was feeding 220kV Debari, 220kV Chittorgarh via 220kV RAPS-A-RAPS-B tie line and load at 220/132kV Kota Sakatpura via 220kV RAPS-A-Kota Sakatpura ckt-2. ix)Further at 20:29hrs, frequency decreased to 47.8Hz and 220kV RAPS-A-Kota Sakatpura ckt-2 tripped on under frequency as per islanding scheme. x)With this tripping, system with RAPS-A unit-2 and load at Debari & Chittorgarh got islanded. RAPS-A generation was reduced to 160MW. Island operated till approx. 22:47hrs, frequency of island was maintained in the range of 51-52Hz and voltage was in the range of 230-240kV. Further, at ~22:47hrs, RAPS-A unit-2 turbine generator tripped on over fluxing (~112.5%), voltage recorded just before the tripping was ~282kV. xi)As per SCADA, total generation loss of approx. 2000MW is observed and at the same time load loss of approx. 300MW is observed in Rajasthan control area.	0	0.493	2020	308	5.726	0.965	43506	53019	760

S. No.	Name of Transmission Element Tripped	Owner/ Utility	Outage		Load Loss/ Gen. Loss	Brief Reason (As reported)	Category as per CEA Grid standards	# Fault Clearance Time (>100 ms for 400 kV and 160 ms for 220 kV)	*FIR Furnished (YES/NO)	DR/EL provided in 24 hrs (YES/NO)	Other Protection Issues and Non Compliance (inference from PMU, utility details)	Suggestive Remedial Measures	Remarks
			Date	Time									
1	800 KV HVDC Kurukshetra(PG) Pole-03	POWERGRID	2-Mar-24	19:24	Nil	due to DC differential protection operated at Kutukshetra end.	NA	NA	YES (After 24 hrs)	NO			As per PMU, fluctuation in Voltage is observed.
2	800 KV HVDC Kurukshetra(PG) Pole-1	POWERGRID	2-Mar-24	19:24	Nil	due to DC differential protection operated at Kurukshetra end.	NA	NA	YES (After 24 hrs)	NO			As per PMU, fluctuation in Voltage is observed.
3	132 KV Rihand(UP)-Garwa(JS) (UP) Ckt-1	UPPTCL	3-Mar-24	13:54	Nil	Earth fault	NA	NA	YES (After 24 hrs)	NO			DR/EL not received.
4	400 KV Singrauli(NT)-Vindhyachal(PG) (PG) Ckt-1	POWERGRID	7-Mar-24	12:12	Nil	Auto-Reclosure Problem	NA	NA	YES	NO			As per PMU, fluctuation in Voltage is observed. No fault in system is observed
5	220 KV Modak(RS)-Bhanpura(MP) (MPSEB) Ckt-1	MPSEB	12-Mar-24	12:21	Nil	Transient fault	NA	NA	YES (After 24 hrs)	NO			As per PMU, no fault is observed.
6	400 KV Kankroli-Zerda (PG) Ckt-1	POWERGRID	13-Mar-24	23:05	Nil	PLCC maloperation	NA	NA	YES (After 24 hrs)	YES (After 24 hrs)			As per PMU, Y-N fault and unsuccessful auto-reclosing observed.
7	800 KV HVDC Kurukshetra(PG) Pole-4	POWERGRID	21-Mar-24	18:19	Nil	DC Supply Fail	NA	NA	YES (After 24 hrs)	YES			As per PMU, fluctuation in Voltage is observed.
8	800 KV HVDC Kurukshetra(PG) Pole-2	POWERGRID	21-Mar-24	18:19	Nil	DC Supply Fail	NA	NA	YES (After 24 hrs)	YES			As per PMU, fluctuation in Voltage is observed.
9	765 KV Phagi(RS)-Gwalior(PG) (PG) Ckt-2	POWERGRID	24-Mar-24	14:04	Nil	Phase to earth fault R-N	NA	NA	YES (After 24 hrs)	YES (After 24 hrs)			As per PMU, multiple R-N faults are observed.
10	800 KV HVDC Kurukshetra(PG) Pole-03	POWERGRID	26-Mar-24	10:03	Nil	Relay maloperation	NA	NA	YES (After 24 hrs)	NO			As per PMU, fluctuation in Voltage is observed.
11	765 KV Phagi(RS)-Gwalior(PG) (PG) Ckt-2	POWERGRID	27-Mar-24	11:37	Nil	Phase to earth fault R-N	NA	NA	YES	YES (After 24 hrs)			As per PMU, R-N fault and unsuccessful auto-reclosing observed.

12	800 KV HVDC Kurukshetra(PG) Pole-2	POWERGRID	27-Mar-24	15:04	Nil	Relay maloperation	NA	NA	YES (After 24 hrs)	YES (After 24 hrs)			As per PMU, fluctuation in Voltage is observed.
13	800 KV HVDC Kurukshetra(PG) Pole-4	POWERGRID	27-Mar-24	15:04	Nil	Relay maloperation	NA	NA	YES (After 24 hrs)	YES (After 24 hrs)			As per PMU, fluctuation in Voltage is observed.
14	800 KV HVDC Kurukshetra(PG) Pole-03	POWERGRID	29-Mar-24	14:36	Nil	Relay maloperation	NA	NA	YES	NO			As per PMU, fluctuation in Voltage is observed.
15	800 KV HVDC Kurukshetra(PG) Pole-2	POWERGRID	29-Mar-24	20:26	Nil	Relay maloperation	NA	NA	YES	NO			As per PMU, fluctuation in Voltage is observed.
16	800 KV HVDC Kurukshetra(PG) Pole-4	POWERGRID	29-Mar-24	20:26	Nil	Relay maloperation	NA	NA	YES	NO			As per PMU, fluctuation in Voltage is observed.
17	800 KV HVDC Agra-Bishwanath Chariali (PG) Ckt-1	POWERGRID	31-Mar-24	15:41	Nil	Earth fault	NA	NA	YES	YES			As per PMU, fluctuation in Voltage is observed.

 # Fault Clearance time has been computed using PMU Data from nearest node available and/or DR provided by respective utilities (*Annexure-* ***II)***

****Yes, if written Preliminary report furnished by constituent(s)***

R-Y-B phase sequencing (Red, Yellow, Blue) is used in the list content.All information is as per Northern Region unless specified.

^^ tripping seems to be in order as per PMU data, reported information. However, further details may be awaited.

Reporting of Violation of Regulation for various issues for above tripping

1	Fault Clearance time(>100ms for 400kV and >160ms for 220kV)	1. CEA Grid Standard-3.e 2. CEA Transmission Planning Criteria
2	DR/EL Not provided in 24hrs	1. IEGC 37.2(c) 2. CEA Grid Standard 15.3
3	FIR Not Furnished	1. IEGC 37.2(b) 2. CEA Grid Standard 12.2 (Applicable for SLDC, ALDC only)
4	Protection System Mal/Non Operation	1. CEA Technical Standard of Electrical Plants and Electric Lines: 43.4.A 2. CEA (Technical Standards for connectivity to the Grid) Regulation, 2007: Schedule Part 1. (6.1, 6.2, 6.3)
5	A/R non operation	1. CEA Technical Standard of Electrical Plants and Electric Lines: 43.4.C 2. CEA Technical Planning Criteria

Status of submission of FIR/DR/EL/Tripping Report on NR Tripping Portal

Time Period: 1st March 2024 - 31st March 2024

S. No.	Utility	Total No. of tripping	First Information Report (Not Received)		Disturbance Recorder (Not Received)	Disturbance Recorder (NA) as informed by utility	Disturbance Recorder (Not Received)	Event Logger (Not Received)	Event Logger (NA) as informed by utility	Event Logger (Not Received)	Tripping Report (Not Received)	Tripping Report (NA) as informed by utility	Tripping Report (Not Received)	Remark
			Value	%	Value		%	Value		%	Value		%	
1	ADANI	2	2	**100**	2	0	**100**	2	0	**100**	2	0	**100**	DR, EL & Tripping report need to be submitted
2	AHEJ3L	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
3	AHEJ4L	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
4	ALTRA XERGI POWER PVT LTD	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
5	AMP Energy Green Private Limited	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
6	ANTA-NT	4	3	**75**	3	0	**75**	3	0	**75**	3	0	**75**	
7	APFOL	2	2	**100**	2	0	**100**	2	0	**100**	2	0	**100**	
8	AREPRL	1	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	Details received
9	AURAIYA-NT	2	2	**100**	2	0	**100**	2	0	**100**	2	0	**100**	DR, EL & Tripping report need to be submitted
10	BAIRASUIL-NH	2	2	**100**	2	0	**100**	2	0	**100**	2	0	**100**	
11	BBMB	55	18	**33**	20	15	**50**	21	23	**66**	22	2	**42**	
12	CPCC1	47	9	**19**	8	8	**21**	10	8	**26**	12	4	**28**	
13	CPCC2	37	0	**0**	1	7	**3**	1	8	**3**	0	0	**0**	Details received
14	CPCC3	35	1	**3**	3	2	**9**	4	0	**11**	1	0	**3**	DR, EL & Tripping report need to be submitted
15	DADRIGAS-NT	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
16	DADRI-NT	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
17	DHAULIGANGA-NH	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
18	DULHASTI-NH	4	1	**25**	1	2	**50**	1	2	**50**	1	0	**25**	
19	FARIDABAD-NT	2	2	**100**	1	1	**100**	2	0	**100**	2	0	**100**	
20	JHAJJAR	1	0	**0**	0	0	**0**	0	0	**0**	1	0	**100**	
21	KISHENGANGA-NH	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
22	KOLDAM-NT	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
23	NJPC	1	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	Details received
24	PARBATI-II-NH	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	DR, EL & Tripping report need to be submitted
25	PKTSL	1	0	**0**	1	0	**100**	1	0	**100**	0	0	**0**	Details received
26	RAILWAYS	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	DR, EL & Tripping report need to be submitted
27	RAMPUR	1	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	Details received
28	RAPPA	10	5	**50**	10	0	**100**	10	0	**100**	9	0	**90**	DR, EL & Tripping report need to be submitted
29	RAPPB	6	6	**100**	4	0	**67**	4	0	**67**	4	0	**67**	
30	RAPPC	5	5	**100**	5	0	**100**	5	0	**100**	5	0	**100**	
31	RENEW SURYA VIHAAN PRIVATE L	2	2	**100**	2	0	**100**	2	0	**100**	2	0	**100**	
32	RENEW SURYARAVI (RSRPL)	2	1	**50**	1	0	**50**	1	0	**50**	1	0	**50**	
33	SALAL-NH	8	1	**13**	1	2	**17**	1	3	**20**	1	0	**13**	
34	SINGOLI	2	1	**50**	2	0	**100**	2	0	**100**	2	0	**100**	
35	SINGRAULI-NT	3	2	**67**	3	0	**100**	3	0	**100**	3	0	**100**	

Status of submission of FIR/DR/EL/Tripping Report on NR Tripping Portal

Time Period: 1st March 2024 - 31st March 2024

S. No.	Utility	Total No. of tripping	First Information Report (Not Received)		Disturbance Recorder (Not Received)	Disturbance Recorder (NA) as informed by utility	Disturbance Recorder (Not Received)	Event Logger (Not Received)	Event Logger (NA) as informed by utility	Event Logger (Not Received)	Tripping Report (Not Received)	Tripping Report (NA) as informed by utility	Tripping Report (Not Received)	Remark
			Value	%	Value		%	Value		%	Value		%	
36	SLDC-DV	5	1	**20**	1	0	**20**	1	0	**20**	1	0	**20**	
37	SLDC-HP	12	0	**0**	5	2	**50**	4	3	**44**	0	0	**0**	Details received
38	SLDC-HR	16	4	**25**	3	4	**25**	3	4	**25**	4	0	**25**	DR, EL & Tripping report need to be submitted
39	SLDC-JK	9	4	**44**	4	5	**100**	4	5	**100**	4	4	**80**	
40	SLDC-PS	19	0	**0**	10	3	**63**	10	3	**63**	13	1	**72**	
41	SLDC-RS	101	6	**6**	10	5	**10**	10	4	**10**	21	0	**21**	
42	SLDC-UK	10	0	**0**	0	5	**0**	1	6	**25**	0	0	**0**	Details received
43	SLDC-UP	82	13	**16**	17	16	**26**	19	17	**29**	18	0	**22**	DR, EL & Tripping report need to be submitted
44	SORANG	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
45	STERLITE	6	4	**67**	0	0	**0**	3	0	**50**	2	4	**100**	
46	TANAKPUR-NH	4	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	Details received
47	TANDA-NT	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	DR, EL & Tripping report need to be submitted
48	UNCHAHAR-NT	1	1	**100**	1	0	**100**	1	0	**100**	1	0	**100**	
49	URI-I-NH	3	0	**0**	0	2	**0**	0	0	**0**	0	0	**0**	Details received
Total in NR Region		**516**	**111**	**22**	**138**	**79**	**32**	**148**	**86**	**34**	**154**	**15**	**31**	

As per the IEGC provision under clause 37.2 (c), detailed tripping report along with DR & EL has to be furnished within 24 hrs of the occurrence of the event

MULTIPLE ELEMENTS TRIPPING AT KTPS(RS), KOTA SAKATPURA, RAPP-A, RAPP-B AND RAPP-C

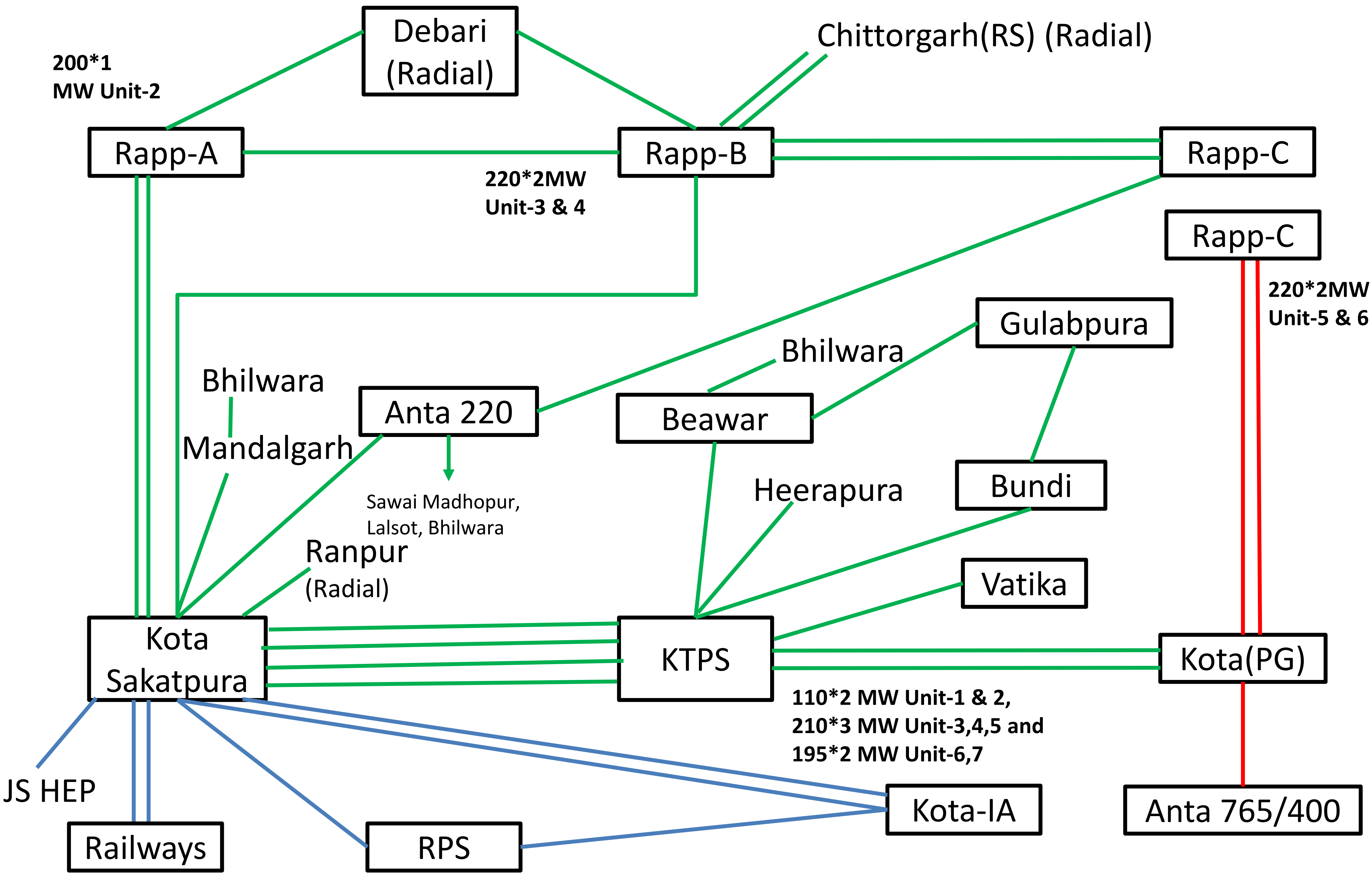
AT 20:22HRS ON 29TH MAR'2024

Event Summary:

- During antecedent condition, all 07 units at KTPS were running and generating approx. 1150MW, power was evacuating through 220kV KTPS-Sakatpura ckt-1,2,3 & 4, 220kV KTPS-Beawar ckt, 220kV KTPS-Bundi ckt and 220kV KTPS-Heerapura ckt. 220kV KTPS-Vatika ckt was under shutdown and 220kV KTPS-Kota(PG) D/C was in opened condition. 200MW Unit-2 at RAPS-A was generating 200MW. RAPS-A generation was evacuating through 220kV RAPS-A-Debari ckt and 220kV RAPS-A-RAPS-B tie line. 220MW Unit-3 at RAPS-B was under shutdown and 220MW Unit-4 at RAPS-B was generating approx. 170MW. RAPS-B generation was evacuating through 220kV RAPS-B-Chittorgarh D/C, 220kV RAPS-B-Debari ckt and 220kV RAPS-B-RAPS-C D/C tie lines. RAPS-C is further connected to 220kV Anta. 220/132kV Kota Sakatpura is having double main transfer bus scheme and bus bar protection is not available there. RPS HEP (generating ~40MW) and Jawahar Sagar HEP (generating ~32MW) also connected at 132kV level at Kota Sakatpura.
- As reported, at 20:22hrs, R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault converted into 3-ph fault with delayed clearance of 760msec is observed.
- Bus bar protection is not available at Kota Sakatpura S/s and Z-4 time delay setting is kept as 160msec. Z-2 time delay setting of 220kV KTPS-Sakatpura ckt-1,2,3 & 4 are also kept as 160msec at KTPS end due to non-availability of bus bar protection at Kota Sakatpura.
- On this fault, 220kV feeders to RAPS-A-I, Ranpur & Mandalgarh from Kota Sakatpura tripped on Z-4 distance protection at Kota Sakatpura end within approx. 200msec of fault. 220kV KTPS-Sakatpura ckt-1 & 3 also tripped on Z-2 distance protection operation at KTPS end within approx. 200msec of fault. 220/132kV ICT-1 at Kota Sakatpura also tripped on differential protection operation.
- Due to tripping of aforementioned 220kV lines, loading of remaining 220kV lines at KTPS & Kota Sakatpura increased significantly. Within approx. 600-700msec of fault, 220kV KTPS-Heerapura ckt and 220kV KTPS-Beawar ckt tripped on Z-1 distance protection operation after power swing detection, 220kV KTPS-Bundi ckt & 220kV Bundi-Gulabpura ckt and 220kV Kota Sakatpura-Anta ckt tripped on distance protection operation suspected due to load encroachment.
- Further, 220kV RAPS-C-Anta ckt and 220kV RAPS-B-Kota Sakatpura ckt also tripped on Z-1 distance protection operation after power swing detection.
- Further, at approx. 20:22:10hrs, SUT-4 at RAPS-B tripped on over frequency protection operation (setting: 51.5Hz with 200msec delay) followed by tripping of GT-4 (setting: 51.5Hz with 500msec delay). Auto transfer initiated and load transferred to UT-4. However, tie CBs (CB-461 & 484) tripped after 1 sec, as per Auto transfer scheme, resulting in one - one PCP tripping and reactor trip on PHT pressure high.
- At the same time, SUT-5 & SUT-6 at RAPS-C tripped on over frequency (51.5 Hz with 200 msec time delay). Auto transfer scheme initiated in both Unit-5 & 6 however it failed due to frequency mismatch. Subsequently reactors of RAPS-5&6 tripped on PHT pressure high. Highest frequency recorded was ~53.16Hz.

- After aforementioned trippings, only RAPS-A unit-2 was available which was feeding 220kV Debari, 220kV Chittorgarh via 220kV RAPS-A-RAPS-B tie line and load at 220/132kV Kota Sakatpura via 220kV RAPS-A-Kota Sakatpura ckt-2.
- Further at 20:29hrs, frequency decreased to 47.8Hz and 220kV RAPS-A-Kota Sakatpura ckt-2 tripped on under frequency as per islanding scheme.
- With this tripping, system with RAPS-A unit-2 and load at Debari & Chittorgarh got islanded. RAPS-A generation was reduced to 160MW. Island operated till approx. 22:47hrs, frequency of island was maintained in the range of 51-52Hz and voltage was in the range of 230-240kV. Further, at ~22:47hrs, RAPS-A unit-2 turbine generator tripped on over fluxing (~112.5%), voltage recorded just before the tripping was ~282kV.
- As per SCADA, total generation loss of approx. 2000MW is observed and at the same time load loss of approx. 300MW is observed in Rajasthan control area.

Connection Diagram between KTPS, RAPP-A, RAPP-B & RAPP-C



Antecedent condition

At 220kV KTPS:

- **220 KV Kota(PG)-KTPS(RVUN) (RS) Ckt-1 & 2** were **out of service**. Lines were out since 09-09-2023. (lines were kept out on request of KTPS, as intimated by KTPS, hotspot related issue arises due to heavy import of power from Kota(PG) end). **(Line has been charged now on 1st April 20:00hrs)**
- **220kV KTPS-Vatika ckt** was under **shutdown**
- All 7 units were running and generating total approx. 1150MW

At RAPS-A:

- 200MW Unit-2 was in service and generating ~195MW.
- Evacuating through 220kV Debari, RAPS-B tie line and Kota Sakatpura D/C

At RAPS-B:

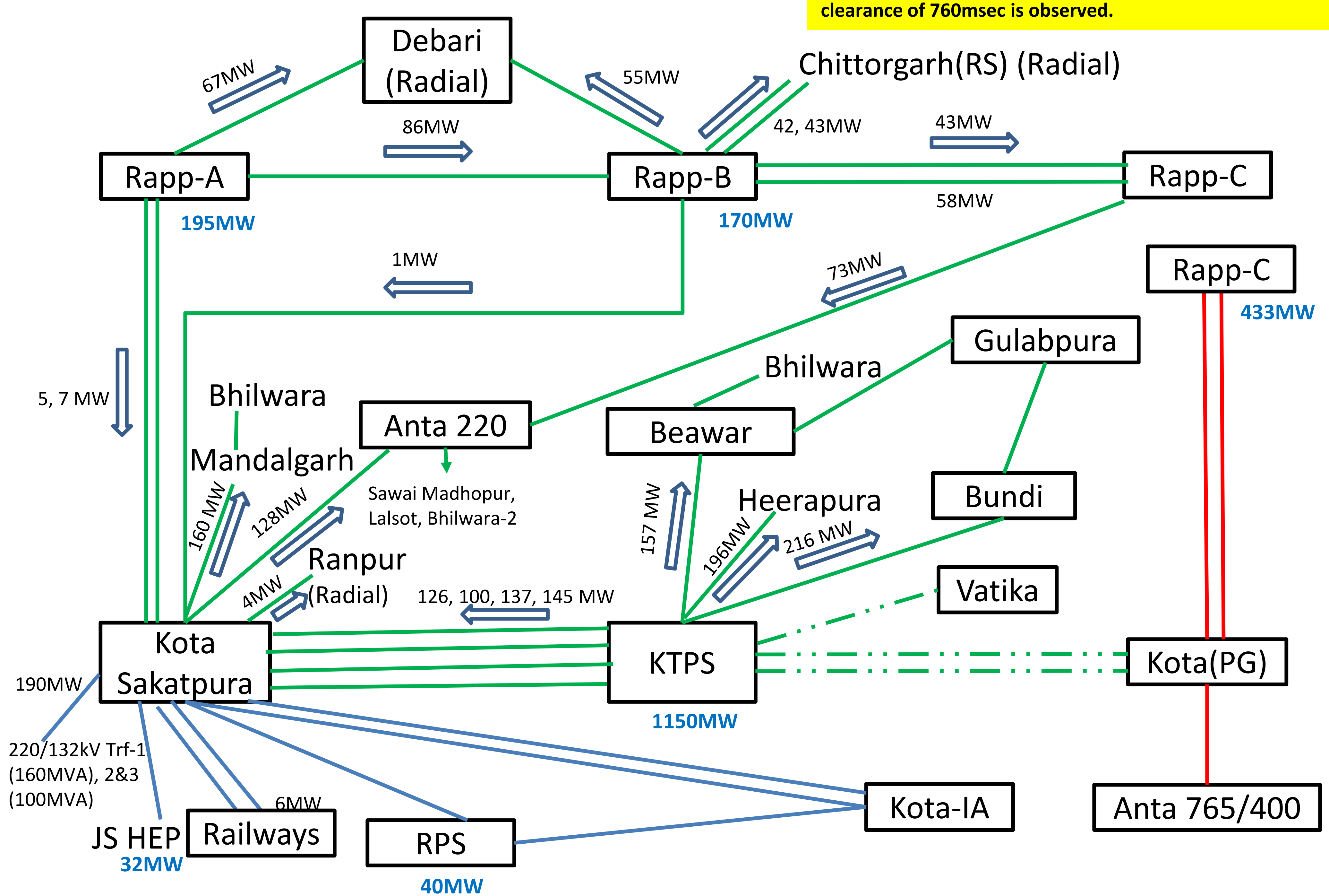
- 220MW Unit-4 was in service and generating ~170MW.
- 220MW Unit-3 was not in service.
- Evacuating through 220kV Debari, Chittorgarh, RAPS-C tie line and Kota Sakatpura ckt

At RAPS-C:

- 220MW Unit-5&6 was in service and generating ~433MW
- Evacuating through 400kV network

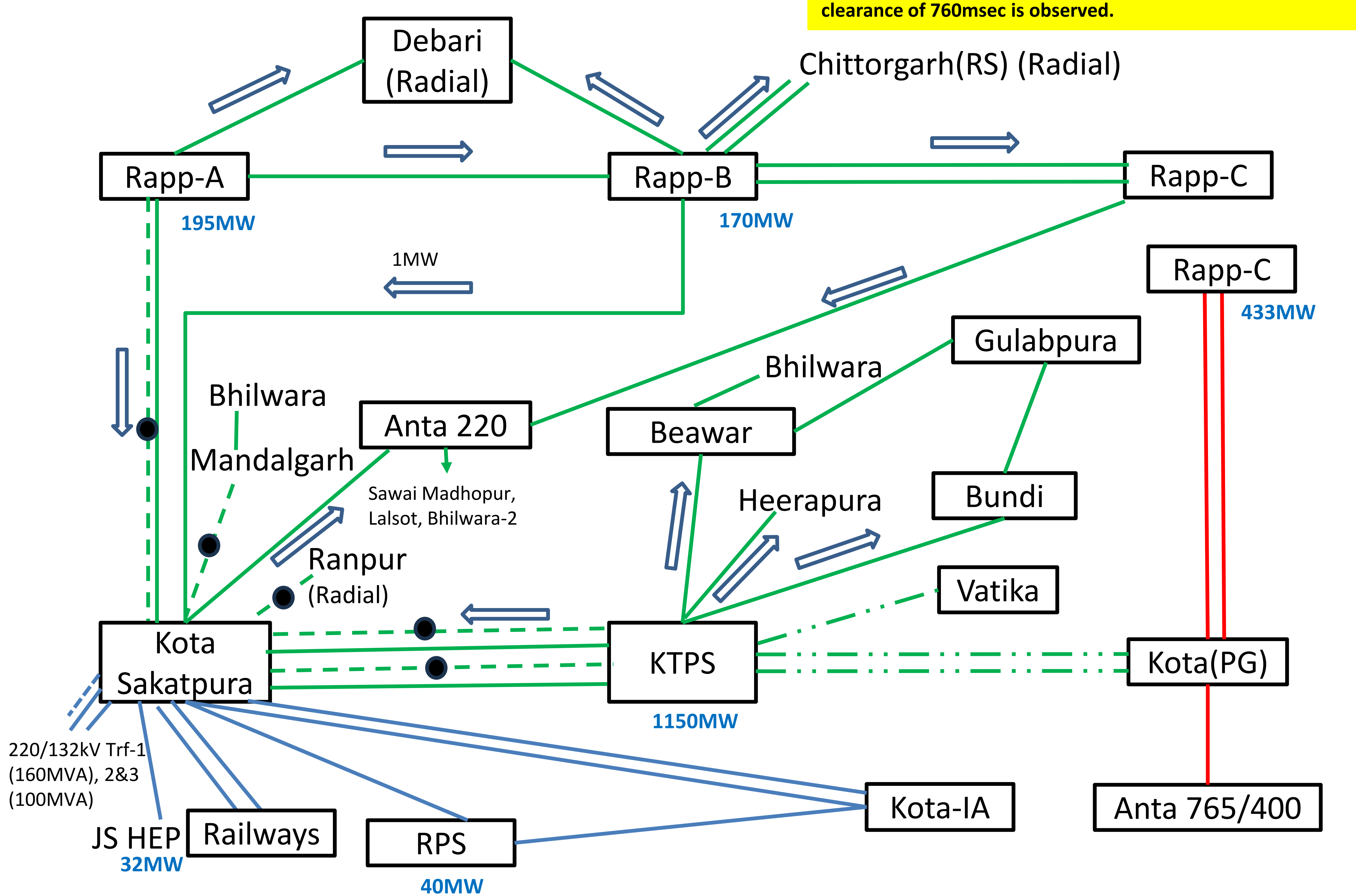
Antecedent scenario (at 20:21 hrs)

Triggering incident: R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault at 20:21:52:280hrs converted into 3-ph fault with delayed clearance of 760msec is observed.



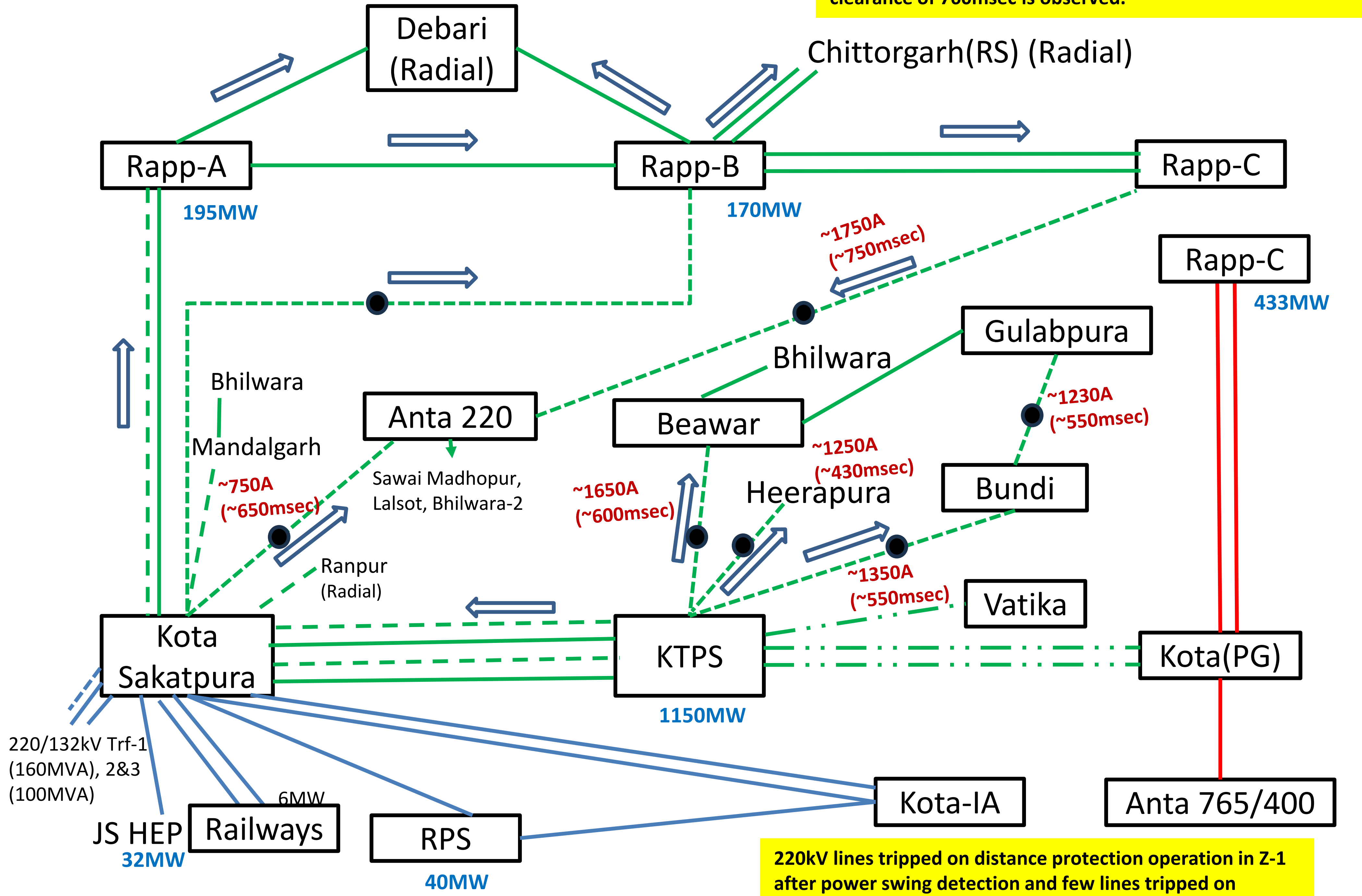
Tripping of multiple 220kV lines in complex (within 200msec of fault time (20:21:52:280hrs))

Triggering incident: R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault at 20:21:52:280hrs converted into 3-ph fault with delayed clearance of 760msec is observed.



Tripping of multiple 220kV lines in complex (within 600-650msec of fault time (20:21:52:280hrs))

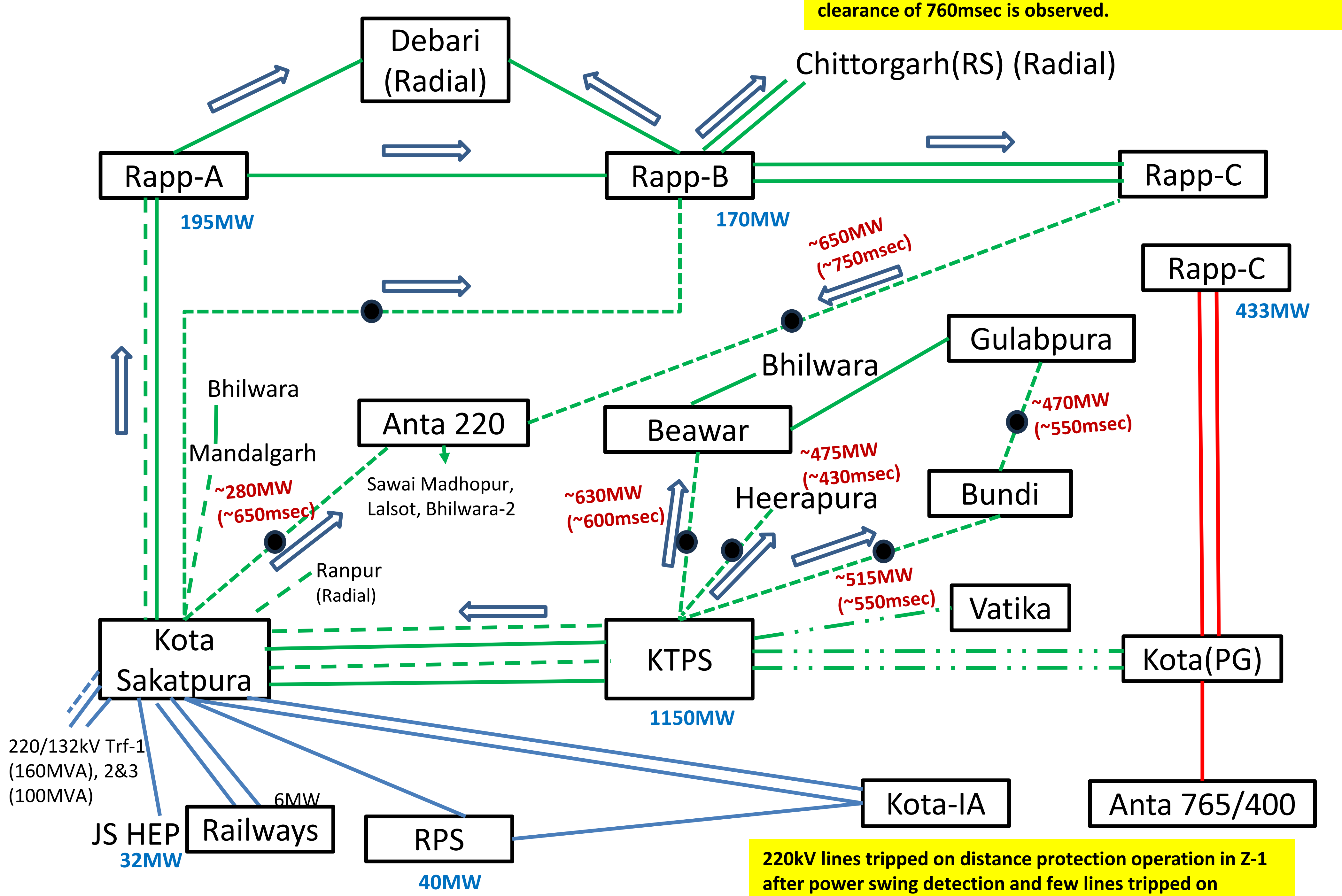
Triggering incident: R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault at 20:21:52:280hrs converted into 3-ph fault with delayed clearance of 760msec is observed.



220kV lines tripped on distance protection operation in Z-1 after power swing detection and few lines tripped on distance protection operation on load encroachment

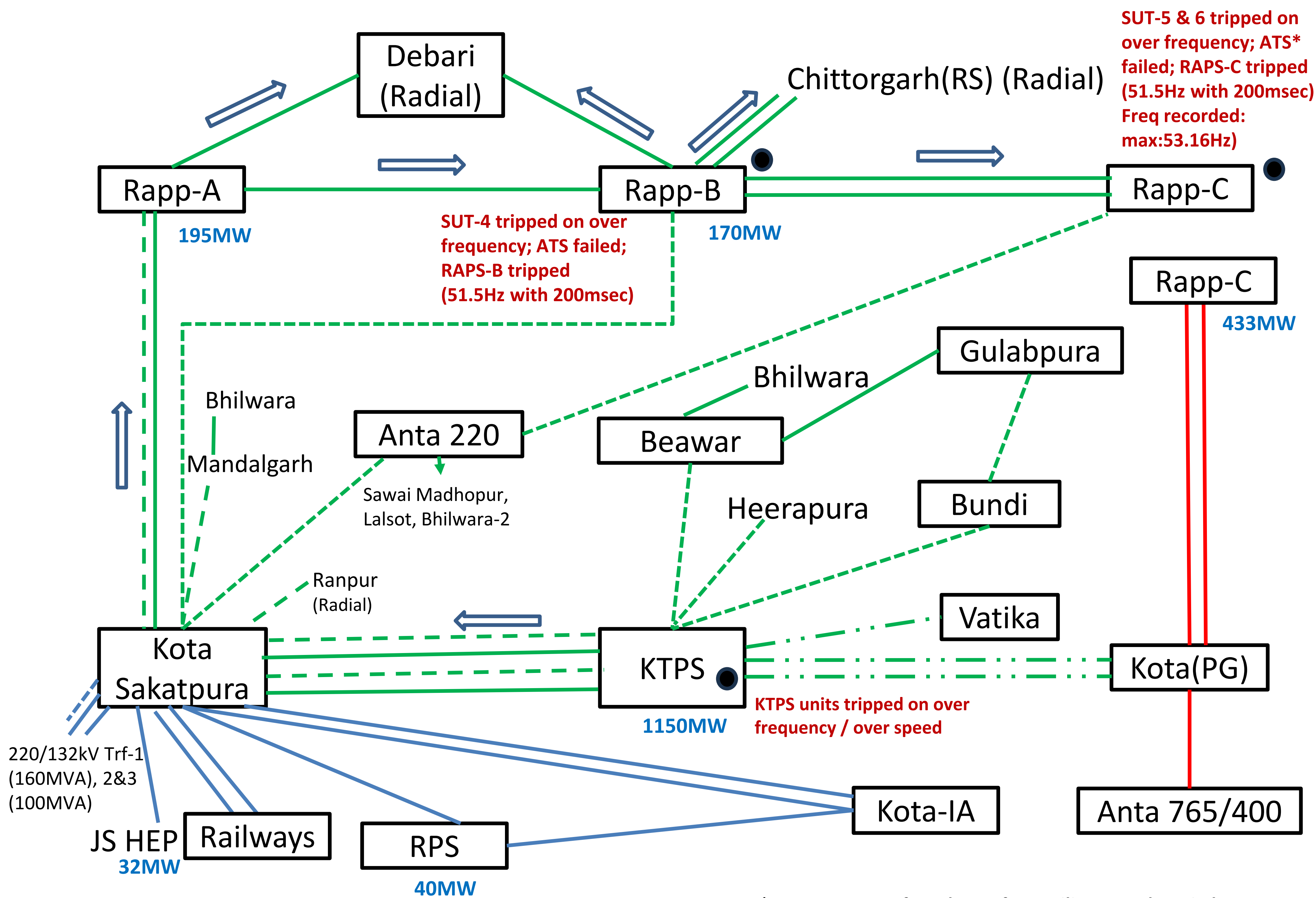
Tripping of multiple 220kV lines in complex (within 600-650msec of fault time (20:21:52:280hrs))

Triggering incident: R-ph CT (220 kV side) of 220 kV/132 kV ICT-1 at Kota Sakatpura blast. As per PMU, R-N fault at 20:21:52:280hrs converted into 3-ph fault with delayed clearance of 760msec is observed.



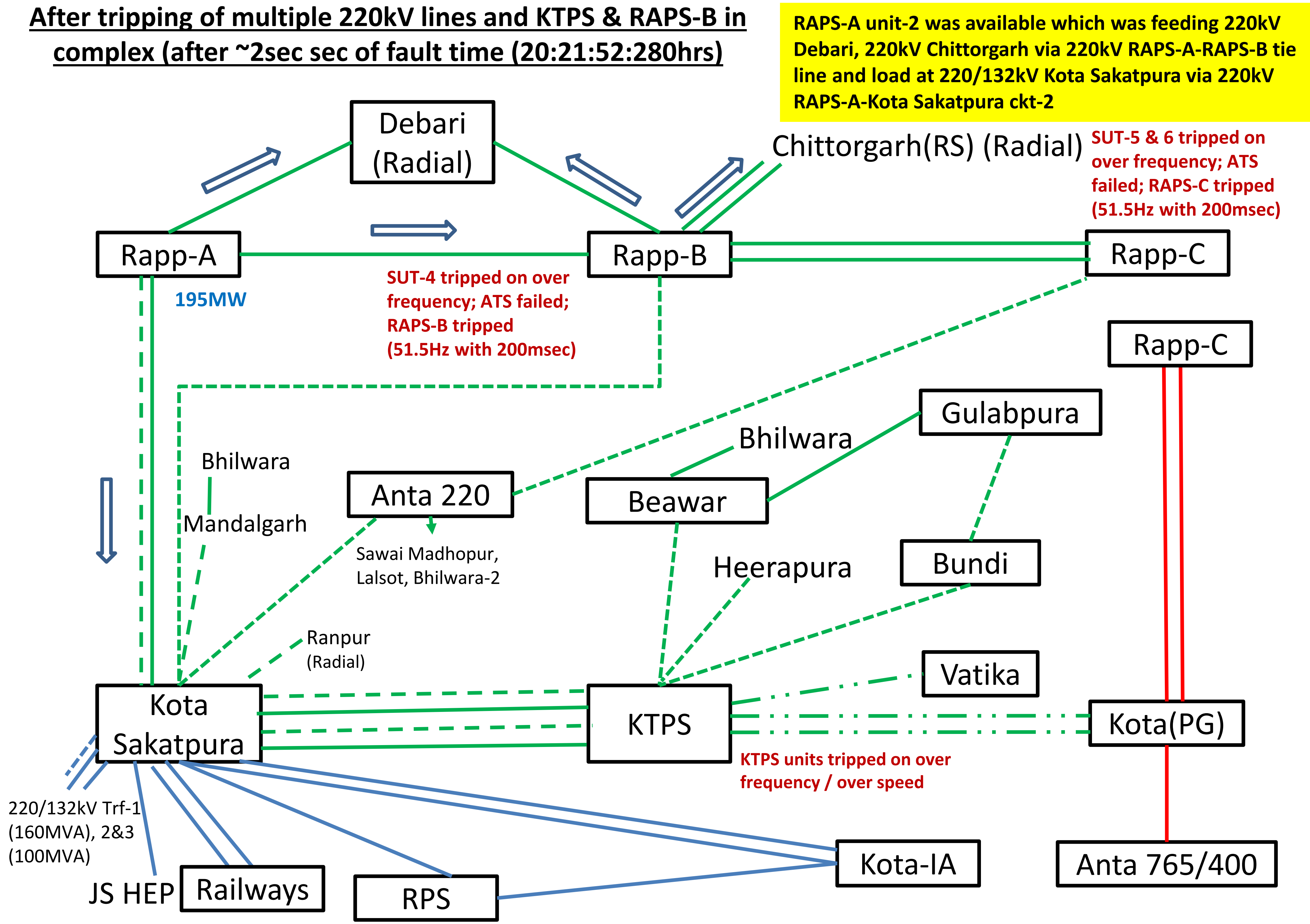
220kV lines tripped on distance protection operation in Z-1 after power swing detection and few lines tripped on distance protection operation on load encroachment

RAPS-B, RAPS-C & KTPS units tripped (within 1-2sec of fault time (20:21:52:280hrs))



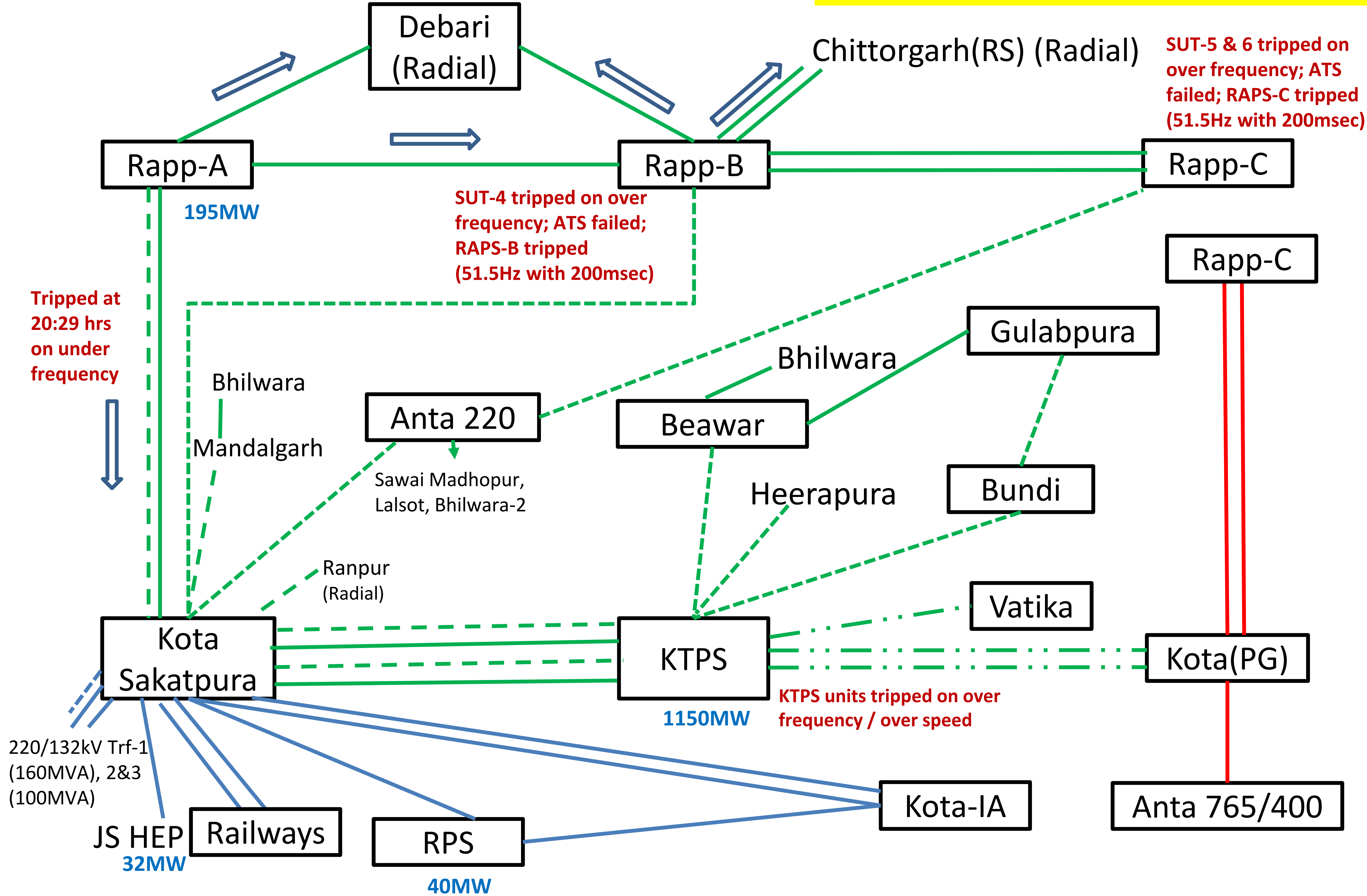
*ATS: Auto transfer Scheme for auxiliary supply switchover

After tripping of multiple 220kV lines and KTPS & RAPS-B in complex (after ~2sec sec of fault time (20:21:52:280hrs)



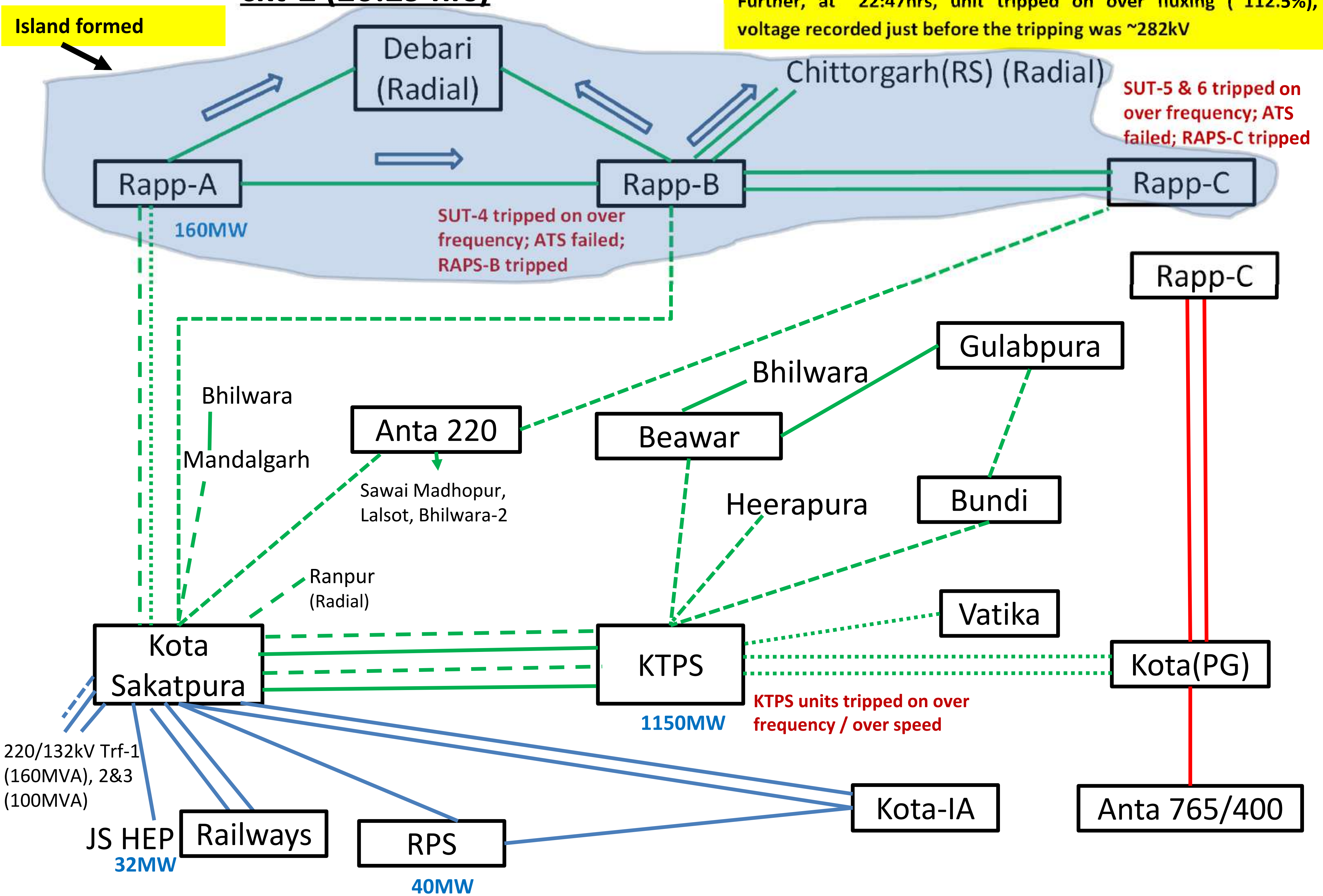
After tripping of multiple 220kV lines and KTPS & RAPS-B in complex (after ~2sec sec of fault time (20:21:52:280hrs)

Further at 20:29hrs, frequency decreased to 47.8Hz and 220kV RAPS-A-Kota Sakatpura ckt-2 tripped on under frequency as per islanding scheme.

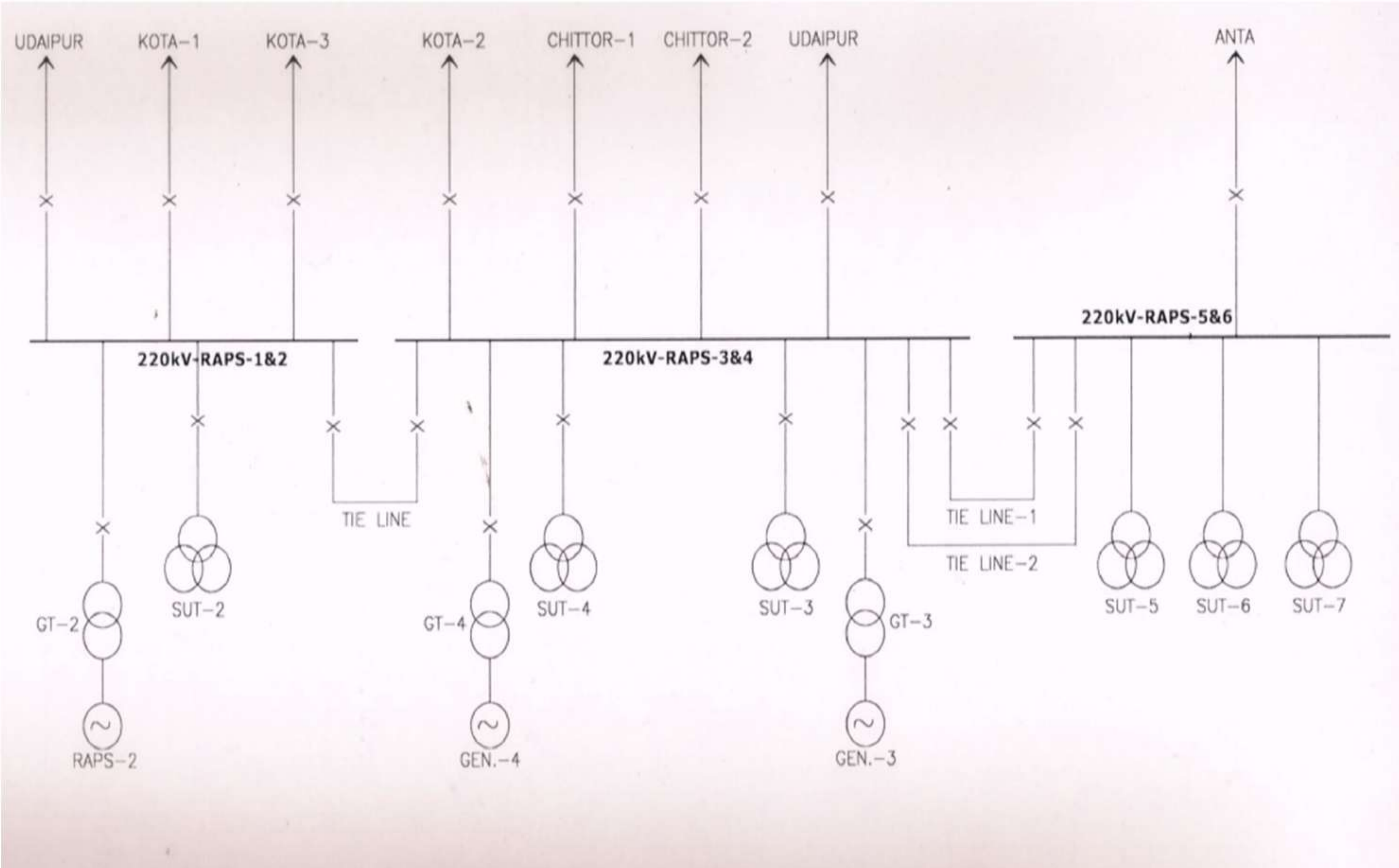


After tripping 220kV RAPS-A-Kota Sakatpura ckt-2 (20:29 hrs)

RAPS-A generation was reduced to 160MW. Island operated till approx. 22:47hrs, frequency (51-52Hz) and voltage (230-240kV). Further, at ~22:47hrs, unit tripped on over fluxing (~112.5%), voltage recorded just before the tripping was ~282kV

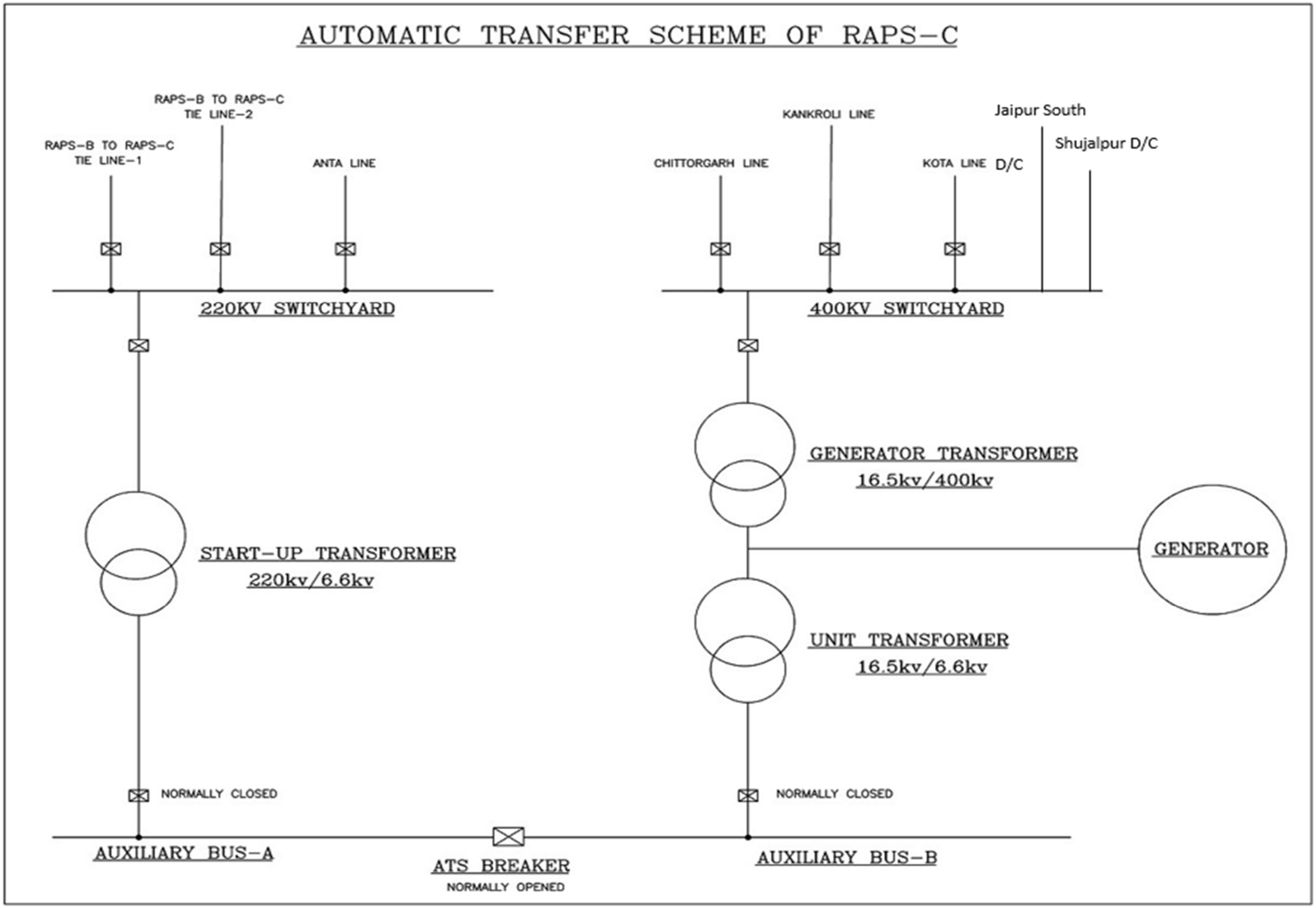


SLD and connectivity of RAPS- A, RAPS-B & RAPS-C

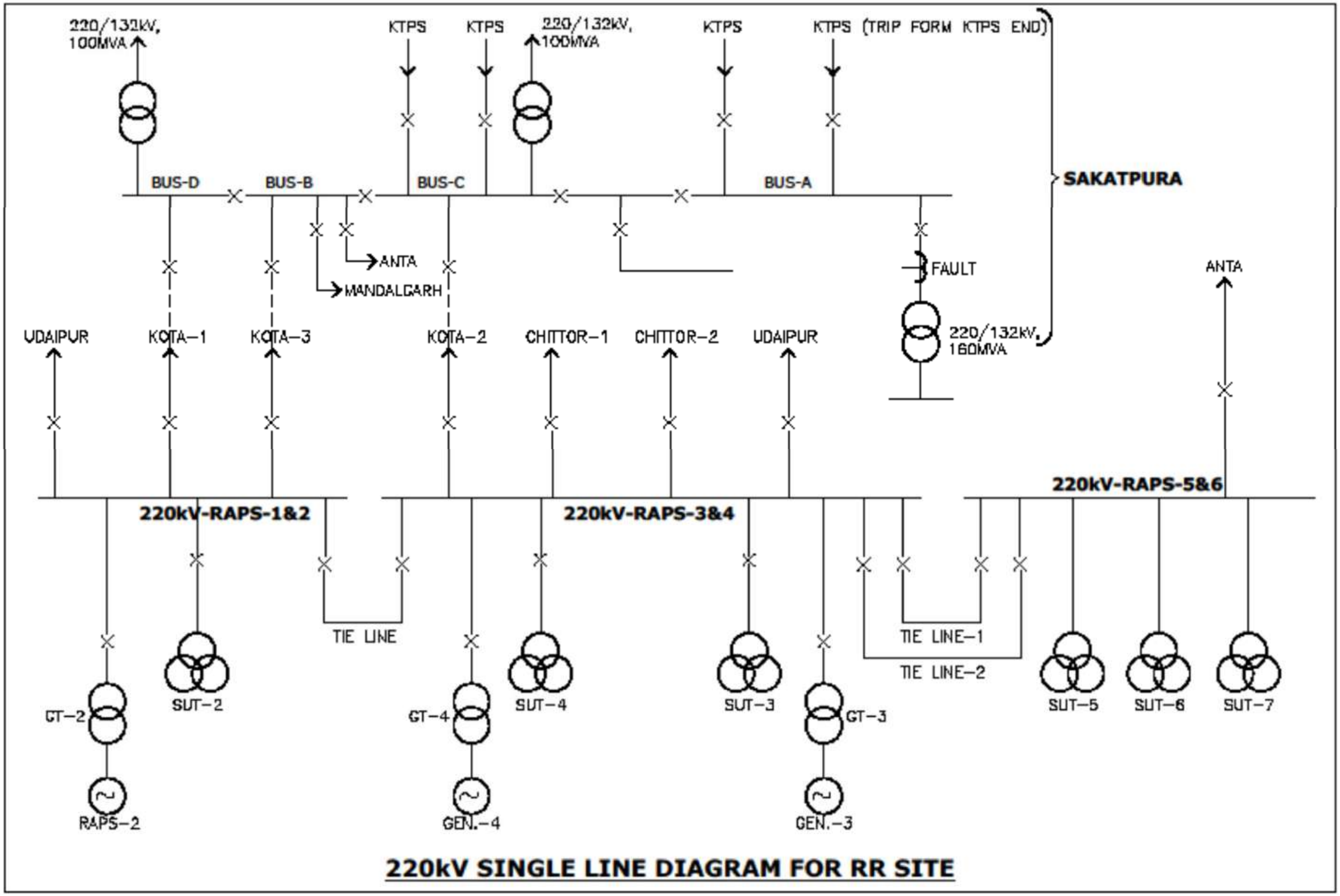


220kV SINGLE LINE DIAGRAM FOR RR SITE

Auto Transfer Scheme at RAPS-C



Auto Transfer Scheme at RAPS-C



Auto Transfer Scheme at RAPS-C

The power supply to unit auxiliary loads are fed through two sources at 6.6kV level:

i) One source is from 220kV Grid to SUT (Start-Up Transformer) (220kV/6.6kV)
ii) Second source is from Generator to UT (Unit Transformer) (16.5/6.6kV) or GT (400kV/16.5kV) from 400kV grid in case of Generator is in Shut down condition.

Unit auxiliary loads are equally divided on both the sources at 6.6kV level. There are four (04) circulating water pumps at RAPS-C, two (02) pumps are fed from auxiliary bus-A and two (02) from auxiliary bus-B. This arrangement is to ensure the availability of at least two (02) circulating water pumps all the time during failure of any one axillary supply.

In case, any source fails then through Auto Transfer Scheme (ATS), the healthy source bus extends the power supply to failed source bus through closing of the Bus-Coupler Circuit Breaker (normally this CB remain open and ready to close in Auto mode) between these two sources at 6.6kV Voltage level.

Auto Transfer Scheme at RAPS-C

For successful auto transfer through ATS scheme, both the source 220kV and 400kV should be in synchronism prior to fail of any power supply source. ATS relay check the synchronism between 220kV and 400kV system on the basis of voltage, frequency and angle difference. In case, power supply to any of the auxiliary bus fails, either due to tripping of SUT/UT or failure of supply due to outage of connected transmission system, ATS relay will initiate the closing of ATS breaker simultaneously.

Criteria for Automatic transfer to take place are as follows:

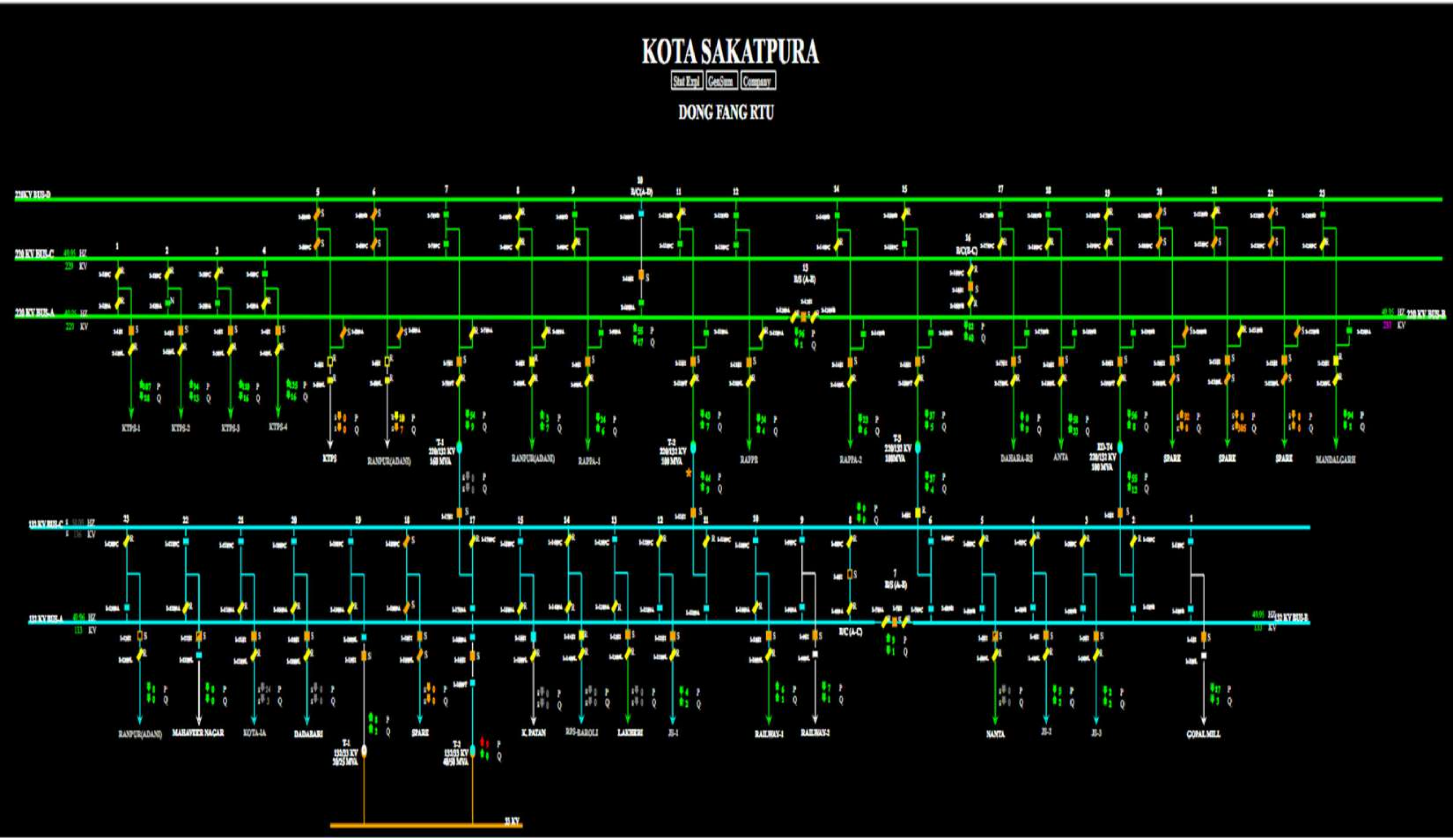
- Bus voltage magnitude: greater than 70%.
- Phase difference: less than 20o
- Total elapsed time: less than 700ms.
- Maximum ΔF: less than 3Hz

.

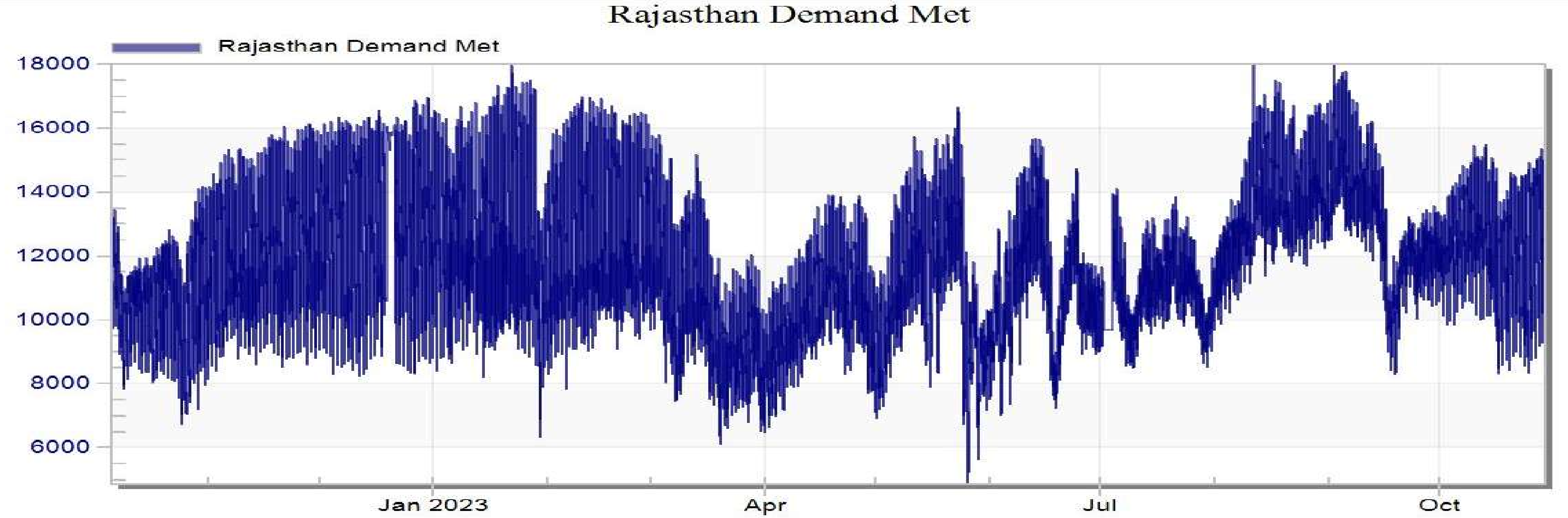
Observation:

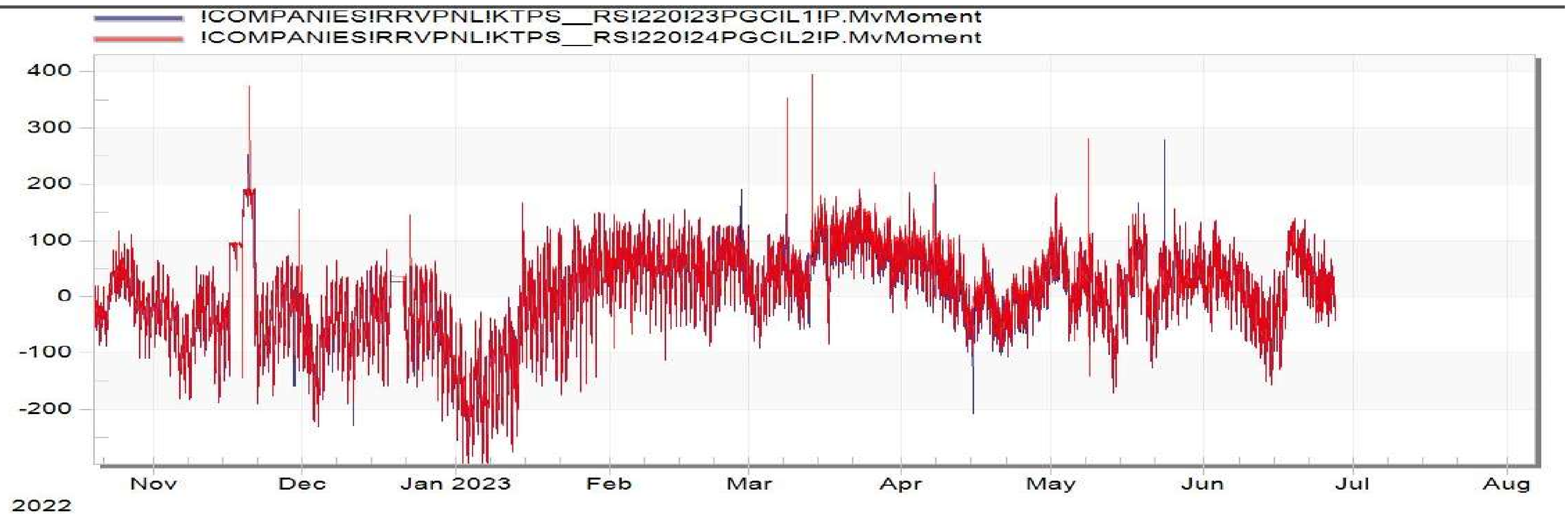
- Bus bar protection is not available at 220/132kV Kota Sakatpura S/s. **(need to be commissioned at the earliest on priority)**
- Many 220kV lines tripped in Z-1 during power swing. As per protection philosophy **all zones need to be blocked for 02 secs on power swing detection.**
- RAPS is also connected to Debari and Chittorgarh radially. Anta is only connectivity available with the grid. After tripping of Anta line, chances of system going into island is very high. **(Possibility of connecting RAPS with the grid via Chittorgarh may be explored)**
- Keeping 220kV KTPS-Kota(PG) D/C in closed condition will relieve the loading of other 220kV lines. **(line was closed on 01st April, 2024 at 20:00hrs)**
- Auto Transfer Scheme failed at RAPS-B & C after tripping of SUTs at respective stations. Any review in ATS design if needed may be explored. Measures to strengthen auxiliary supply of RAPS-C need to be explored to avoid poisoning out of RAPS-C.
- In view of frequent multiple elements tripping in the complex, SPS with logic of tripping of some generation at KTPS in steps in coordination with tripping of 220kV lines may be implemented. Blackout of whole complex may be avoided by implementing SPS in the complex. **(Rajasthan/KTPS may explore the possibility for the SPS in this complex)**
- Frequent tripping of 220kV lines in this complex have been highlighted on various forums. Necessary operation and maintenance related measured need to be initiated on priority to avoid frequent tripping of lines
- It is observed that elements were opened/closed without taking code or intimation to NRLDC. This practice may be avoided in future to ensure smooth grid operation.

SLD of 220/132kV Kota Sakatpura

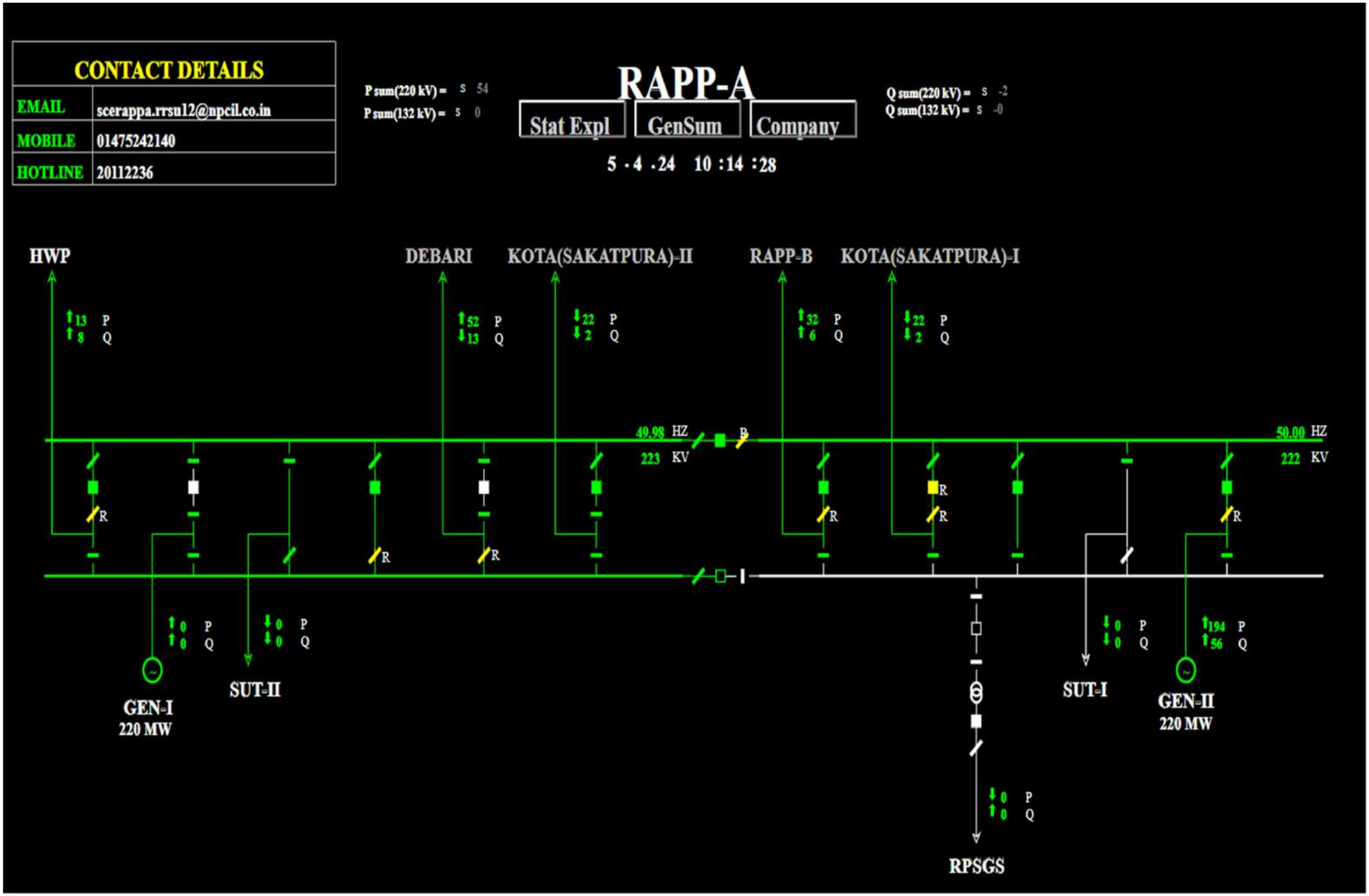


Loading pattern of 220kV KTPS-Kota(PG) D/C

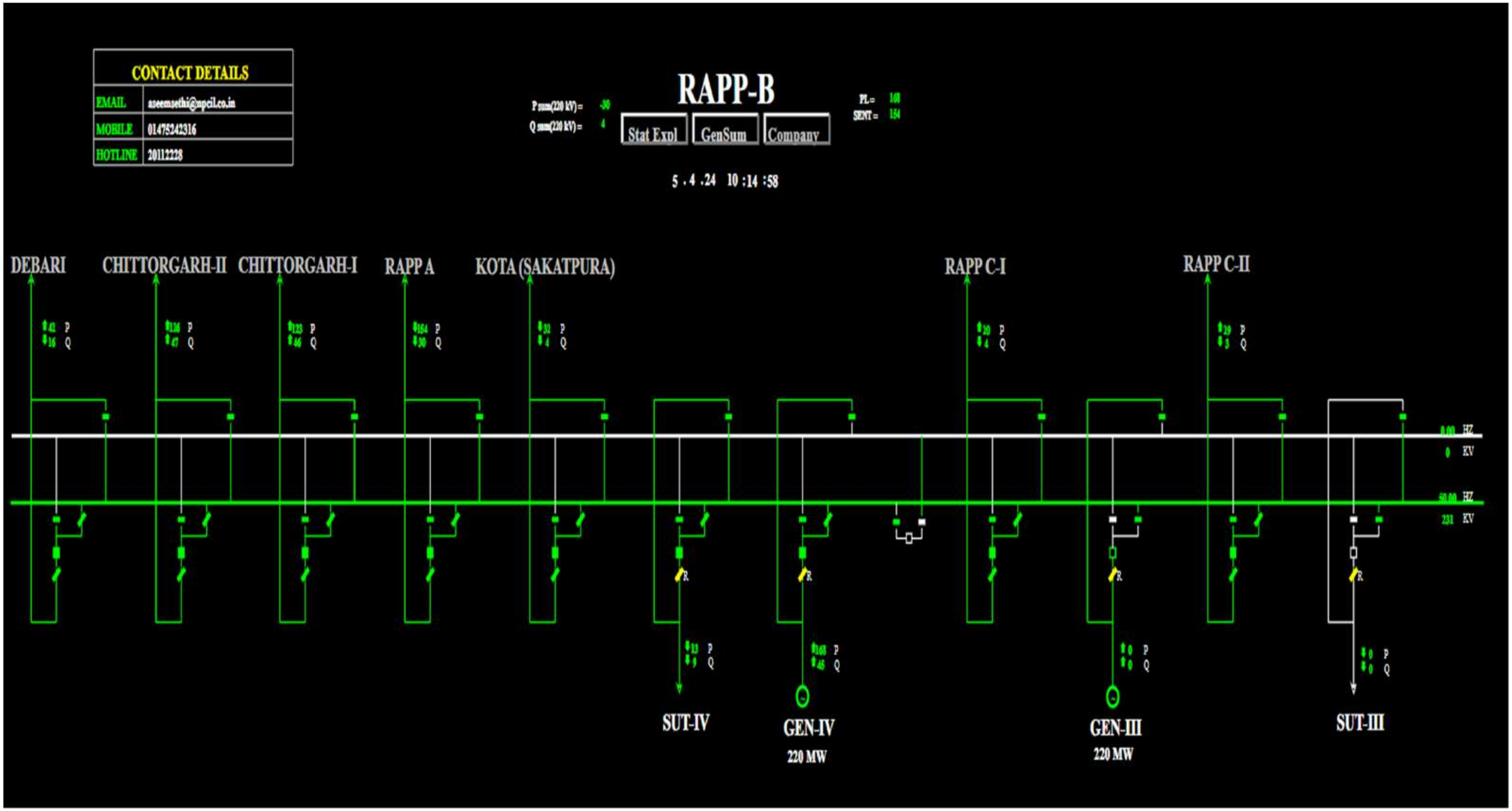




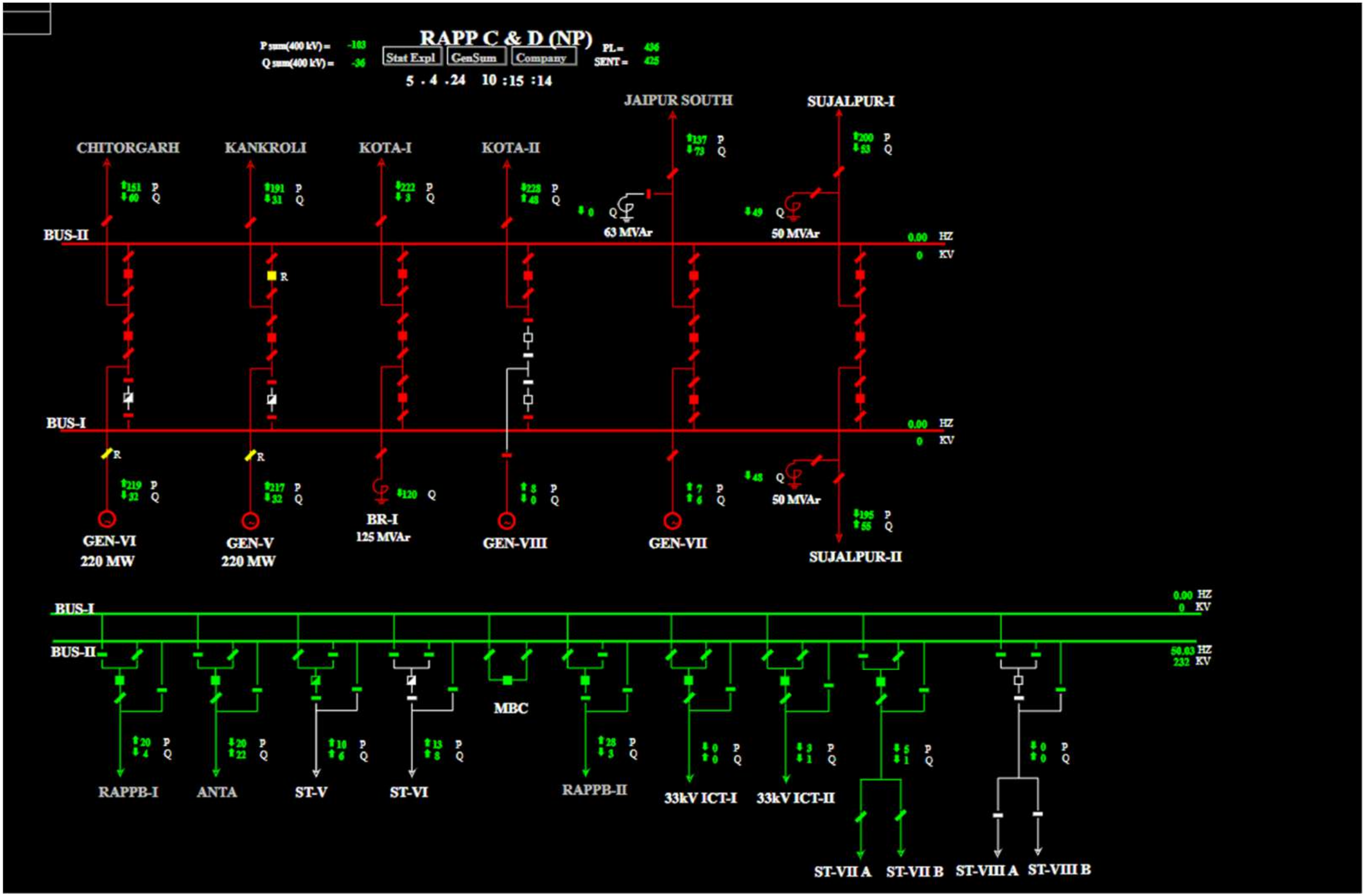
SLD of 220kV RAPS-A(NPCIL)



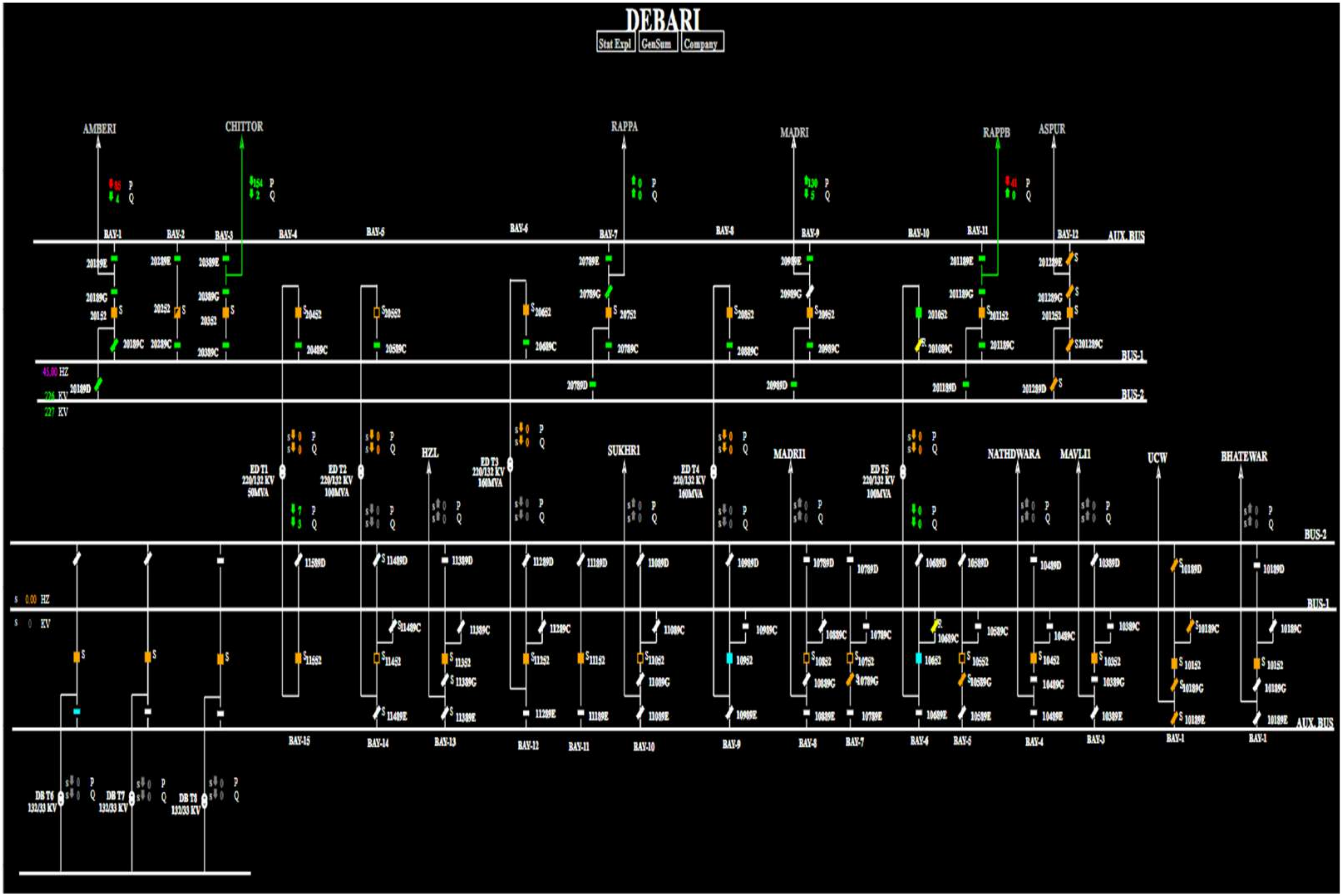
SLD of 220kV RAPS-B(NPCIL)



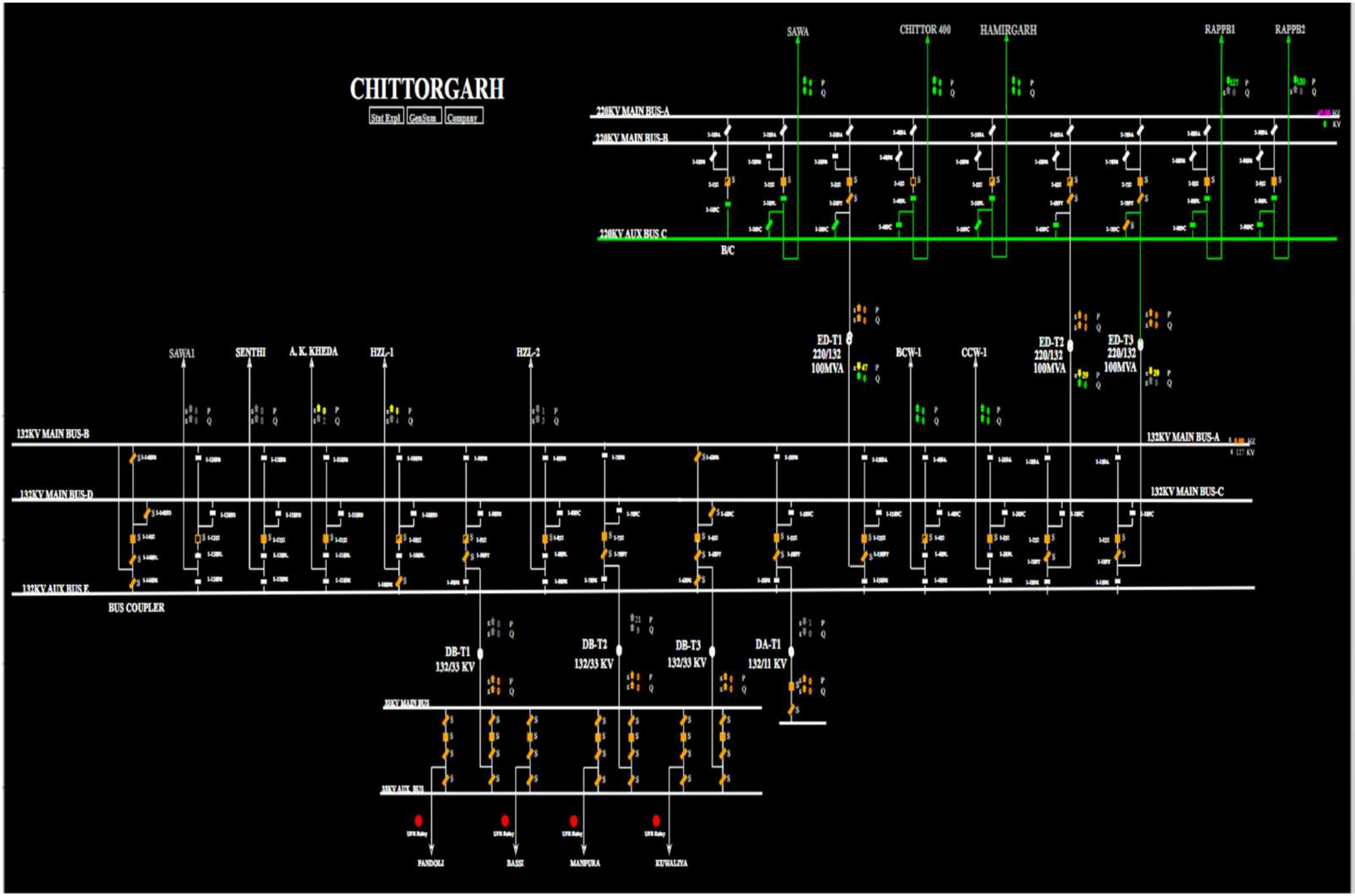
SLD of 220kV RAPS-C(NPCIL)



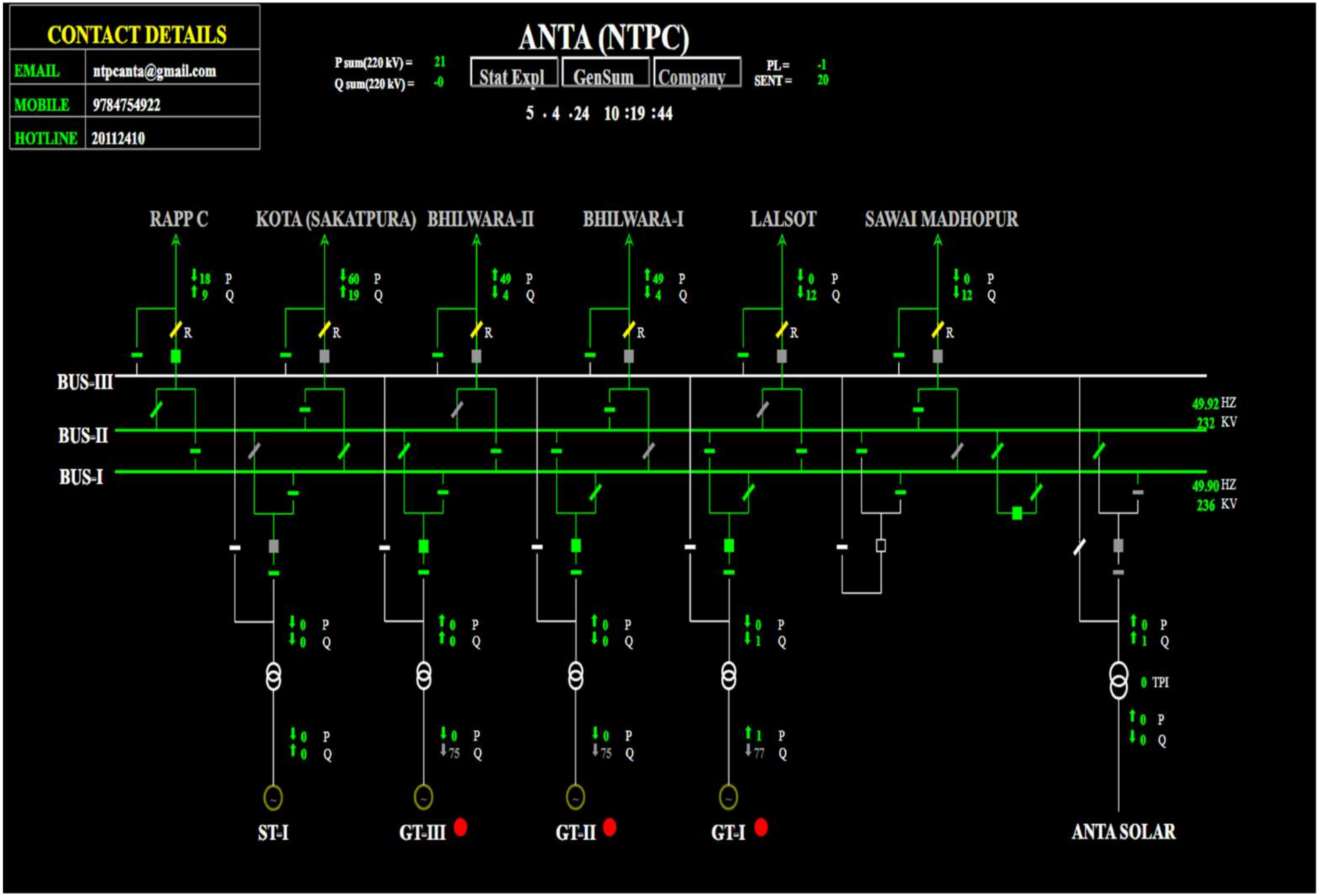
SLD of 220/132kV Debari



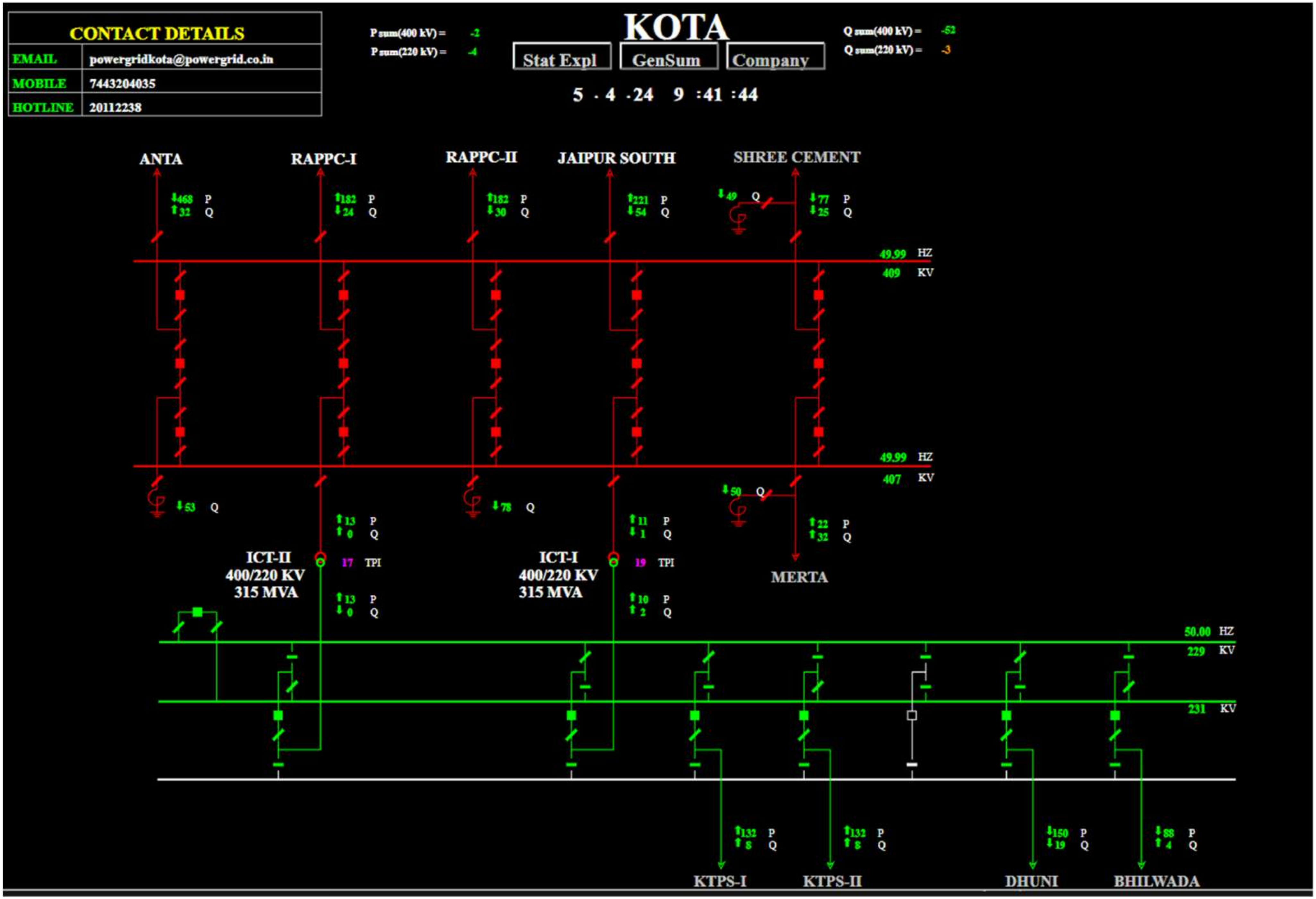
SLD of 220/132kV Chittorgarh



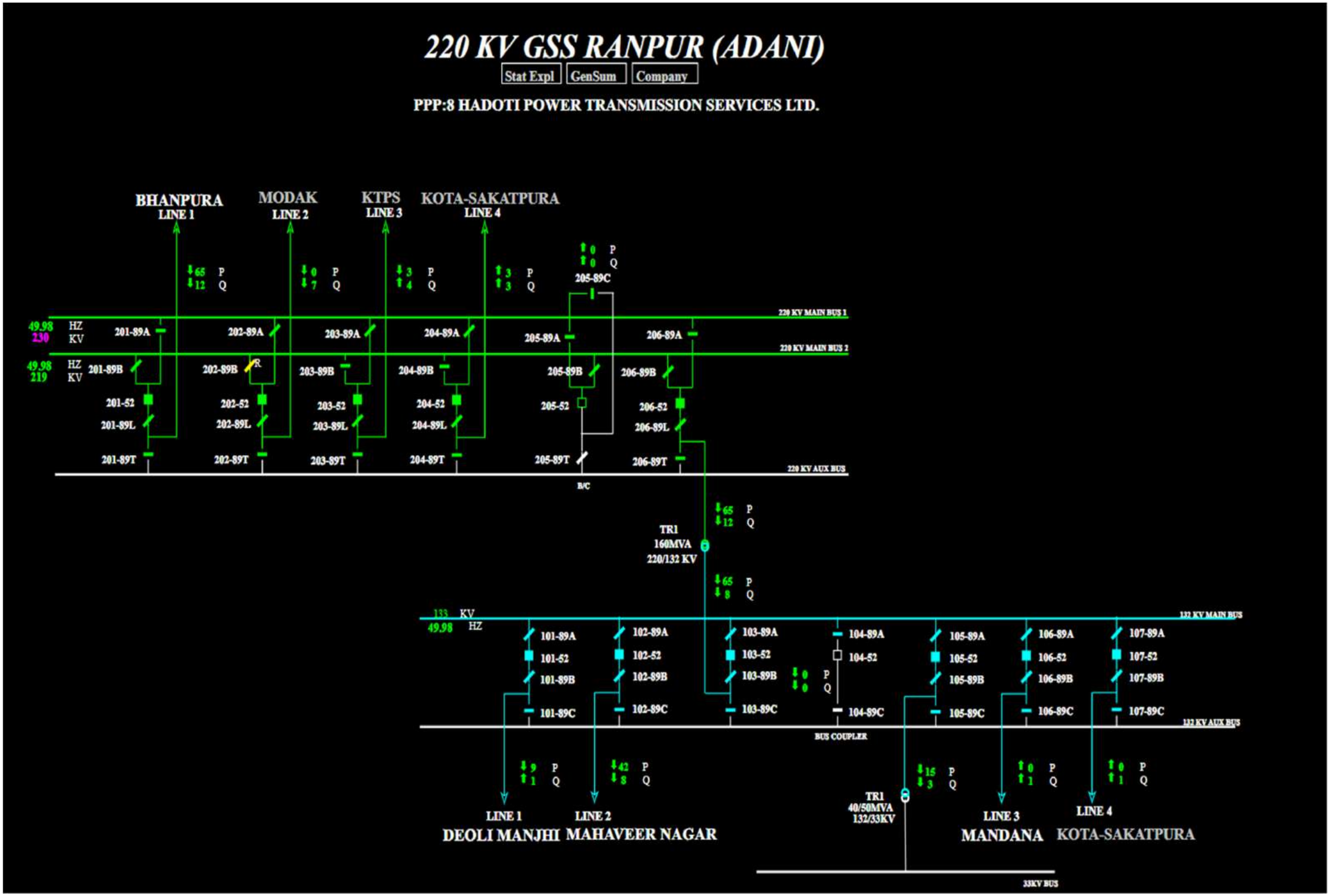
SLD of 220kV Anta(NTPC)



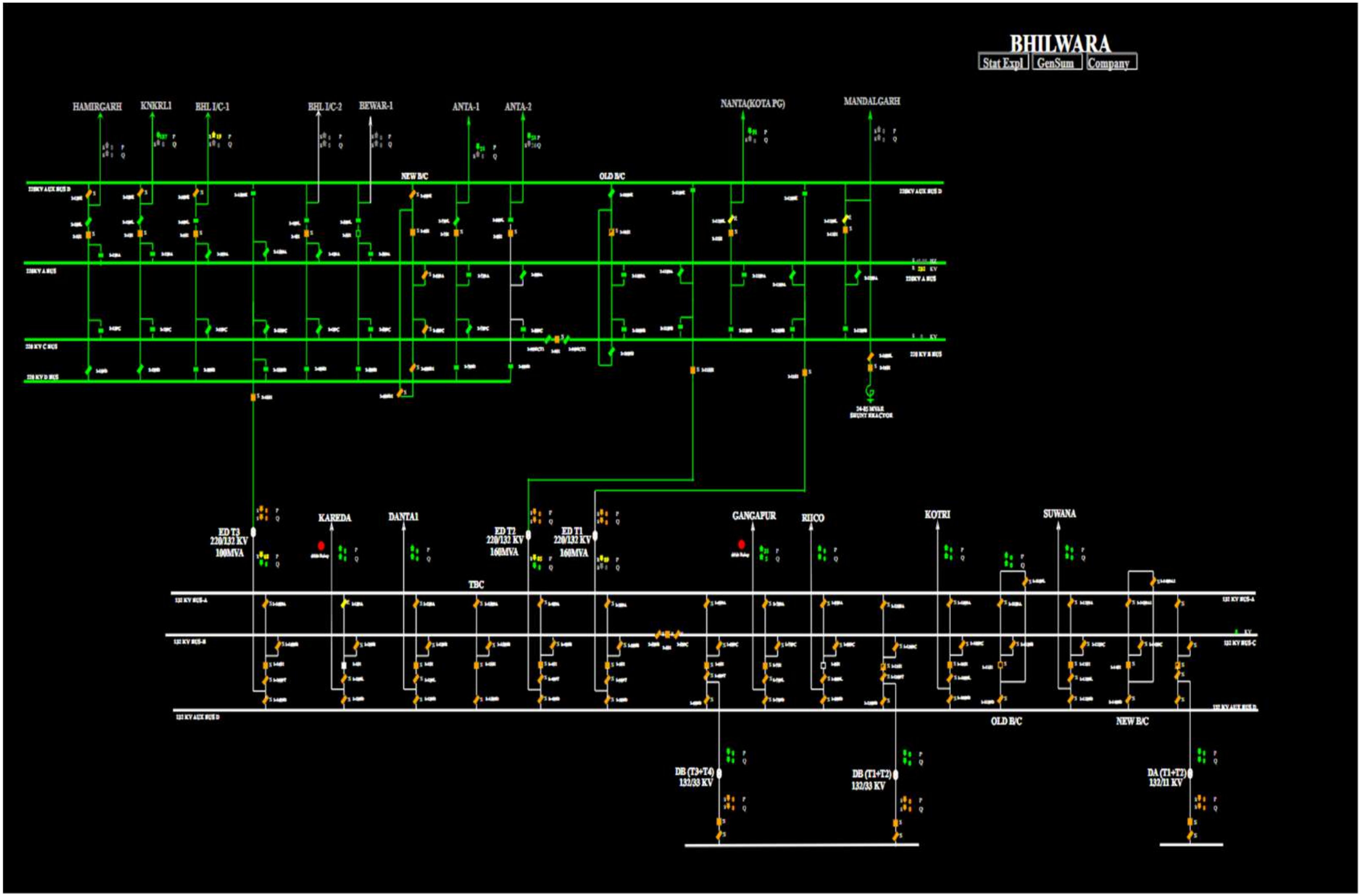
SLD of 400/220kV Kota(PG)



SLD of 220/132kV Ranpur

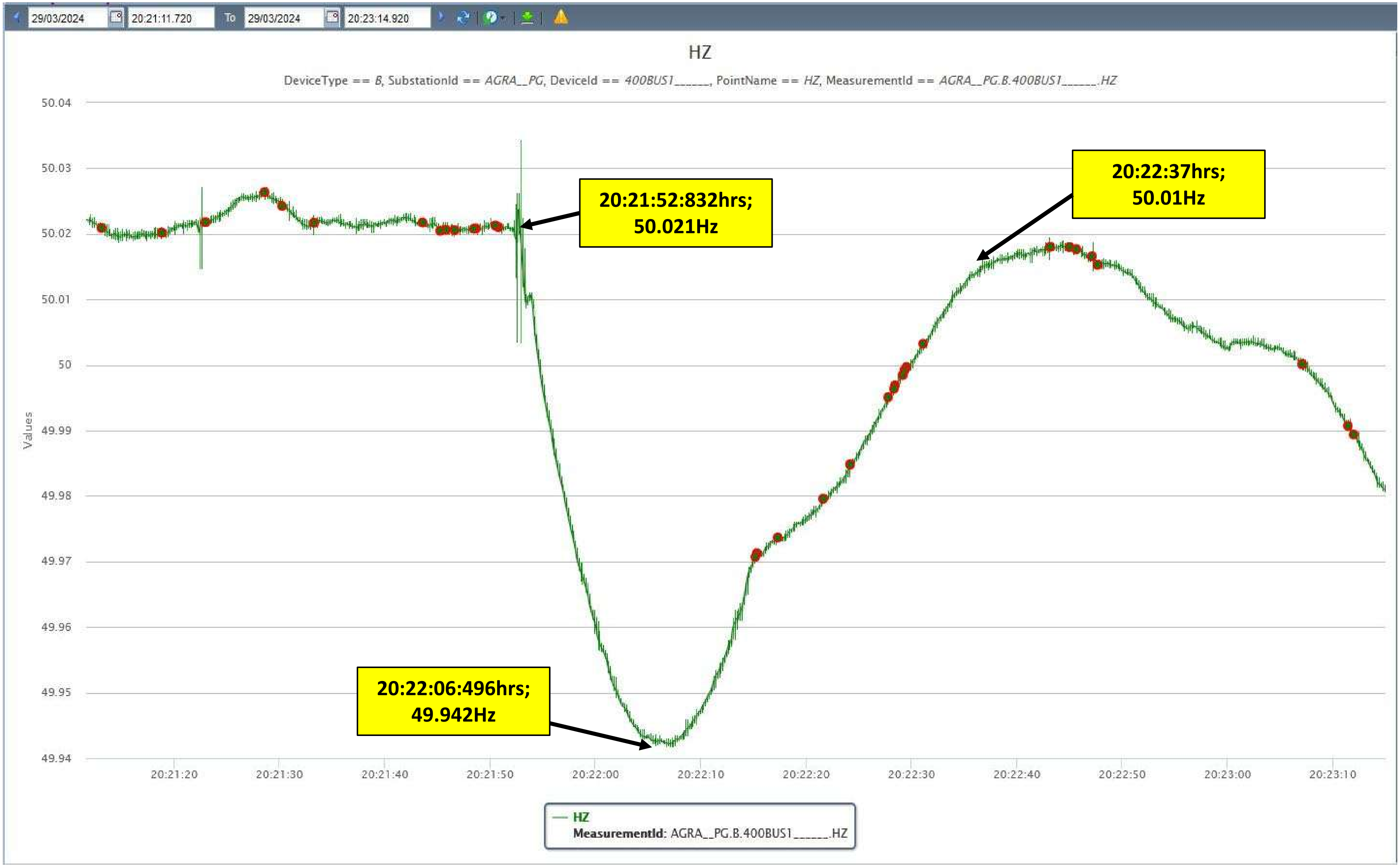


SLD of 220/132kV Bhilwara



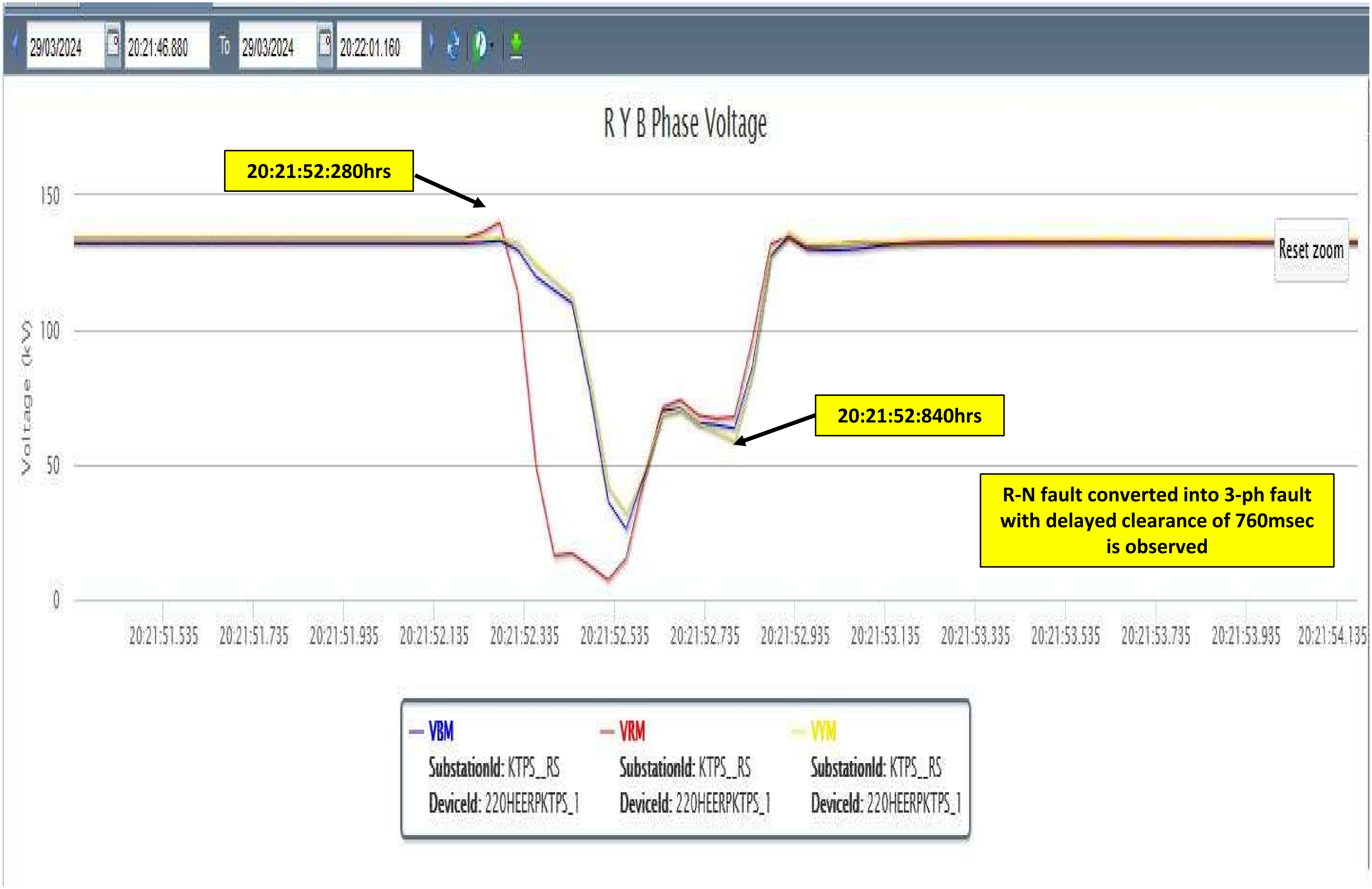
PMU Plot of frequency at Agra(PG)

20:22 hrs/29-Mar-24

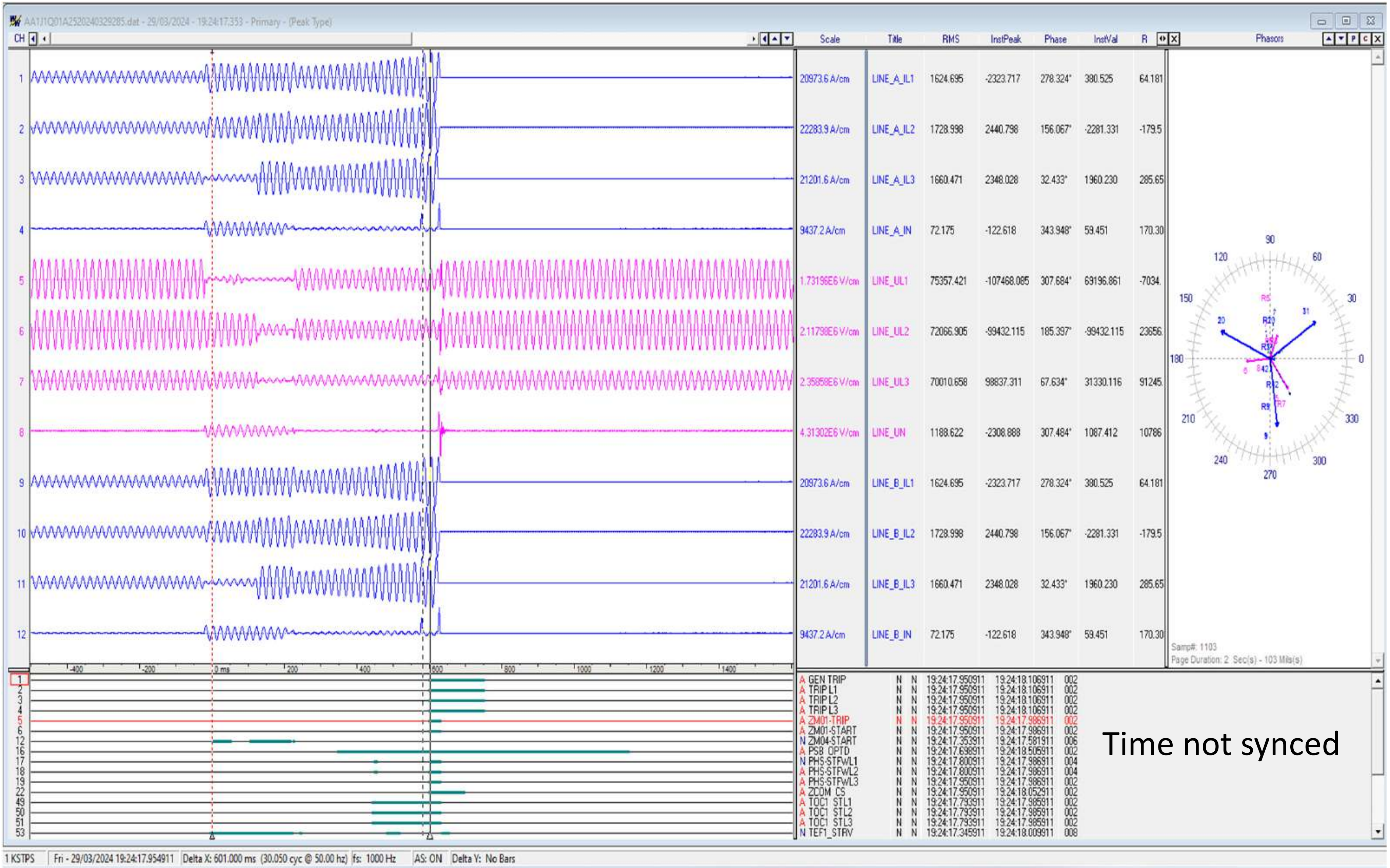


PMU Plot of voltage of 220kV KTPS-Heerapur ckt at KTPS(RVVN)

20:22 hrs/29-Mar-24

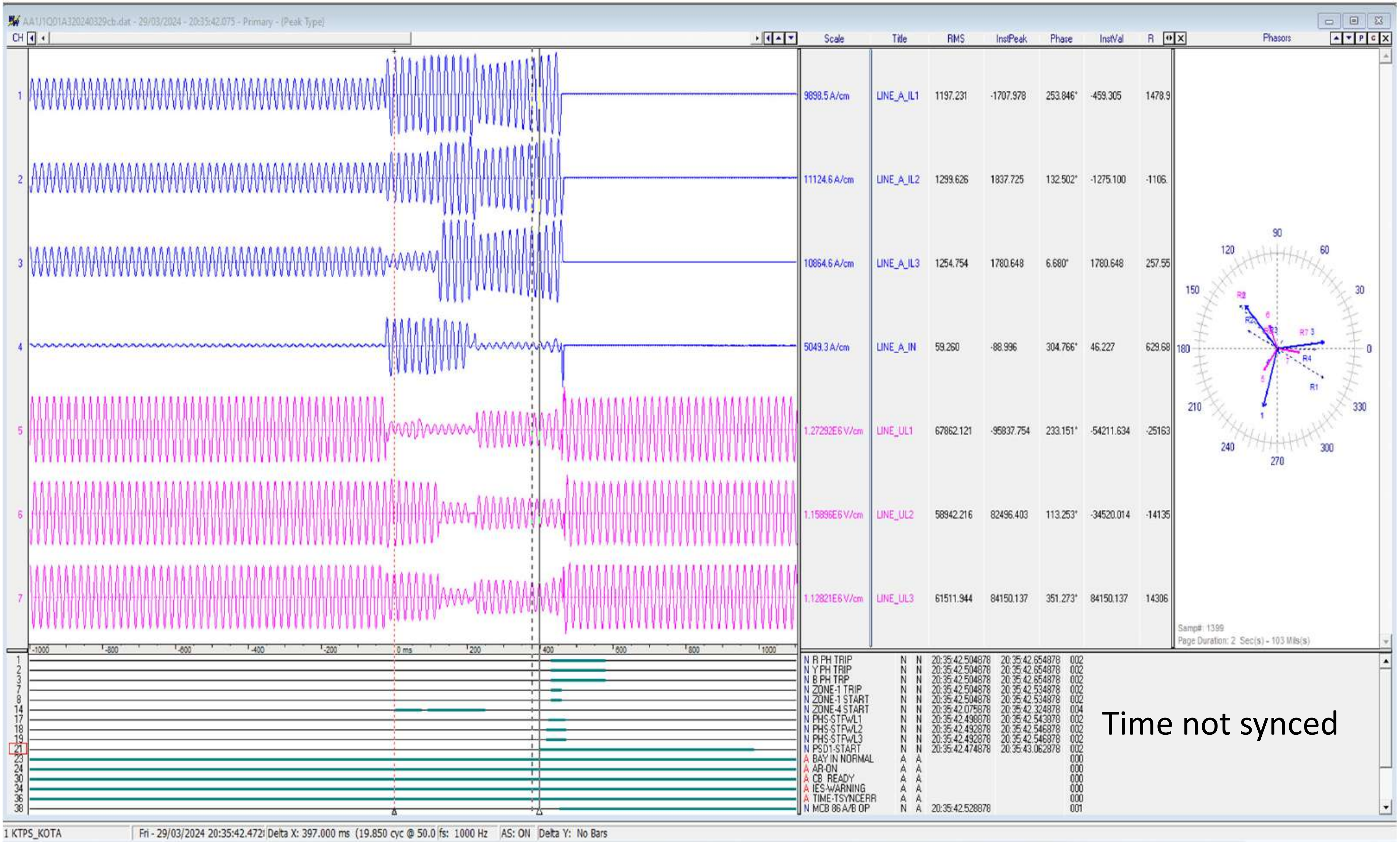


DR of 220kV KTPS(end)-Beawar ckt



After ~350msec of R-N fault, power swing blocking operated and ~600msec of R-N fault, line tripped on Z-1 distance protection operation.

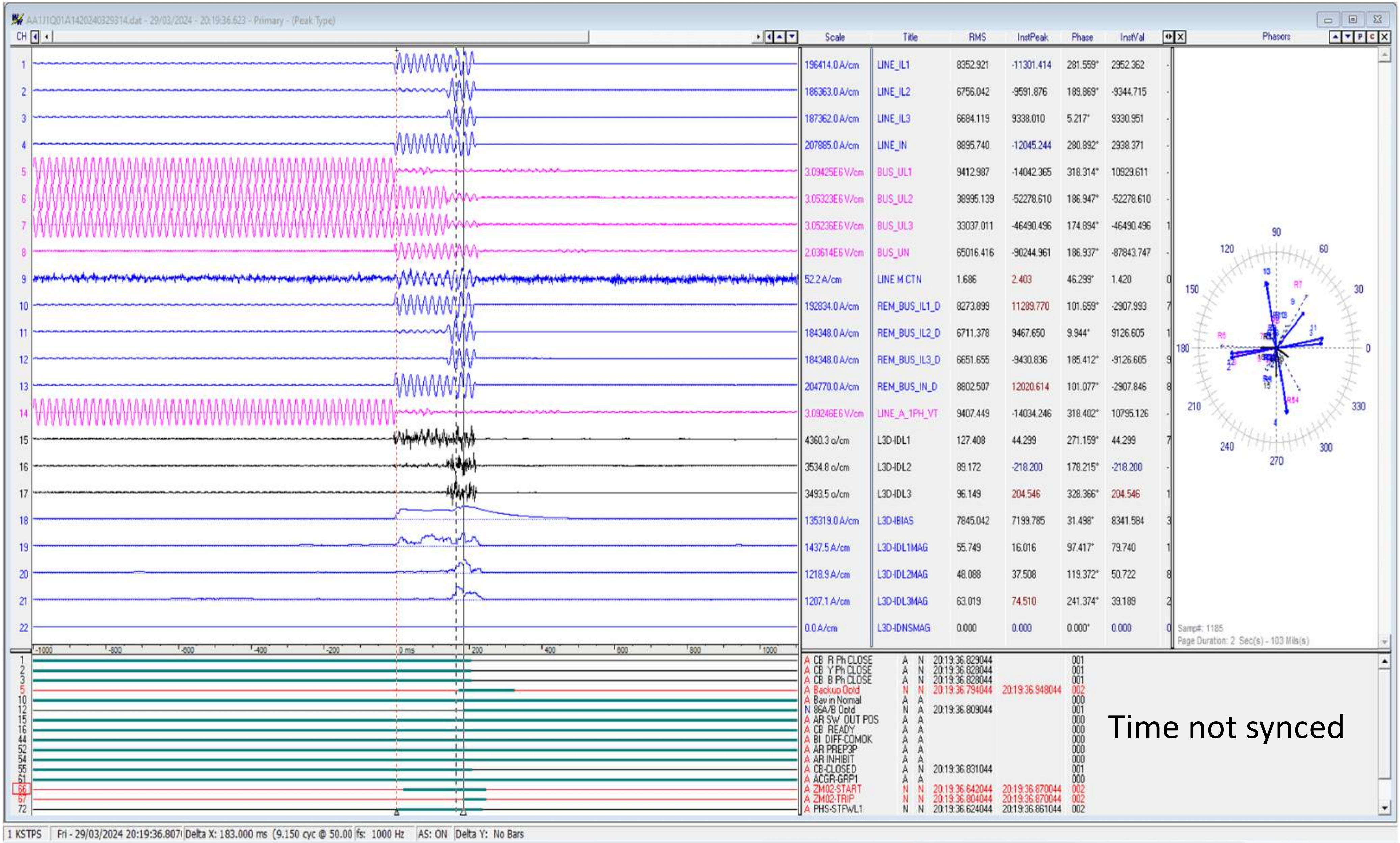
DR of 220kV KTPS(end)-Heerapura ckt



Time not synced

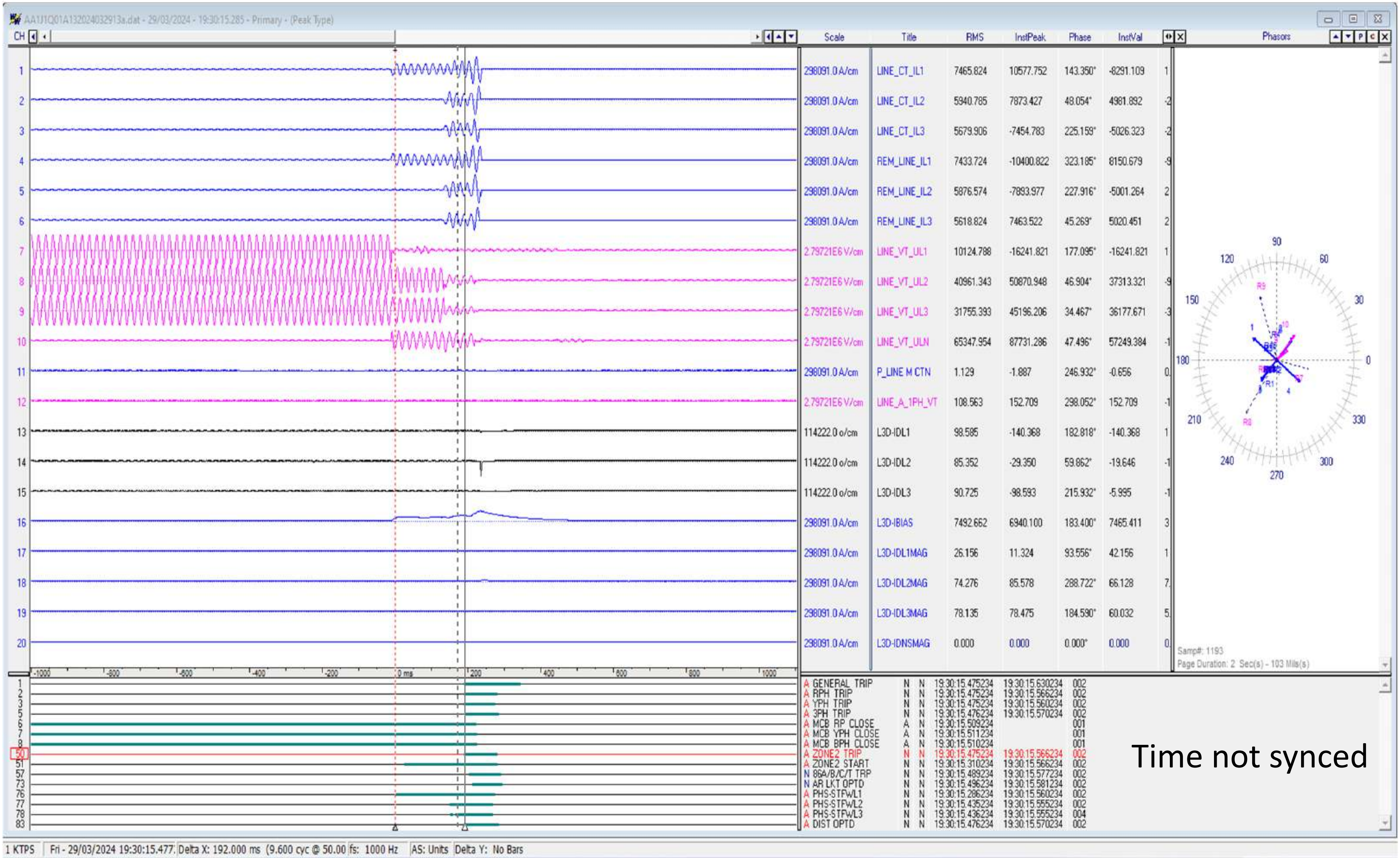
After ~400msec of R-N fault, power swing blocking operated and ~430msec of R-N fault, line tripped on Z-1 distance protection operation.

DR of 220kV KTPS(end)-Kota Sakatpura ckt-1



After ~20msec of R-N fault, distance protection sensed fault in Z-2 and after ~200msec of R-N fault, line tripped on Z-2 distance protection operation.

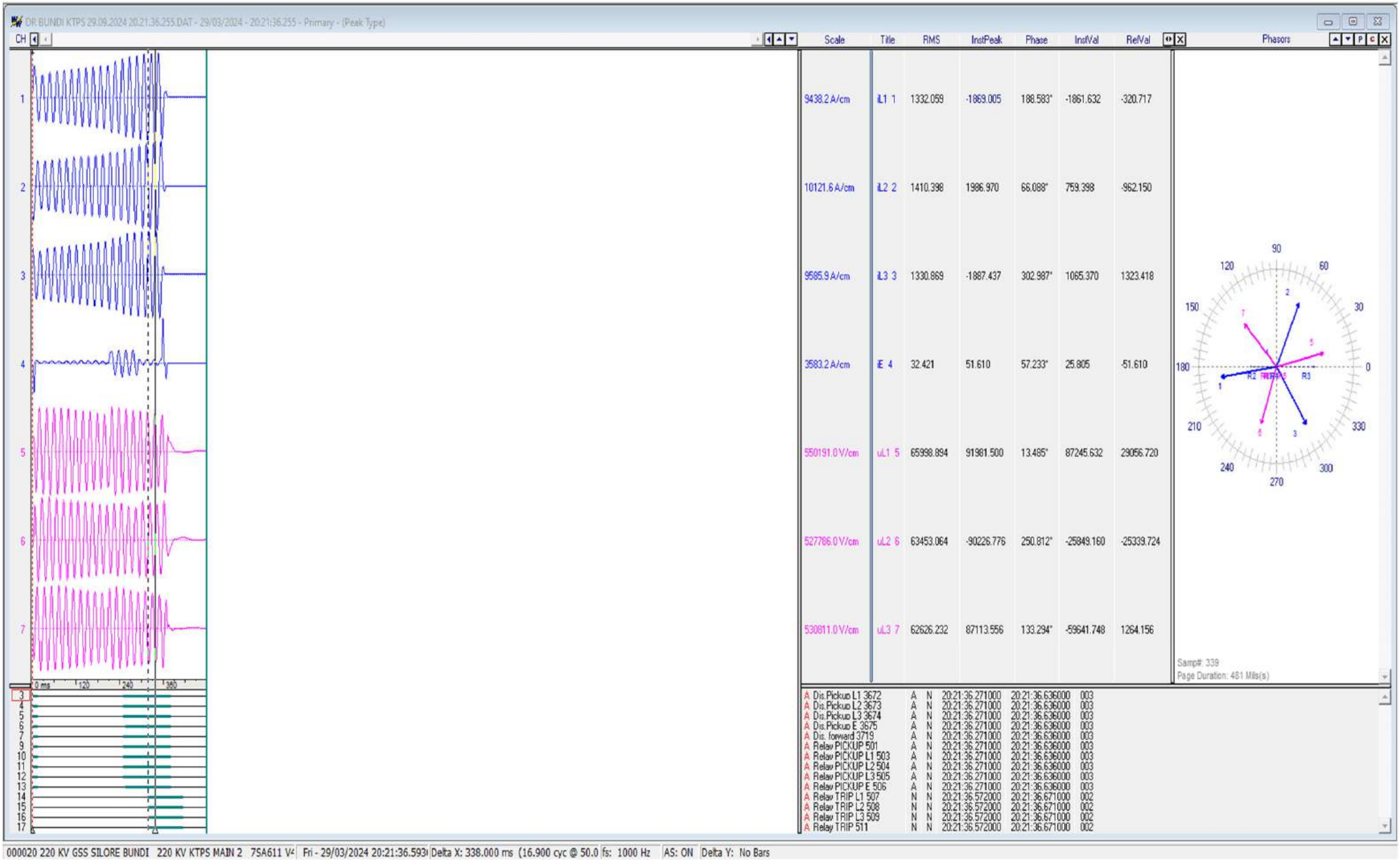
DR of 220kV KTPS(end)-Kota Sakatpura ckt-3



Time not synced

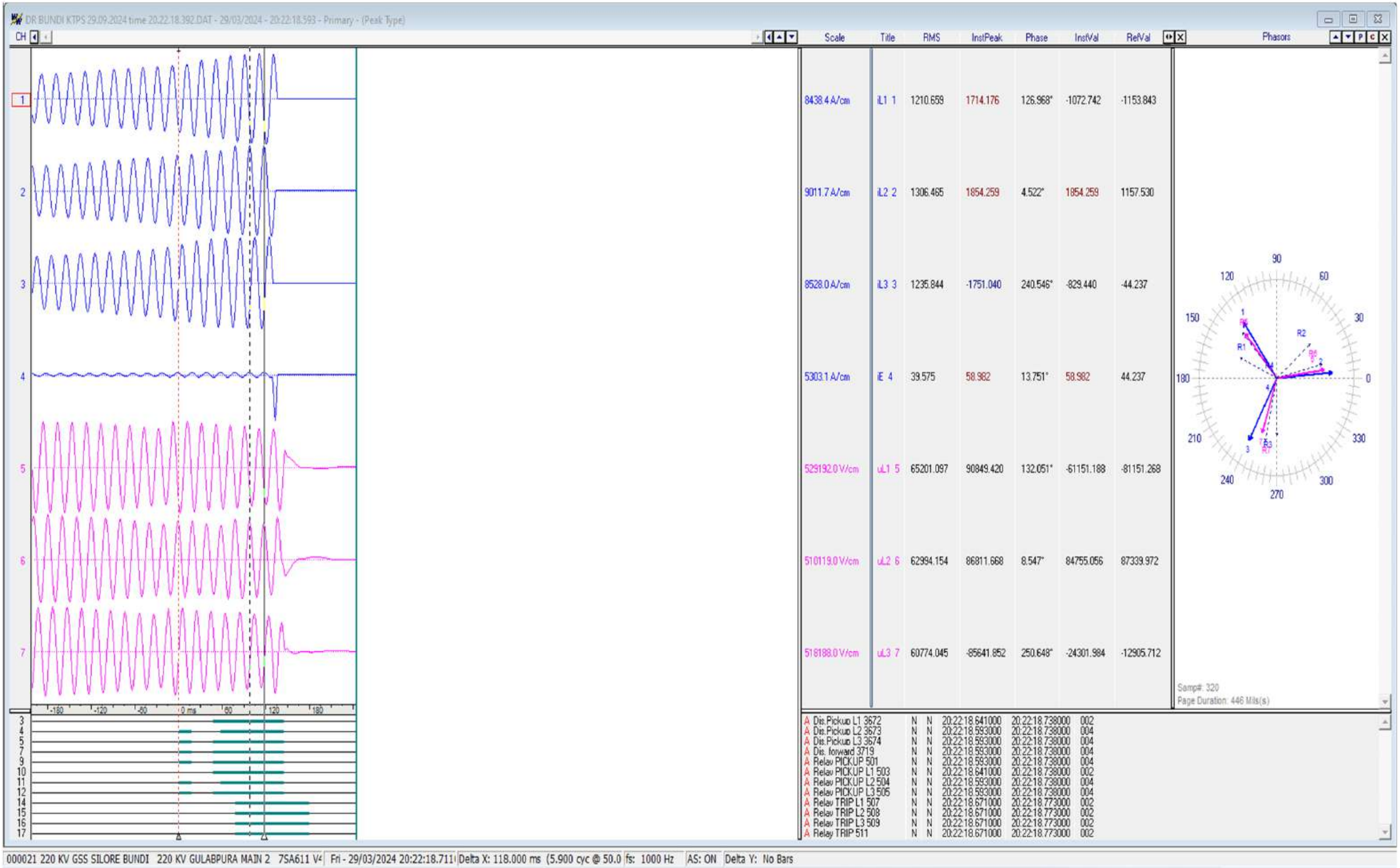
After ~20msec of R-N fault, distance protection sensed fault in Z-2 and after ~200msec of R-N fault, line tripped on Z-2 distance protection operation.

DR of 220kV KTPS-Bundi(end) ckt



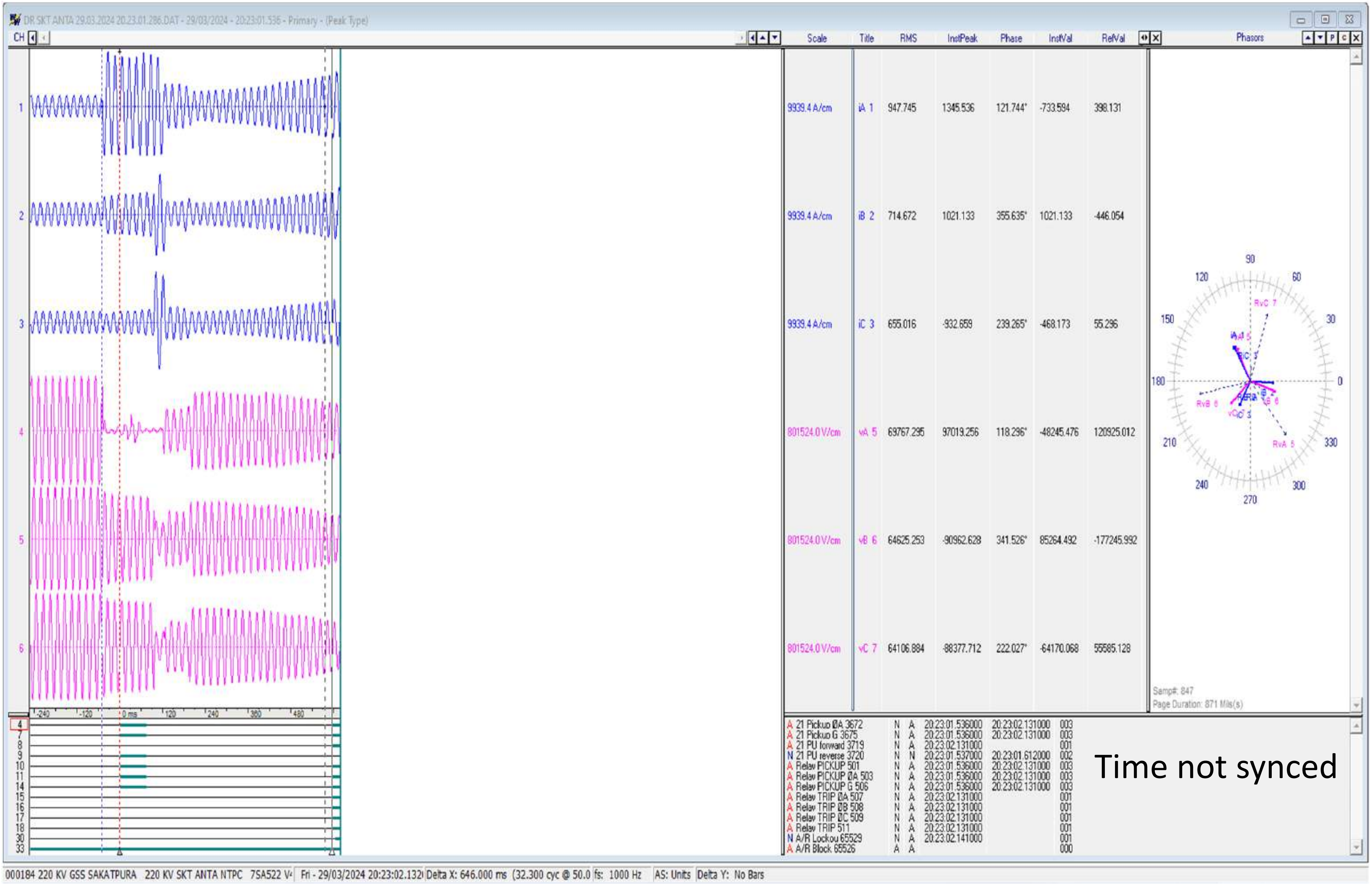
After ~550msec of R-N fault detection, line tripped on distance protection operation; phase currents in the range of 1330-1410A.

DR of 220kV Bundi(end)-Gulabpura ckt



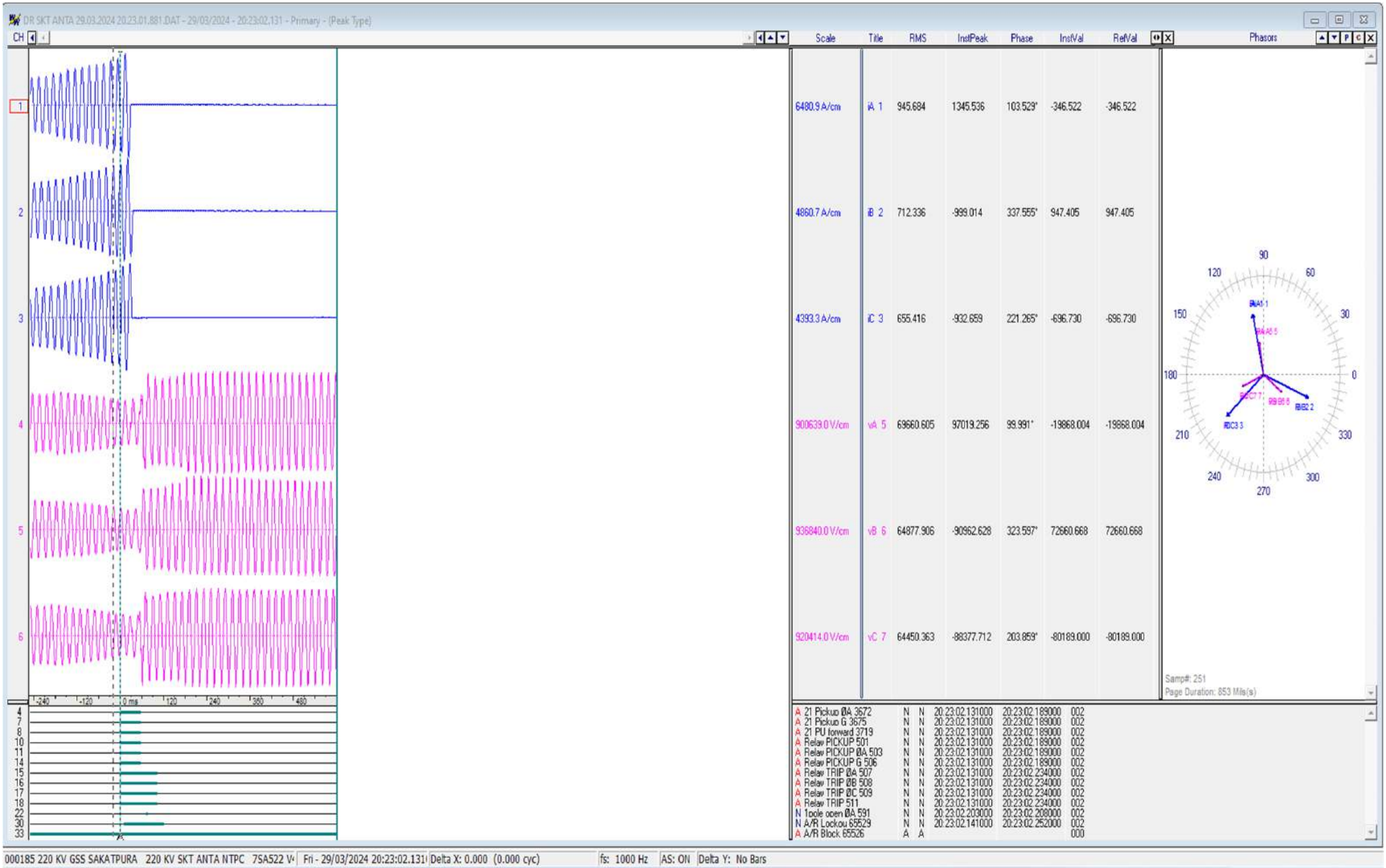
Line tripped on distance protection operation; phase currents in the range of 1200-1300A.

DR of 220kV Kota Sakatpura(end)-Anta ckt



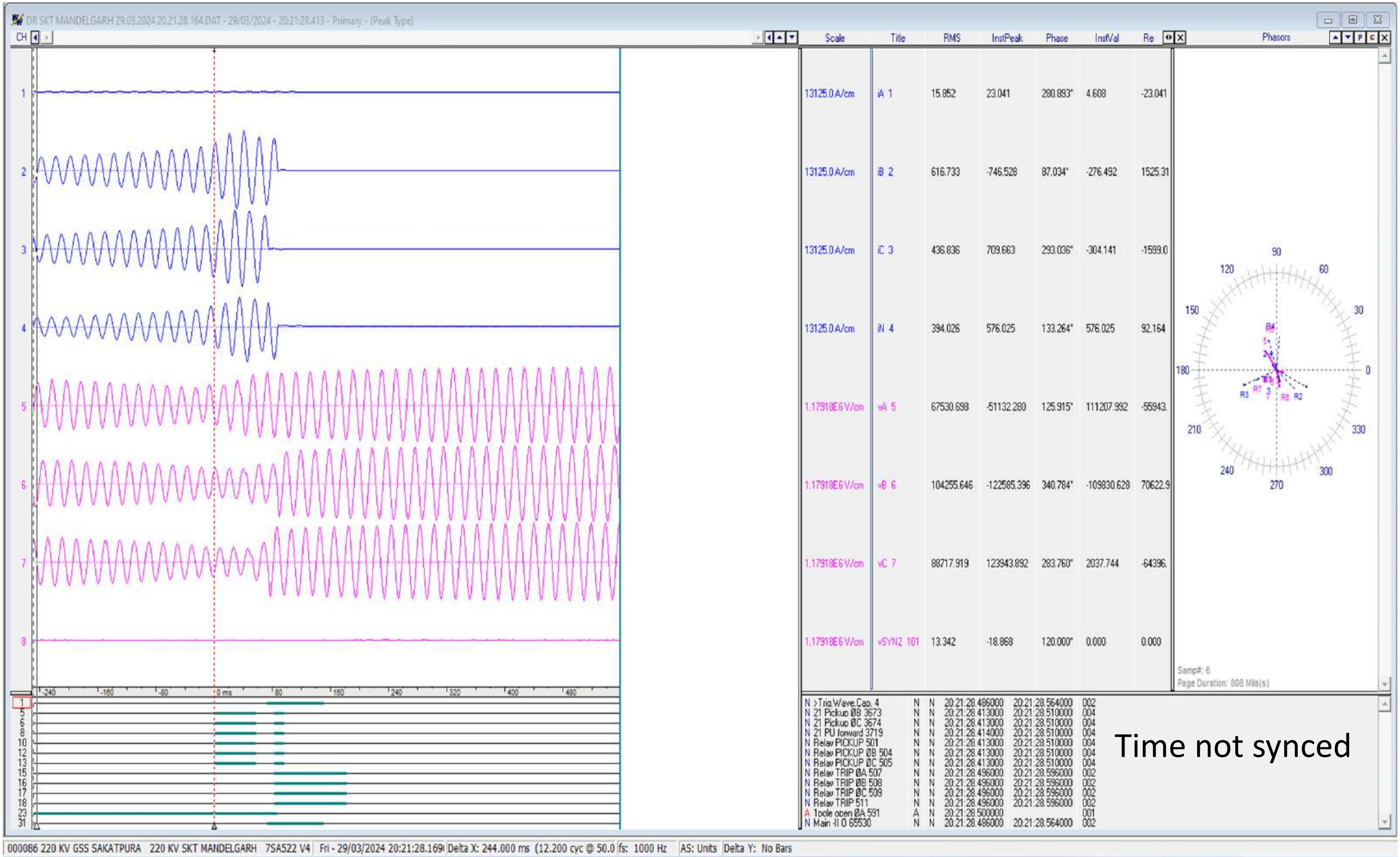
Sensed fault in Z-4 and reset and after ~650msec of R-N fault, line tripped on distance protection operation.

DR of 220kV Kota Sakatpura(end)-Anta ckt



Sensed fault in Z-4 and reset and after ~650msec of R-N fault, line tripped on distance protection operation.

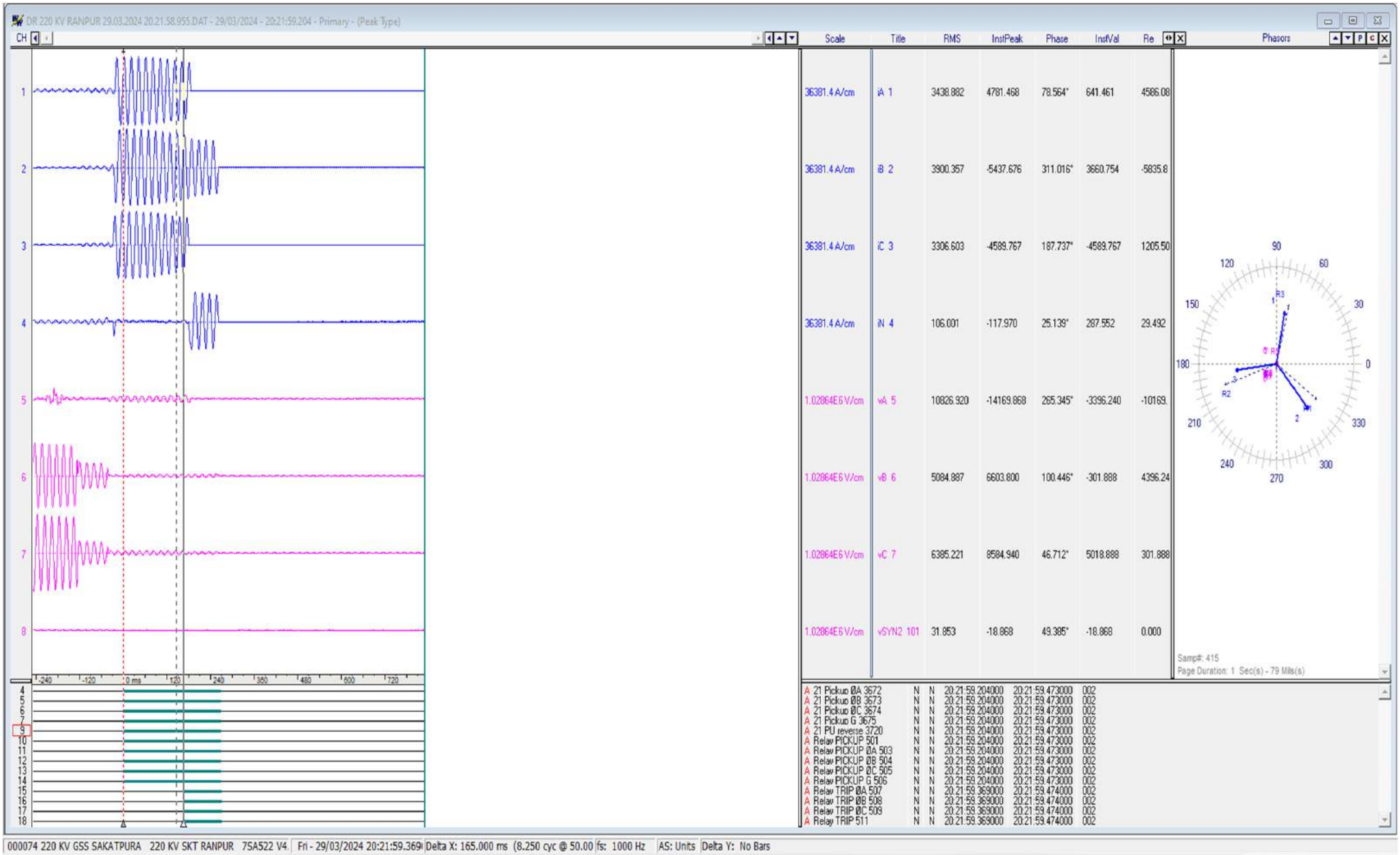
DR of 220kV Kota Sakatpura(end)-Mandalgarh ckt



Time not synced

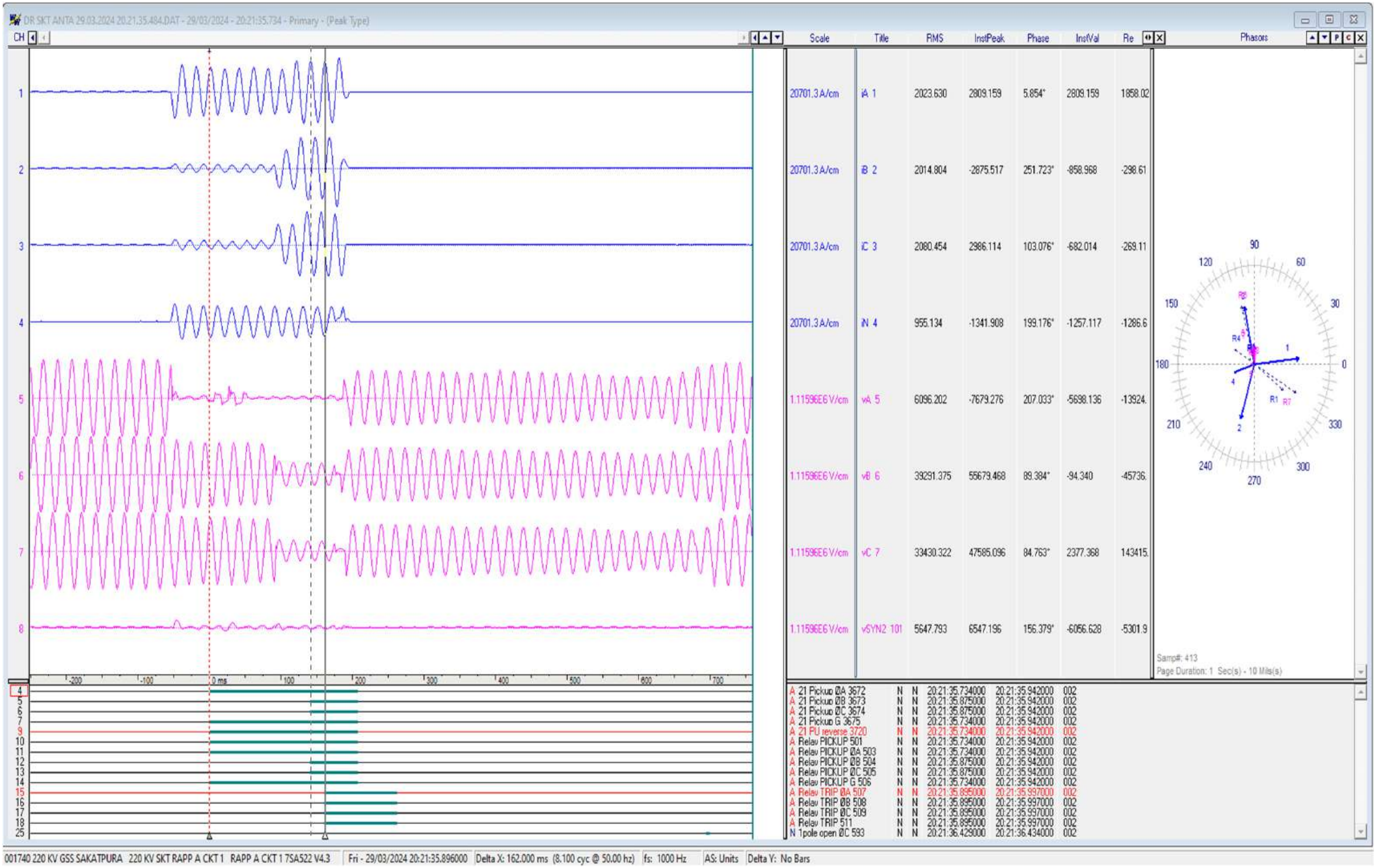
R-ph pole tripping followed by 3-ph trip observed.

DR of 220kV Kota Sakatpura(end)-Ranpur ckt



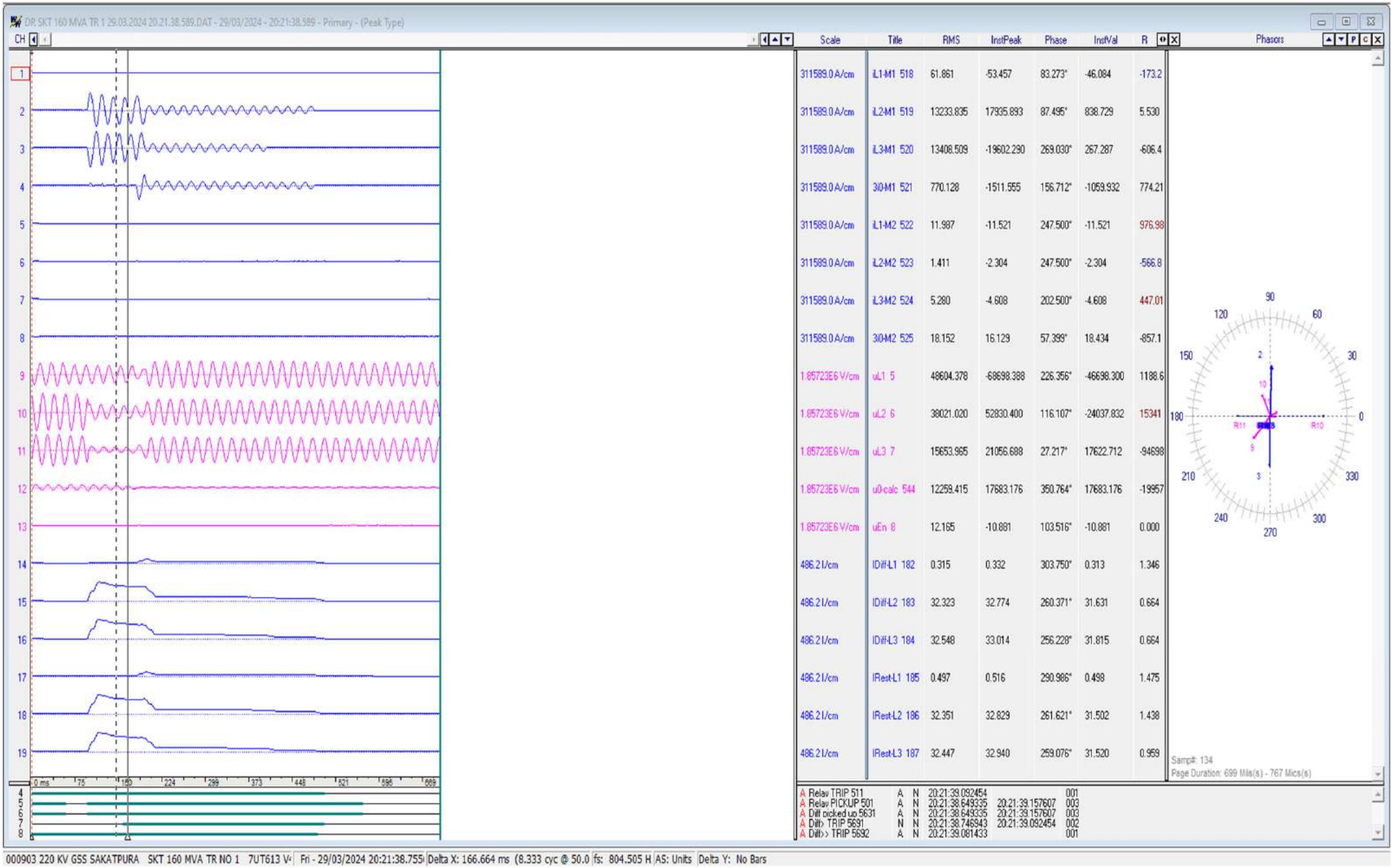
Fault sensed in Z-4, 3-ph trip after ~160msec of fault is observed.

DR of 220kV Kota Sakatpura(end)-RAPS-A ckt-1



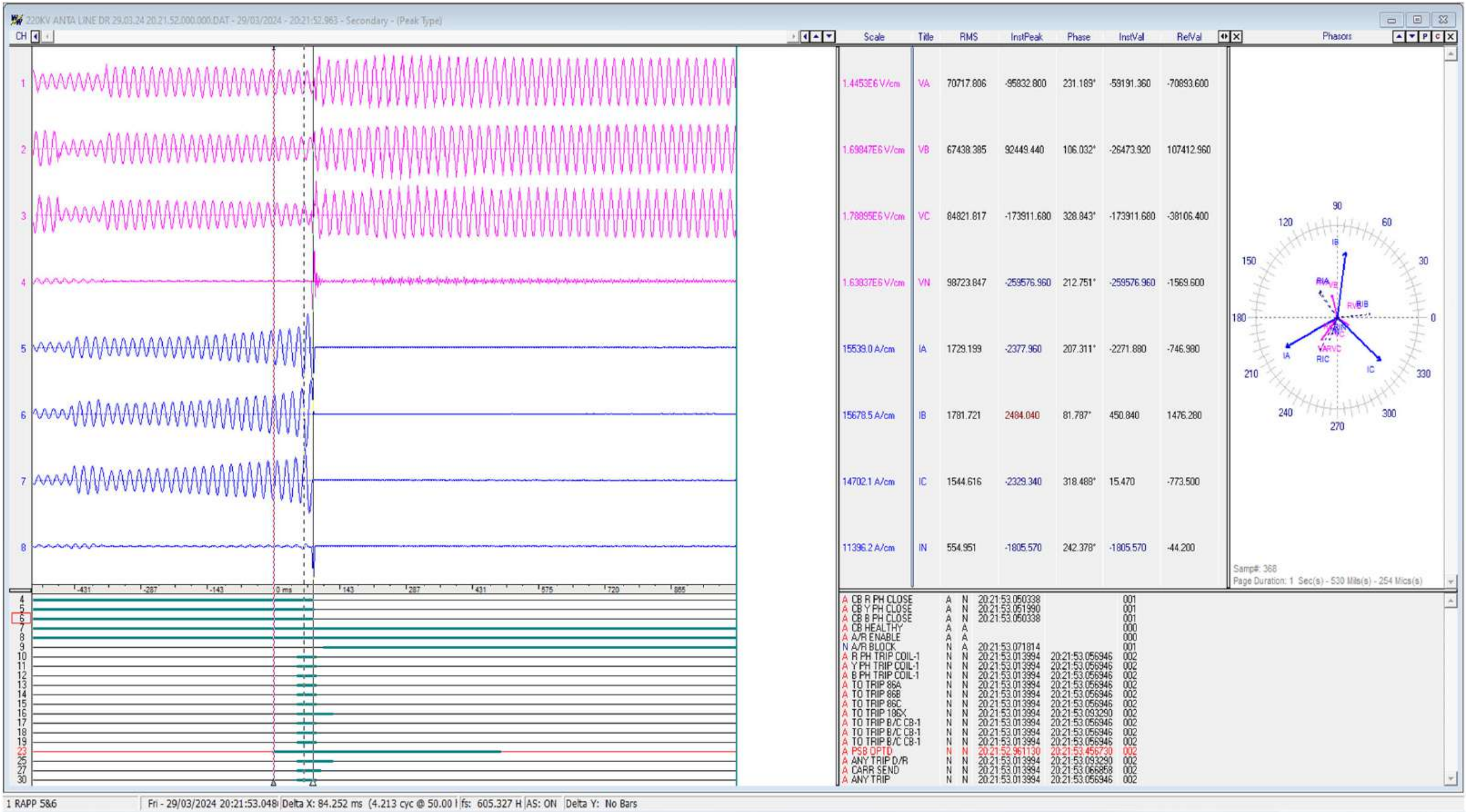
Fault sensed in Z-4, 3-ph trip after ~160msec of fault is observed.

DR of 220/132kV ICT-1 at Kota Sakatpura



Differential protection operated

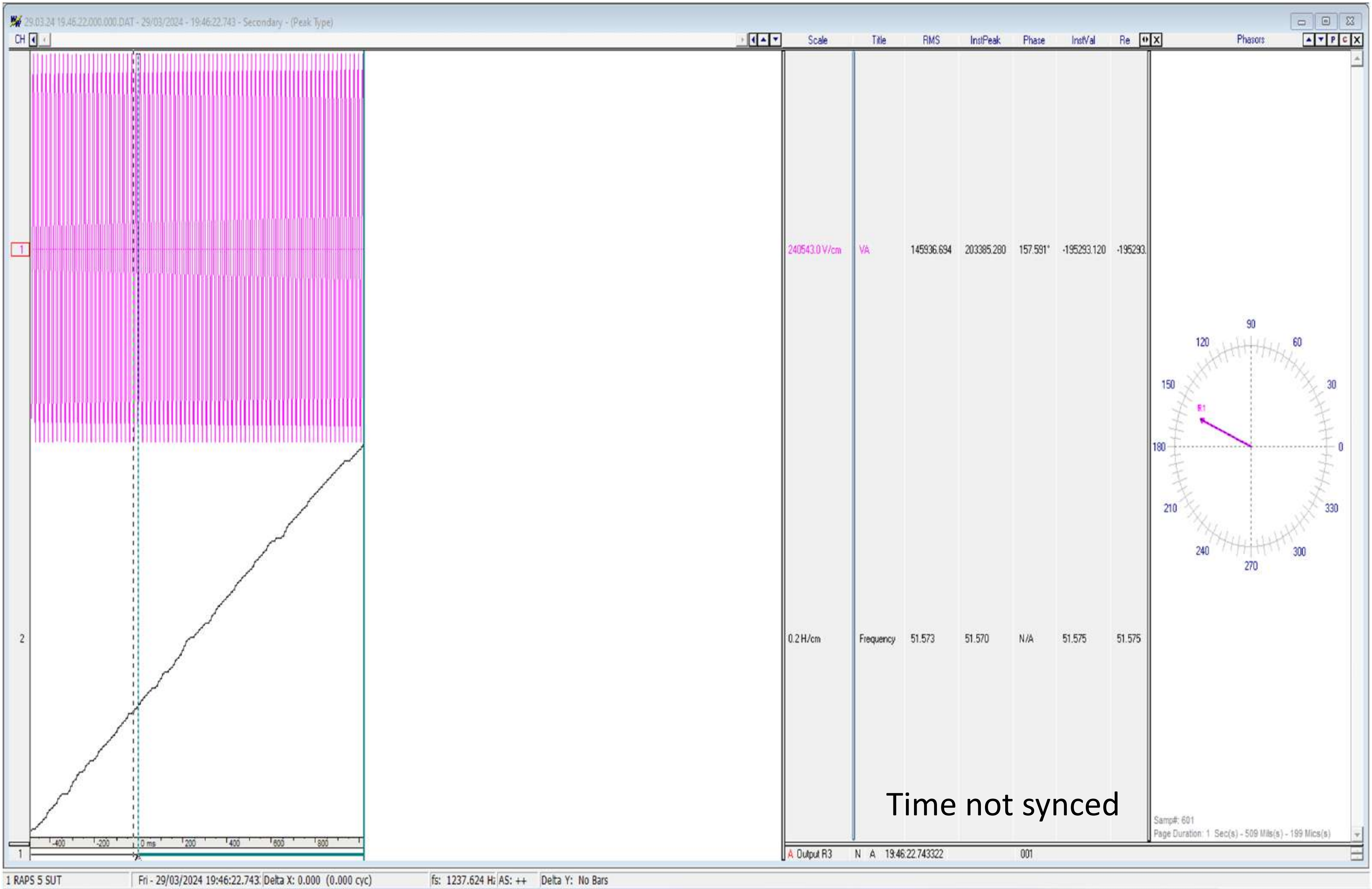
DR of 220kV RAPS_C(end)-Anta ckt



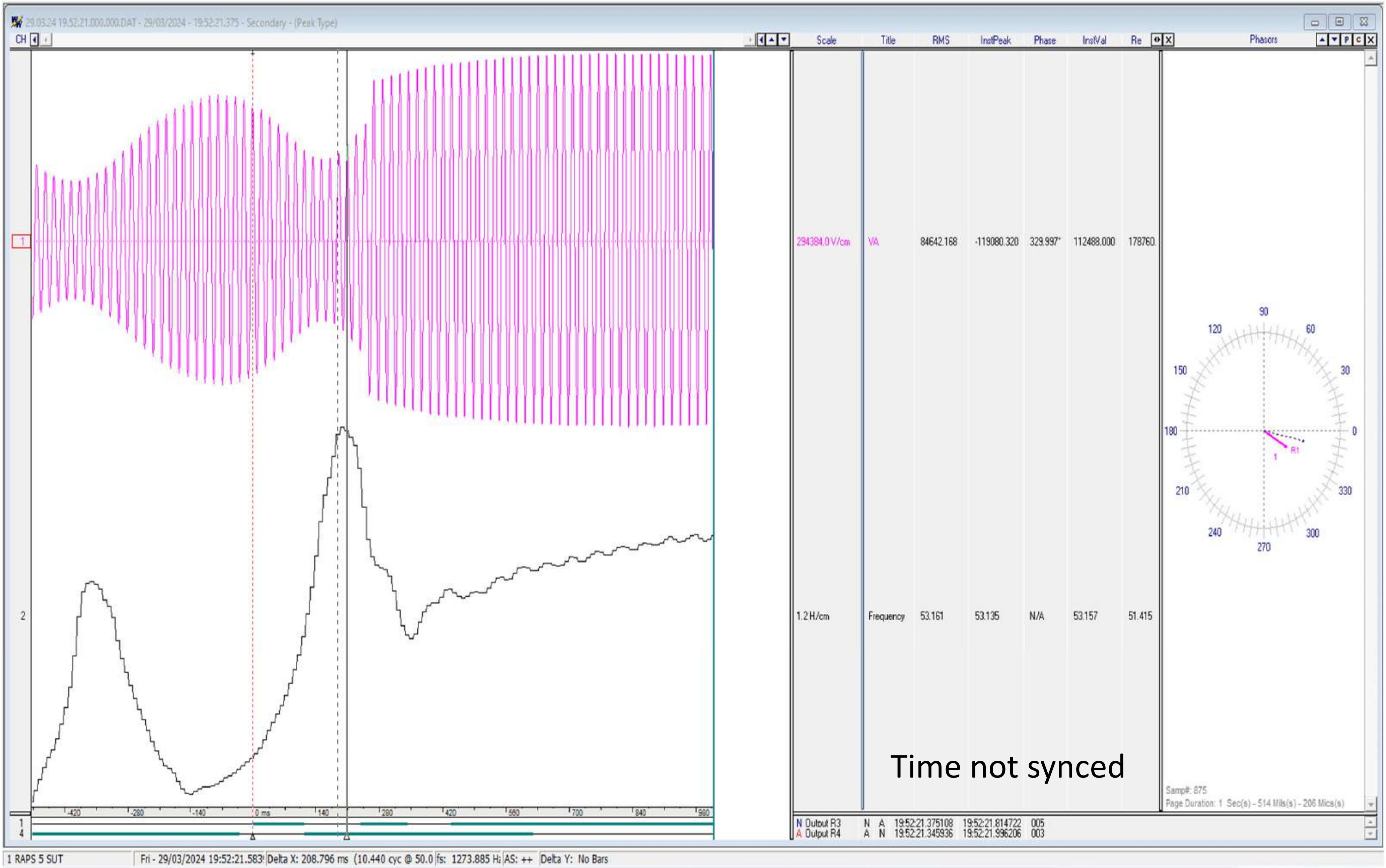
Phase currents:

- At 20:21:52:519 hrs: ~270-290A (~106MW)
- At 20:21:52:962 hrs: Power swing blocking operated: ~900-1000A (~350MW)
- At 20:21:53:048 hrs: ~1600-1800A (~650MW); breaker opened; Z-1 distance protection operated

DR of SUT-5 at RAPP-B

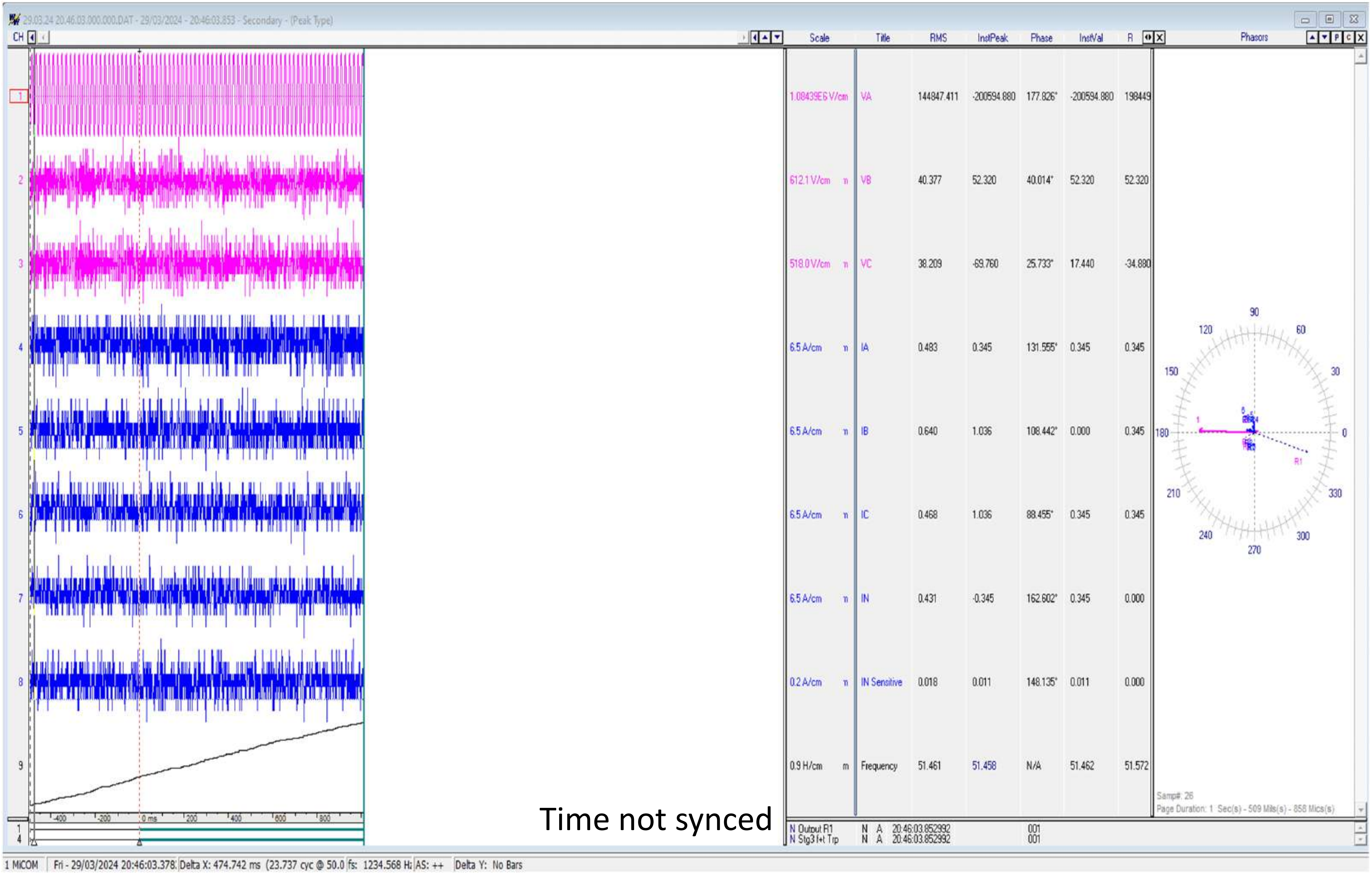


DR of SUT-5 at RAPP-B

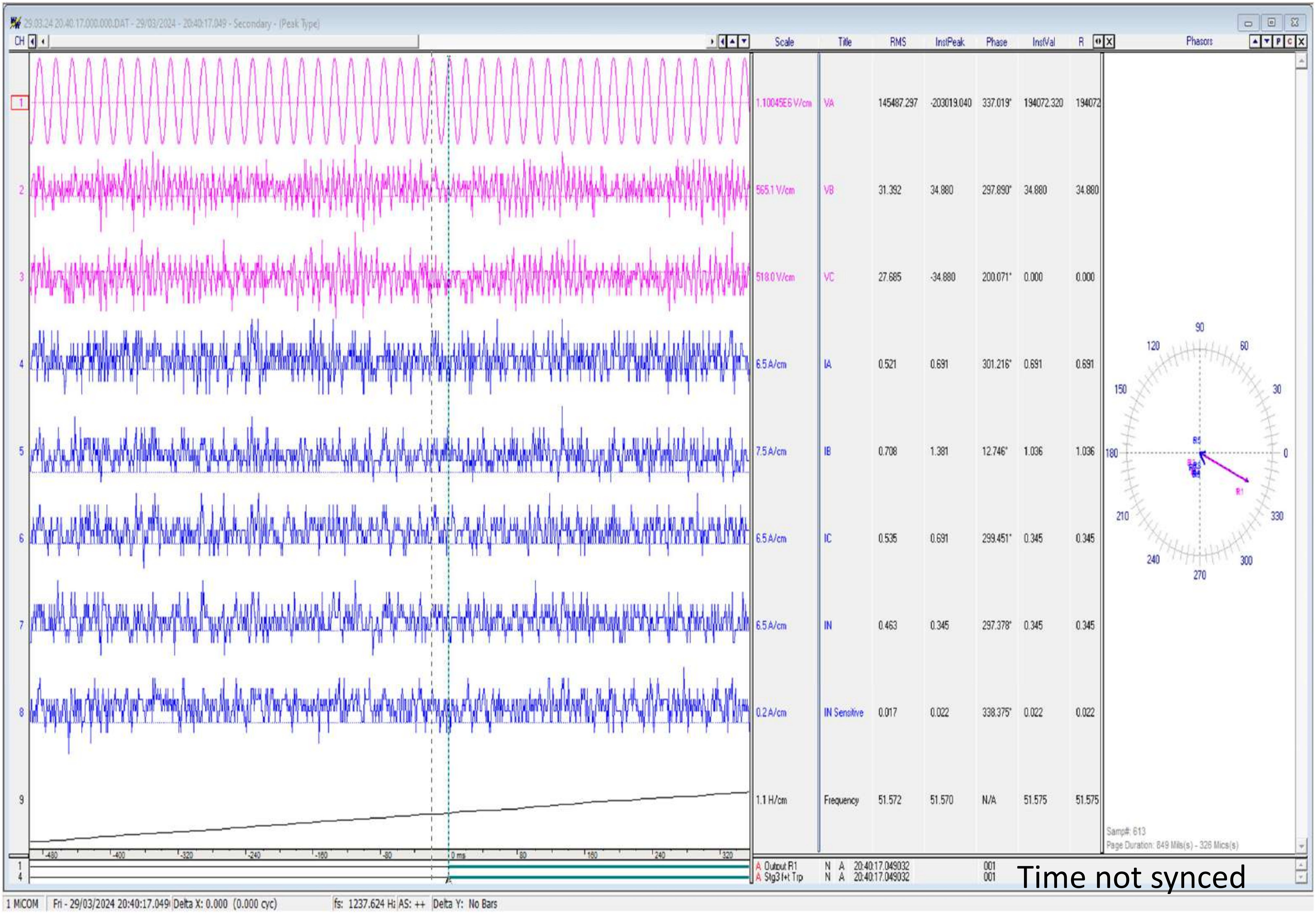


Max. frequency recorded:53.15Hz

DR of SUT-6 at RAPP-B



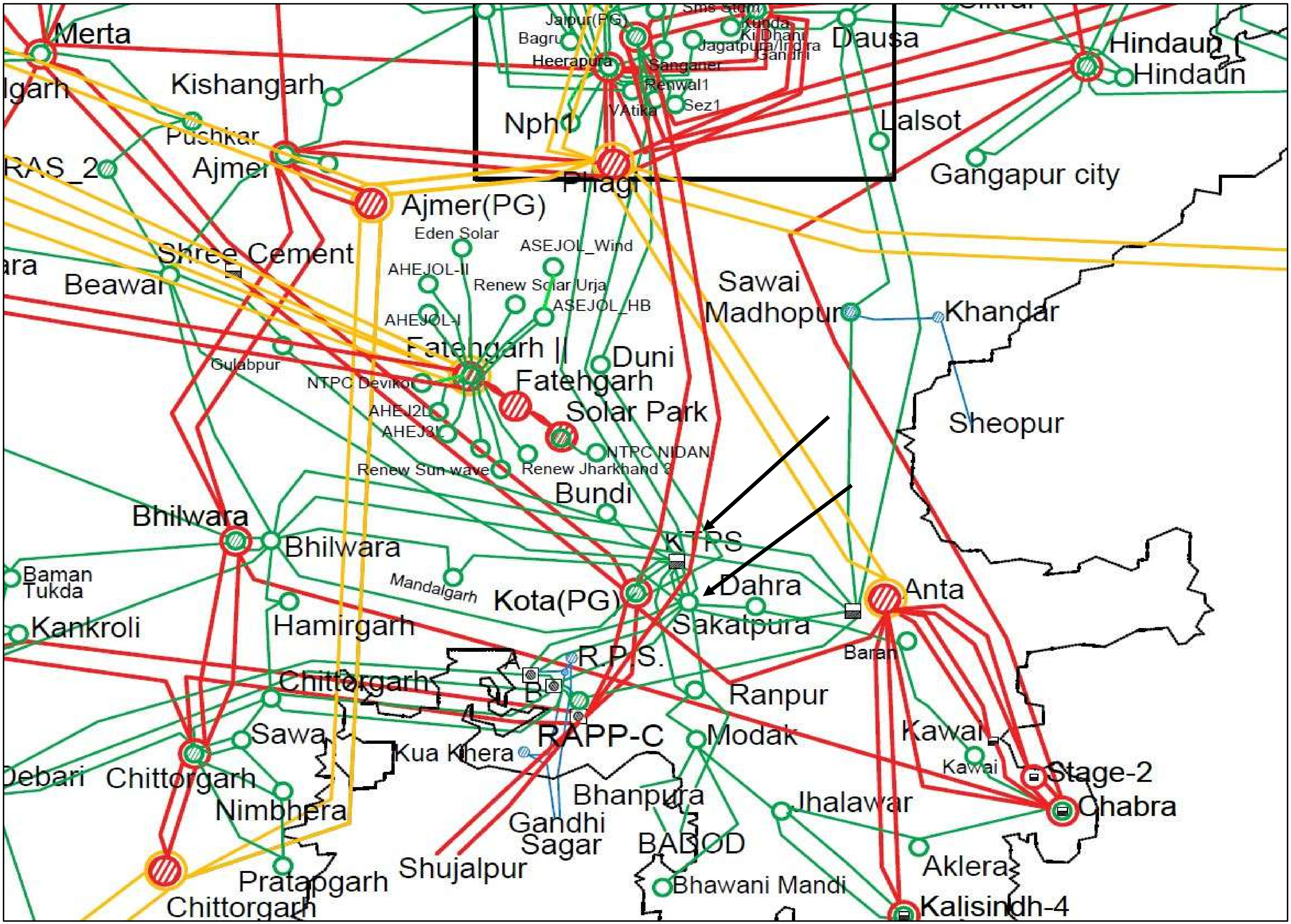
DR of SUT-6 at RAPP-B



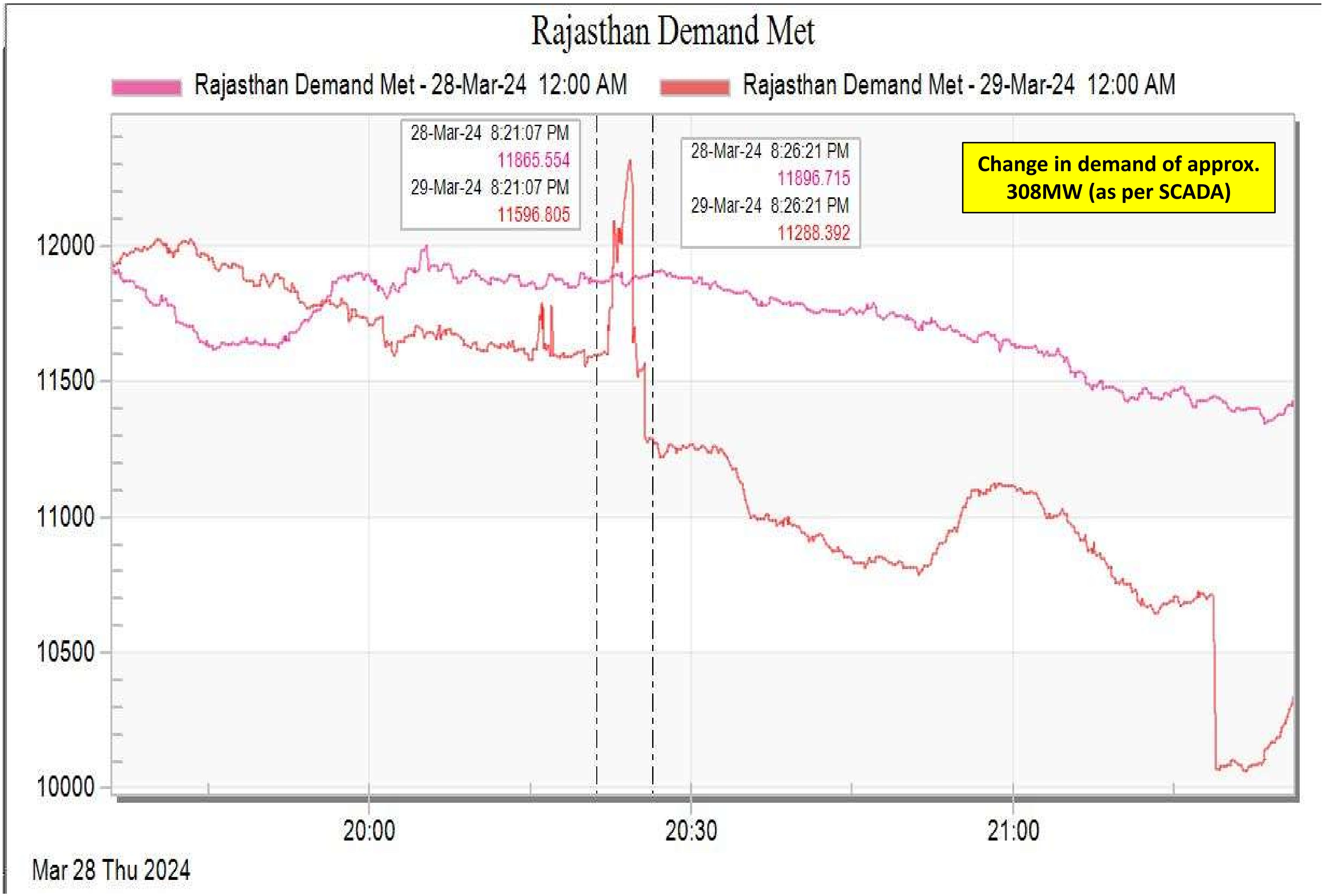
SCADA SOE

Time	Station Name	Voltage	Element	Element Type	Element Status	Remarks
20:21:51,605	KTPS	220kV	08KOTAS1	Circuit Breaker	Open	Line CB at KTPS end of 220kV KTPS-Sakatpura ckt-1
20:21:51,942	BUND2_R	220kV	04GULAB	Circuit Breaker	Open	Line CB at Bundi end of 220kV Bundi-Gulabpura ckt
20:21:51,953	BUND2_R	220kV	03KTPS	Circuit Breaker	Open	Line CB at Bundi end of 220kV Bundi-KTPS ckt opened
20:21:52,090	MANDL_R	220kV	02KOTAPG	Circuit Breaker	Open	Line CB at Manadalgarh end of 220kV Kota Sakatpura-
20:21:52,796	KTPS	220kV	10U2	Circuit Breaker	Open	KTPS Unit-2 CB opened
20:21:52,897	RANPR_R	220kV	04KOTAS	Circuit Breaker	disturbe	Line CB at Ranpur end of 220kV Kota Sakatpura-Ranpur
20:21:53,107	RAPP3 4	220kV	08KOTAS	Circuit Breaker	Open	Line CB at RAPS-B end of 220kV RAPS-B-Kota Sakatpura
20:21:58,259	KTPS	220kV	12U3	Circuit Breaker	Open	KTPS Unit-3 CB opened
20:21:58,685	KOTA	132kV	20DADAB	Circuit Breaker	Open	
20:21:58,685	KOTA	220kV	09RAPP1	Circuit Breaker	Open	Line CB at Kota Sakatpura end of 220kV RAPS-A-Kota
20:21:58,685	KOTA	220kV	18ANTA	Circuit Breaker	Open	Line CB at Kota Sakatpura end of 220kV Kota Sakatpura-
20:21:58,685	KOTA	132kV	17T1	Circuit Breaker	Open	
20:21:58,685	KOTA	220kV	16MBC	Circuit Breaker	Open	
20:21:58,685	KOTA	220kV	07T1	Circuit Breaker	Open	
20:21:58,685	KOTA	220kV	10MBC	Circuit Breaker	Open	
20:21:58,685	KOTA	220kV	13BS	Circuit Breaker	Open	
20:21:59,972	KOTA	132kV	07BS	Circuit Breaker	Open	
20:22:08,354	RPS	132kV	10U4	Circuit Breaker	Open	
20:22:09,249	RAPP3 4	220kV	07SUTR4	Circuit Breaker	Open	
20:22:09,858	RAPP3 4	220kV	06G4	Circuit Breaker	Open	

Network Diagram

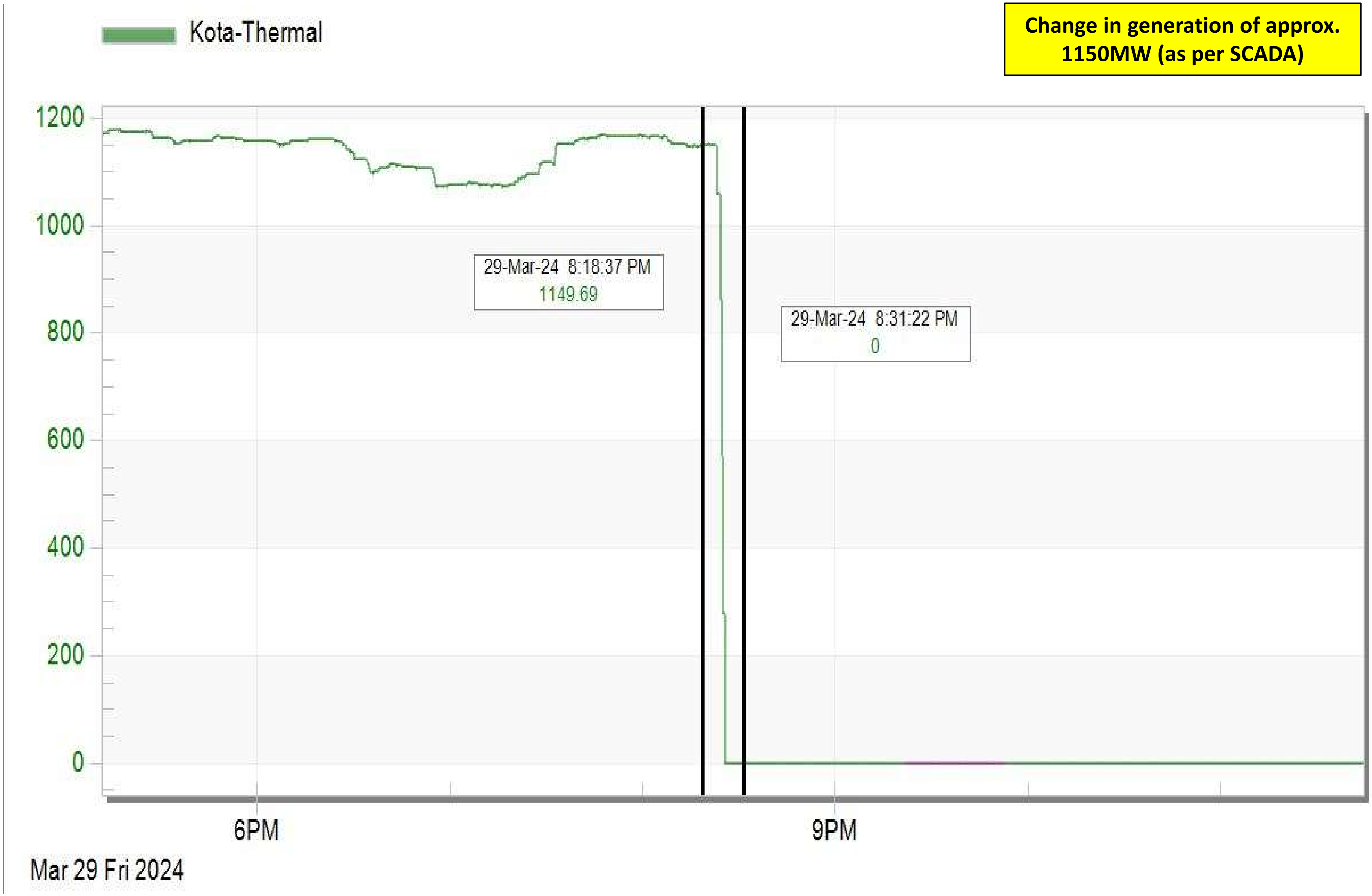


Rajasthan demand during the event

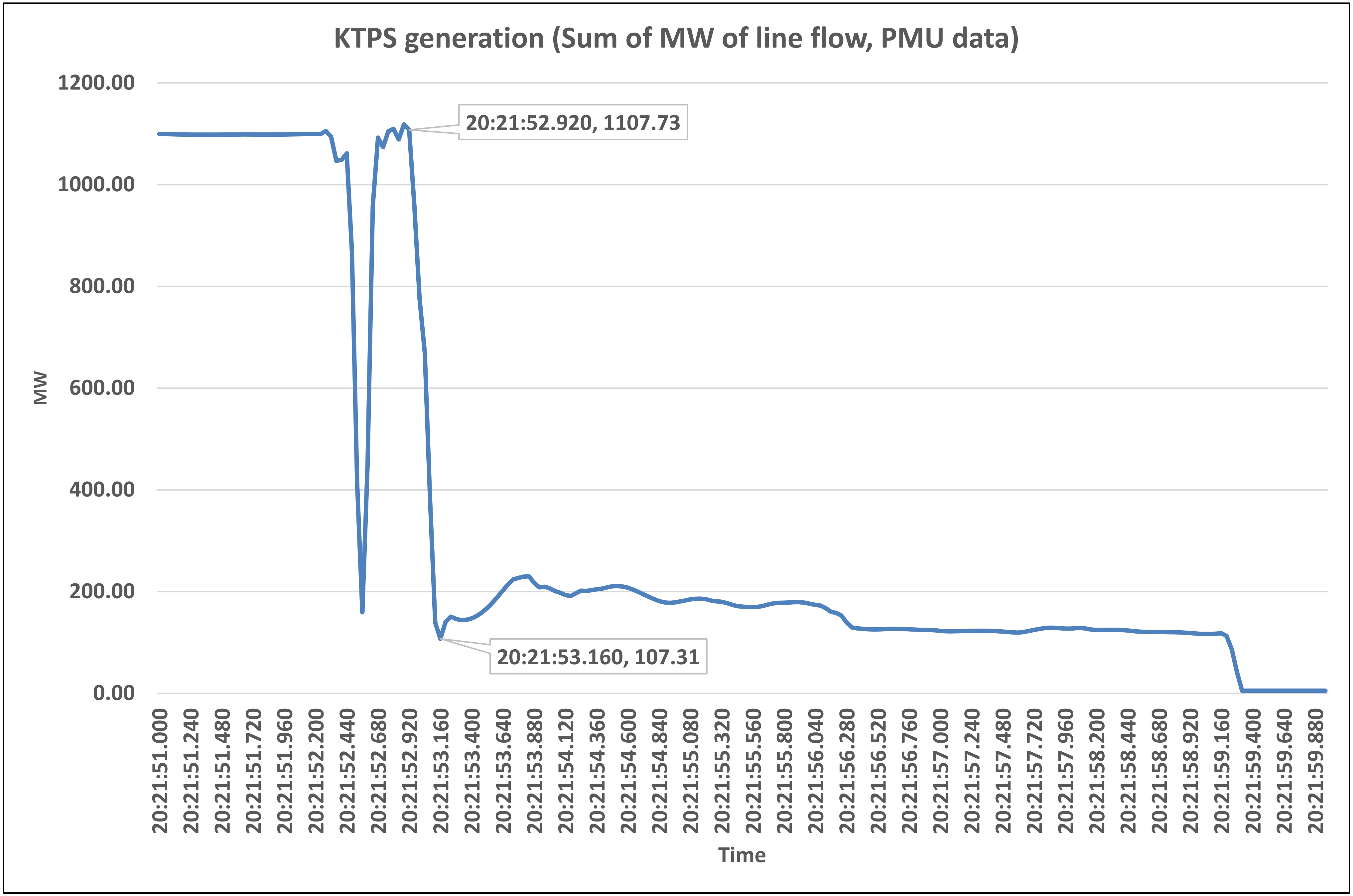


KTPS generation during the event(SCADA data)

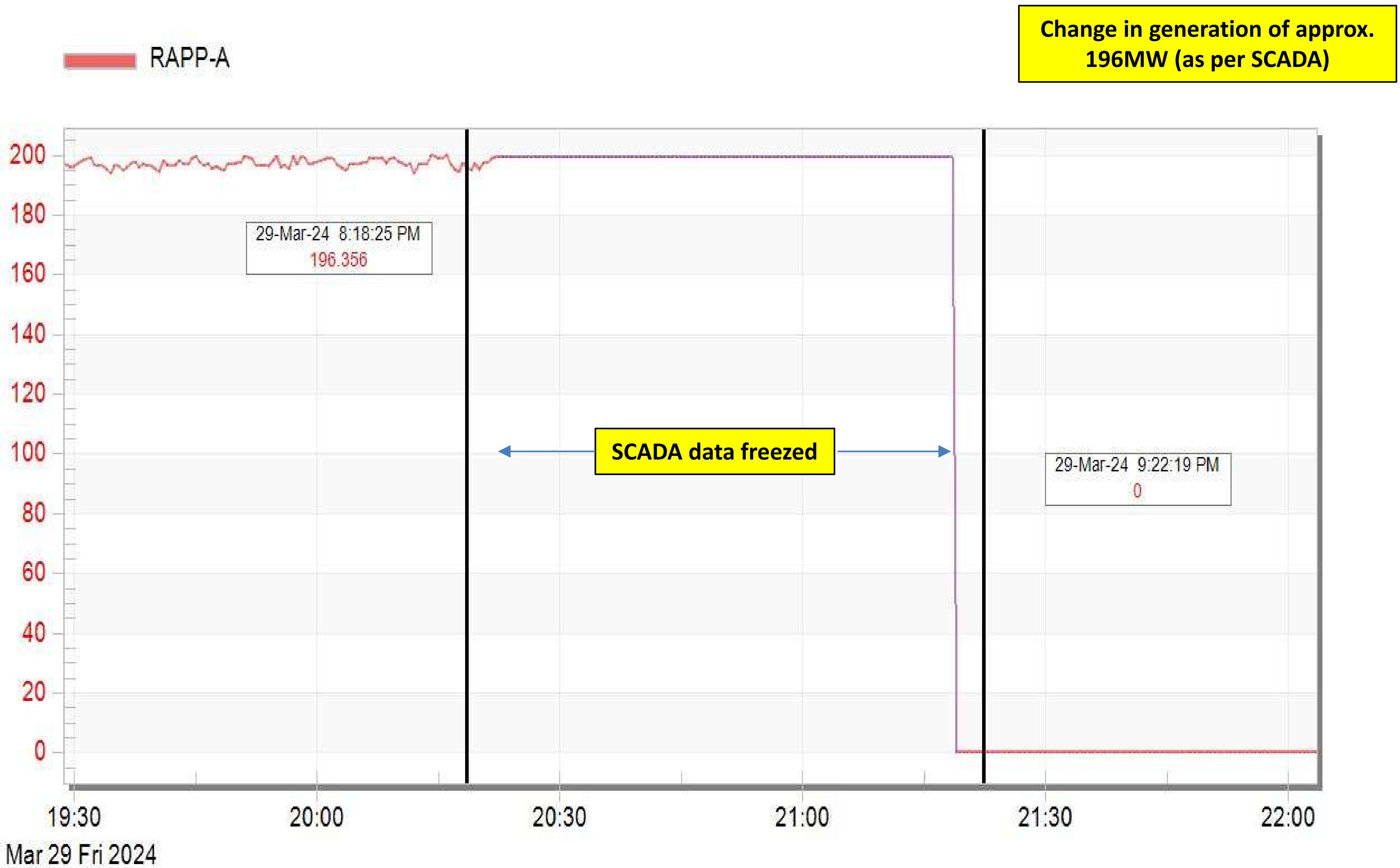
Change in generation of approx. 1150MW (as per SCADA)



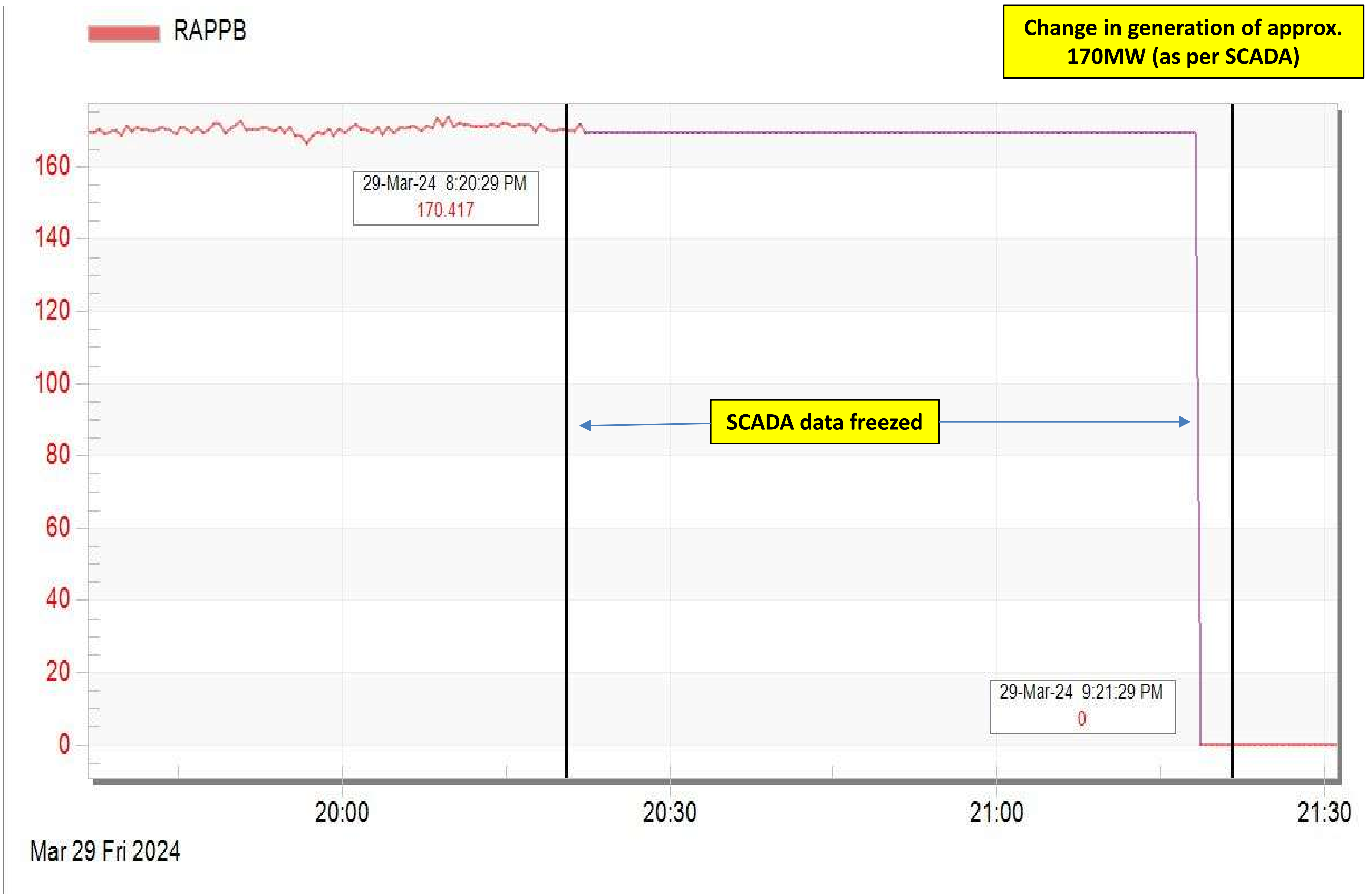
KTPS generation during the event (PMU data)



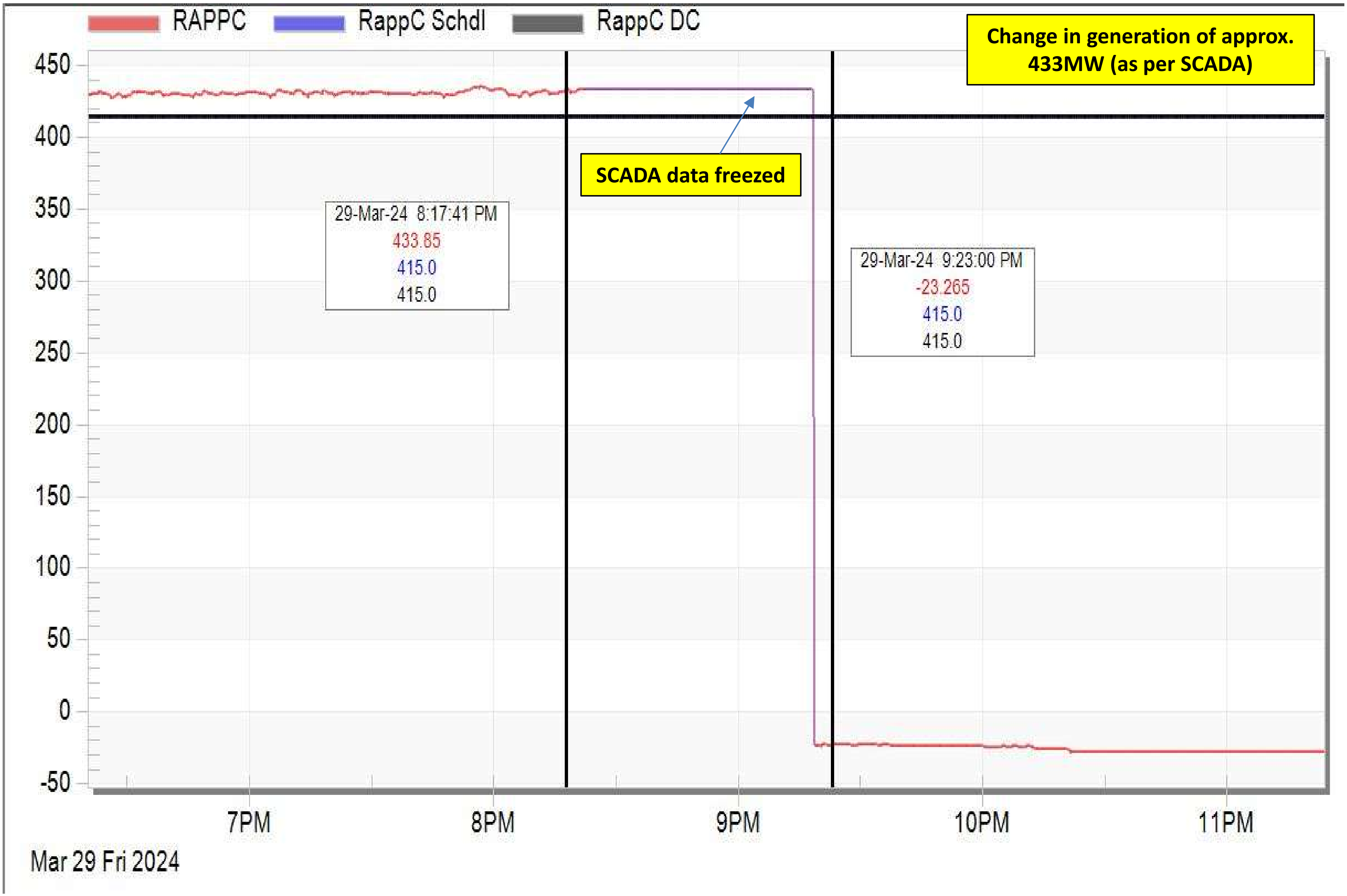
RAPP-A(NP) generation during the event



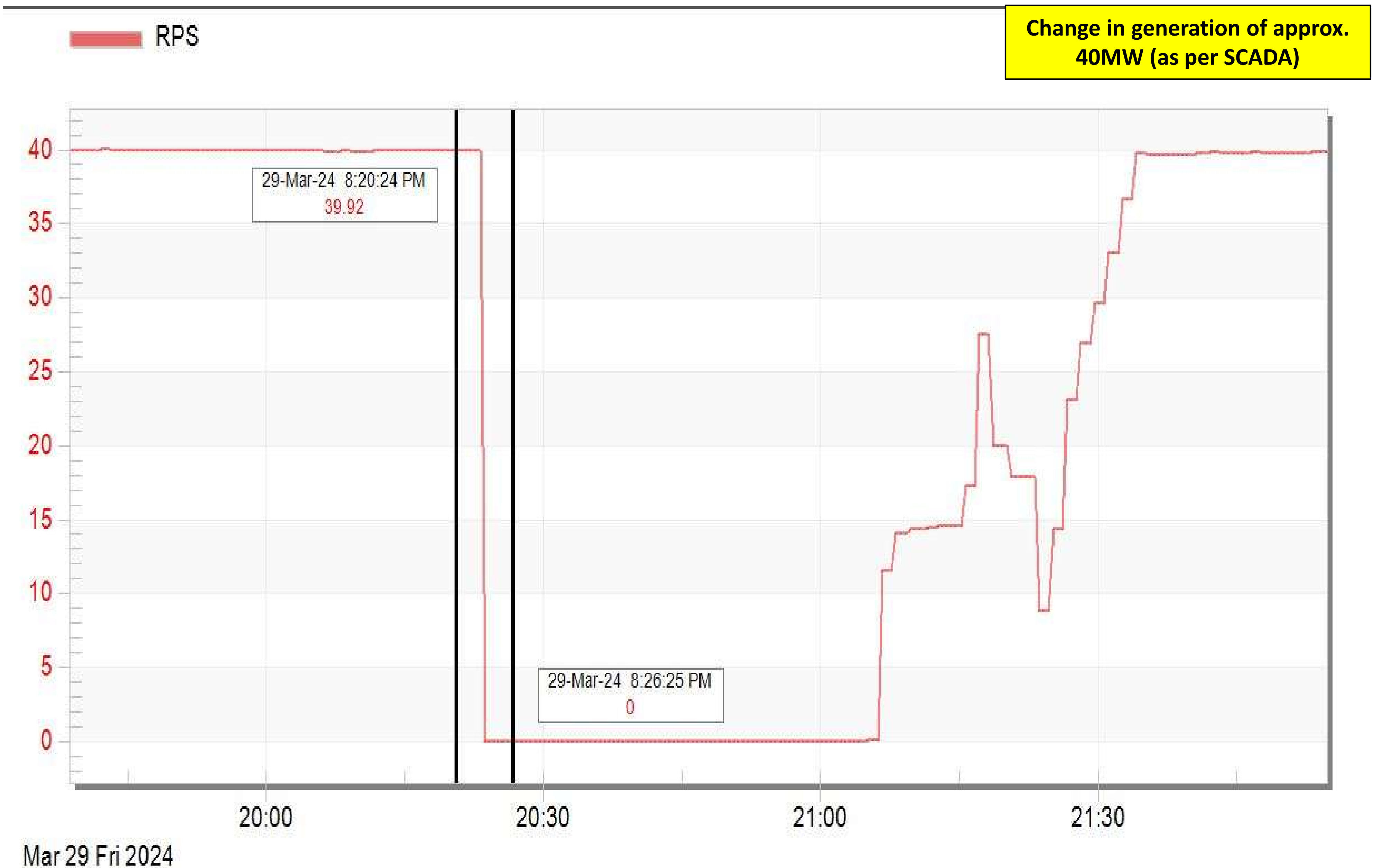
RAPP-B(NP) generation during the event



RAPP-C(NP) generation during the event



RPS HEP generation during the event



Jawahar Sagar HEP generation during the event

Change in generation of approx. 32MW (as per SCADA)